DECEMBER 2021

UKIAH VALLEY BASIN GROUNDWATER SUSTAINABILITY AGENCY

Ukiah Valley Groundwater Sustainability Plan

FINAL REPORT

UKIAH VALLEY BASIN GROUNDWATER SUSTAINABILITY AGENCY
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Ukiah Valley Groundwater Basin
Groundwater Sustainability Plan

Ukiah Valley Basin Groundwater Sustainability Agency
January 12, 2022

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Executive Summary

Abstract

The Sustainable Groundwater Management Act (SGMA), passed by the California legislature in 2014, requires local entities to jointly assess groundwater conditions in their local areas and to develop a Groundwater Sustainability Plan (GSP) by a specified deadline to ensure that sustainable conditions are achieved within 20 years of GSP adoption. An effective and efficient groundwater management plan is critical for the local economy and the health and welfare of the people, the environment, and all other beneficial uses and users of groundwater in a local area.

The Ukiah Valley Basin (Basin) is a medium-priority groundwater basin located in Mendocino County. The sole Groundwater Sustainability Agency for the Basin is the Ukiah Valley Groundwater Sustainability Agency (UVBGSA or GSA). The GSA consists of the following local agencies: the County of Mendocino (County), the City of Ukiah (City), the Upper Russian River Water Agency (URRWA), and the Russian River Flood Control and Water Conservation and Improvement District (RRFC). The GSA applied for and was awarded Proposition 1 and Proposition 68 grant funds to develop the GSP and meet the SGMA-mandated schedule for submitting a GSA-approved GSP to the California Department of Water Resources (DWR) by January 31, 2022. GSA will be funded through member agency contributions during the first 5-year implementation period until a fee structure is implemented to support and fund GSA activities. Additional funding opportunities will continue to be explored, including grants. In late-2022, DWR will open round 2 solicitations under the SGMA Grant Program, which will provide approximately $204 million to high and medium priority subbasins to implement the GSP and its projects and management actions.

A variety of local interests are represented by the GSA and served on the technical advisory committee (TAC), including municipal-residential water users, agricultural water users, public water systems, local land use planning agencies, environmental users, surface water users, tribal governments, disadvantaged communities, groundwater monitoring and reporting entities, holders of overlying groundwater rights, adjacent Basins, industrial users, commercial users, remediation pumpers, natural ecosystems, and the general public. Many of these local entities have a long history with groundwater and surface water management in the Basin and are well equipped to perform SGMA-required planning functions.

The GSA, TAC members, and the public have undertaken a thorough and timely review of past, current, and projected future water resources needs and groundwater conditions to meet SGMA requirements for GSP development. Throughout the development of the GSP, regular communication and engagement activities were conducted to inform and receive input from local stakeholders and the public. The GSP includes a comprehensive groundwater basin description, which was used to develop a regional integrated hydrological model that quantifies current water budgets and projects future conditions of the Basin. The GSP also includes an assessment of the impacts of predicted future groundwater levels on beneficial users, including groundwater-dependent ecosystems, shallow wells, and interconnected surface water using the best available data and science available. Importantly, these assessments are used to develop measurable sustainable management criteria that avoid significant and unreasonable impacts to these beneficial users, and that can be monitored and adjusted throughout plan implementation.

The key finding of the GSP, based on a thorough analysis of the best available information, is that the Basin will be sustainable over the next twenty years if planned projects and management actions (PMAs) are implemented as needed with respect to climate change and changes in the water system.

These PMAs will help maintain groundwater levels and storage volumes and protect ecosystems, interconnected surface water, and shallow wells. Potential climate change impacts are not fully understood at this stage due to data gaps and the need for additional modeling and data collection. The GSP will implement a more comprehensive data collection that improves modeling capabilities and can provide a better assessment of climate change impacts in the future. The proposed PMAs will promote adaptive management practices and long-term resiliency to varying climatic conditions, such as more frequent, longer-lasting, and more intense droughts and less frequent and wetter winters. As described in Chapter 2, the sustainable yield for the entire Basin is estimated to be at least 6,500 acre-feet, based on historical, average groundwater pumping. The sustainable yield of the Basin is defined based on avoidance of undesirable results. Because the Basin is not overdrafted and the historical pumping average may not represent the actual sustainability yield of the Basin.

A groundwater monitoring network comprised of selected wells will be used to track groundwater levels and groundwater quality. Sustainable management criteria set at representative monitoring wells in the network will be implemented to gage these conditions over time and ensure that groundwater levels and quality remain within a range that avoids significant and unreasonable impacts to beneficial uses and users of groundwater. Streamflow measurements are added to the monitoring network to measure surface water depletion due to groundwater pumping in combination with groundwater level measurements and integrated hydrological modeling simulations. Monitoring and data collection efforts will continue through the first five years of GSP implementation to further identify and prioritize project and management actions.

Once approved by the GSA, the activities identified throughout the GSP development process will be implemented, including:

- Ongoing monitoring and annual reporting on conditions in the Basin;
- Ongoing public engagement and outreach;
- Coordination within the watershed and with neighboring basins and water management entities;
- Development and implementation of a shallow well protection and monitoring program;
- Coordination with land use agencies and water supply agencies to promote consistency with the GSP;
- Coordination with regional agencies in the development of updated climate change projections;
- Implementing PMAs as deemed needed by the GSA to maintain and promote sustainability of the Basin; and,
- Preparation of five-year updates to the GSP starting in 2027.

ES-1. Introduction (Chapter 1)

ES-1.1. Background (Section 1.1)

Chapter 1 describes the Sustainable Groundwater Management Act and the purpose of the Groundwater Sustainability Plan. Chapter 1 also introduces the management structure of the agencies developing and implementing the Groundwater Sustainability Plan (GSP).

The 2014 Sustainable Groundwater Management Act (SGMA) was established to provide local and regional agencies the authority to sustainably manage groundwater resources through the development and implementation of Groundwater Sustainability Plans for high and medium priority basins (e.g., Ukiah Valley). In accordance with SGMA, this GSP was developed and will be implemented by the GSA located within Mendocino County. The GSA manages the Ukiah Valley Groundwater Basin (Basin) and consists of County, City , URRWA, and RRFC.

The California Department of Water Resources (DWR) and the State Water Resources Control Board (State Board) provide primary oversight for implementation of SGMA. DWR adopted regulations that specify the components and evaluation criteria for alternatives to GSPs, and coordination agreements to implement such plans. To satisfy the requirements of SGMA, local agencies must do the following:

Locally controlled and governed Groundwater Sustainability Agencies (GSAs) must be formed for all high- and medium-priority groundwater basins in California.

- GSAs must develop and implement GSPs or Alternatives to GSPs that define a roadmap for how groundwater basins will reach long-term sustainability.
- The GSPs must consider six sustainability indicators defined as: groundwater level decline, groundwater storage reduction, seawater intrusion, water quality degradation, land subsidence, and surface-water depletion.
- GSAs must submit annual reports to DWR each April 1 following adoption of a GSP.
- Groundwater basins should reach sustainability within 20 years of implementing their GSPs.

This GSP was prepared to meet the regulatory requirements established by DWR, as shown in the completed GSP Elements Guide, provided in **Appendix 1-E**, which is organized according to the California Code of Regulation Sections of the GSP Emergency Regulations.

ES-1.2. Purpose of the Groundwater Sustainability Plan

The GSP outlines a 20-year plan to direct sustainable groundwater management activities that consider the needs of all users in the Basin and ensure a viable groundwater resource for beneficial use by agricultural, residential, industrial, municipal, and ecological users. Furthermore, current drought conditions suggest that the GSP can provide solutions and support the development of drought resiliency measures for future emergency conditions. The initial GSP is a starting point towards the achievement of the sustainability goal for the Basin. Although available information and monitoring data have been evaluated throughout the GSP development to set sustainable management criteria and define projects and management actions, there are gaps in knowledge and additional monitoring requirements. The information gained in the first five years of plan implementation and through the planned monitoring network expansions will be used to further refine the strategy outlined in this draft of the GSP. The GSA will work towards implementing the GSP to meet all provisions of SGMA and will utilize available local resources and resources from State and Federal agencies to achieve this. It is anticipated that coordination with other agencies that conduct monitoring and/or management activities will occur throughout GSP implementation to fund and conduct this important work. Additional funding required may be achieved through fees, or other means, to support progress towards compliance with SGMA.

ES-2. Plan Area and Basin Setting (Chapter 2)

Chapter 2 provides an overview of the Basin. This includes descriptions of plan area, relevant agencies and programs, groundwater conditions, water quality, interconnected surface waters, and groundwater-dependent ecosystems. These details inform the hydrogeologic conceptual model and water budget developed for the Basin which will be used to frame the discussion for sustainable management criteria (Chapter 3) and projects and management actions (Chapter 4).

ES-2.1. Description of Plan Area (Section 2.1)

ES-2.1.1. Summary of Jurisdictional Areas and Other Features (Section 2.1.1)

The Basin is a medium priority Basin located in Northern California that encompasses a surface area of 37,500 acres (59 square miles (mi)). The Basin is located in Mendocino County and underlies the Ukiah Valley and the Redwood Valley. The Russian River flows through the entire length of the Basin and is joined by several smaller tributaries. Lake Mendocino borders the eastern side of the Basin and provides managed releases to the East Fork of the Russian River through the operation of the Coyote Valley Dam. The east and west forks of the Russian River merge north of the City of Ukiah and flow southward towards the Basin drainage and Hopland. The Basin is bounded by the Mendocino Range of the Coastal Ranges and is bordered by the Sanel Valley Groundwater Basin (1-053) to the south.

Most land within the Basin is privately owned except for small California Tribal Reservations and Rancheria areas, land owned by the State of California, and land in the proximity of Lake Mendocino that is owned by the federal government. Four small portions of the Basin are designated federal tribal lands and are exempt from SGMA requirements. These tribal lands are owned by the Guidiville Rancheria Tribe, Pinoleville Pomo Nation, Coyote Valley Tribe, and Redwood Valley Little River Band of Pomo Indians. Communities within the Basin are designated as either Disadvantaged Communities (DACs) or Severely Disadvantaged Communities (SDACs) based on annual median income. The population of the Basin (including the Ukiah Census County Division (CCD), the Calpella Census Designated Place (CDP), and the Redwood Valley CDP) was approximately 29,671 in the 2010 census.

Current land use within the Basin is divided into three major categories: agricultural, urban, and native vegetation, which includes forests and riparian vegetation. According to the 2010 Land Use Survey (DWR, 2019d), the three largest land use percentages are listed as Native and Riparian Vegetation (51.3%), Vineyards (20.7%), and Urban (19.14%). Smaller agricultural and farm uses include fruit and nut crops, grain and hay crops, as well as pasture.

Public information regarding well uses and location in the Basin is limited to data from the DWR Online System for Well Completion Reports (OSWCR) (DWR 2019c). The public data gives an estimate of the quantity of each major well use category as follows: domestic (n = 1058), agricultural (n = 117), and public/municipal (n = 70). Because OSWCR represents an index of Well Completion Report (WCR) records dating back many decades, this dataset may include abandoned wells, destroyed wells, or wells with quality control issues such as inaccurate, missing, or duplicate records, but is nevertheless a valuable resource for planning efforts. For the spatial distribution of wells within the Basin, the greatest density of wells resides in the valley floor, specifically near Ukiah City, Calpella, and Redwood Valley.

ES-2.1.2. Water Resources Monitoring and Management Programs (Section 2.1.2)

Section 2.1.2 documents monitoring and management of surface water and groundwater resources in the Basin and their relation to GSP implementation. These include federal, state, and local agencies and their associated activities in the Basin.

ES-2.1.3. Land Use Elements or Topic Categories of Applicable General Plans (Section 2.1.3)

Applicable land use and community plans in the Basin are outlined in **Section 2.1.3** including the Ukiah Valley Area Plan and the County of Mendocino General Plan.

ES-2.1.4. Additional GSP Elements (Section 2.1.4)

Well policies, groundwater use regulations and the role of land use planning agencies and federal regulatory agencies in GSP implementation are outlined in **Section 2.1.4**.

ES-2.1.5. Notice and Communication (Section 2.1.5)

Development of a Communication Plan (CommPlan) to promote the efficient and effective coordination of both internal and external communications, as well as stakeholder engagement in the UVBGSA GSP creation efforts is outlined in **Section 2.1.5**.

ES-2.2. Basin Setting (Section 2.2)

Section 2.2 includes descriptions of geologic formations and structures, aquifers, and properties of geology related to groundwater, among other related characteristics of the Basin.

ES-2.2.1. Hydrogeologic Conceptual Model (Section 2.2.1)

The purpose of the HCM is to meet the regulatory requirements mandated by SGMA and to establish a framework hydrogeologic model with which to guide development of the GSP and management of the Basin. This includes future modeling efforts and monitoring programs.

Basin Setting (2.2.1.1)

The Basin underlies the Redwood Valley and Ukiah Valley, along with their tributary valleys, in Mendocino County, California. It is approximately 22 miles long and 5 miles wide at its widest point with a total area of 37,500 acres. The ground surface elevation of the Basin ranges from approximately 500 feet mean sea level (msl) in the south to 1,000 feet msl in the north (DWR, 2004). The Basin is bounded on all sides by the Coastal Ranges, primarily the Mendocino Range (Farrar, 1986). Highway 101 runs the entire length of the Basin and connects with Highway 20, which enters the Basin from the east, at Calpella (DWR, 2004). City of Ukiah is the only incorporated city within the Basin. The Russian River, and its tributaries, along with Lake Mendocino are the major surface water features within the Basin. The Russian River runs through the entire length of the Basin with many smaller tributaries contained within the Basin. The east fork of the river flows into Lake Mendocino and enters the Basin just south of the lake. The west fork originates to the north towards Redwood Valley and each fork merges into the main stem below Coyote Valley Dam. Annual precipitation in the Basin ranges from 45 inches in the north to 35 inches in the south (DWR, 2004).

Soils 2.2.1.2

Soils within the Ukiah Valley Basin were analyzed based on two categories: hydrologic soil groups and taxonomic soil orders. The Natural Resources Conservation Service (NRCS) Hydrologic Soils Group classifications (Soil Survey Staff, 2014) provide an indication of soil infiltration potential and ability to transmit water under saturated conditions. Hydrologic soil groups are developed based on saturated hydraulic conductivities of shallow, surficial soils. Each group has an associated range with higher conductivities (greater infiltration) in Group A and lower conductivities (lower infiltration) in Group D. High infiltration soils, Group A, are located primarily in small bands along the rivers. Moderate infiltration soils, Group B, occupy the majority of the Basin and are primarily in the central portion of the Basin. Slow infiltration soils, Group C and Group D, occupy the northern and southern portions as well as the eastern edge of the Basin.

Taxonomic orders were identified using the Soil Survey Geographic Database from the NRCS. A total of 5 taxonomic orders are present within the Basin. These soil orders include Alfisol, Entisol, Inceptisol, Mollisol, and Vertisol. The most prominent soils groups within the Basin are Mollisols and Inceptisols. Mollisol is an order formed primarily through the accumulation of calcium-rich organic matter typically containing swelling type clays and a granular/crumb structure. Mollisols are found throughout the Basin and primarily along the low-lying middle of the Basin where vegetation and clays are present. Inceptisols are weakly developed mineral soils that contain a soil horizon but have very little soil development. Inceptisols are found primarily in the foothills or highlands. Younger Entisols, which are weakly developed mineral soils without a soil horizon, are found along the river channels and likely associated with young alluvial deposits. Alfisols, which are strongly weathered mineral soils, and Vertisols, which are identified by shrink swell clays, are found in small patches scattered throughout the Basin.

Regional Geology 2.2.1.3

There are four significant geologic formations identified within the Basin: Quaternary (Recent) Alluvium, Pleistocene Terrace Deposits, Pliocene/Pleistocene Continental Basin Deposits, and Franciscan Formation. The Franciscan Formation is not considered to be part of the Basin from the perspective of SGMA. The Franciscan Formation consists of rocks from the Jurassic to Cretaceous age and is considered the basement and bedrock for the Basin along with comprising the majority of the surrounding Mendocino Range.

Continental Basin Deposits are Pliocene and Pleistocene in age and underlie the Quaternary Alluvium and Terrace Deposits. They are comprised of poorly consolidated and poorly sorted clayey and sandy gravel, clayey sand, and sandy clay (Farrar, 1986). The vertical distribution of the Continental Basin Deposit materials includes thick clay layers that lie over and below confined aquifers consisting of sands and gravels. The high clay content in the formation results in low permeability and low producing wells (MCWA, 2010).

Terrace Deposits are Pleistocene in age and composed of partially to loosely cemented beds of gravel, sand, silt, and clay. They are similar in composition to Continental Basin Deposits but with less silt and clay. Terrace Deposits are discontinuous and long, narrow, elevated, gently inclined surfaces that are laterally interfingered with neighboring beds. Aggradation of eroded material, most likely from the surrounding Franciscan formation, formed the Terrace Deposits (Farrar, 1986).

Lastly, Quaternary Alluvium is the primary water producing geologic unit in the Basin. It consists of unconsolidated gravel, sand, silt, and minor amounts of clay that were deposited in thin bands along river channels and wider flood plains of the Russian River and its tributaries, along with alluvial fans and as colluvium (Cardwell, 1965).

Principal Aquifers and Aquitards 2.2.1.4

There are two principal aquifers which make up the Basin. Principal Aquifer I – Quaternary Alluvium is the primary production aquifer for the Basin. It is constrained to small, narrow bands along the Russian River and its tributaries. Its extent and depth increases moving south in the Basin. Estimated storage capacity of Aquifer I varies between 60,000 to 120,000-acre feet (74 to 148 million cubic meters) using specific yields between 6 to 20 percent (DWR, 2016a; Farrar, 1986). Due to its proximity to the river systems and high permeability, the Quaternary Alluvium is considered hydraulically connected with adjacent rivers (Cardwell, 1965).

Principal Aquifer II – Terrace Deposits and Continental Basin Deposits is the second main aquifer. The Principal Aquifer II comprises the largest portion of the Basin and is a low-yield aquifer that contains both the thin and discontinuous Terrace deposits and the gravelly/sandy clays and thick clays of the Continental Basin deposits. Both geologic formations have low hydraulic conductivities, and the large clay content can act to locally confine the aquifer, restricting flow between aquifers. At depth, Principal Aquifer II may act like a confined aquifer. Recharge to Principal Aquifer II comes from precipitation where surface outcroppings are present, the Basin margins, and fractured Franciscan Formation bedrock (Fisher, Brown, & Warne, 1965). Storage capacity for Principal Aquifer II is estimated at 324,000 acre-feet (275.6 million cubic meters) but is difficult to develop due to low permeability (Farrar, 1986).

Groundwater Recharge and Flow 2.2.1.5

The general flow direction in the Basin is of north to south with larger flow gradients found in the north and along the edges of the Basin. A maximum water surface elevation of 789 ft-amsl (240.5 m-amsl) was observed in the northernmost portion of the Basin and a minimum elevation of 541 ft-amsl (165 m-amsl) was observed in the southernmost portion of the Basin.

Historical studies indicate that much of the Basin is recharged through precipitation, with shallow alluvial aquifers receiving recharge from surface water. While historical studies identify recharge to Principal Aquifer I as being through stream losses, there is little data confirming this assertion. Planned projects identified in this GSP should help to clarify recharge to Principal Aquifer I. The deeper aquifers receive recharge through deep percolation on the edges of the Basin and through fractures in the Franciscan bedrock. Recharge along the edges of the Basin contributes to the Continental Basin Deposits and is likely slow percolation of precipitation or stormwater (Cardwell, 1965).

The main elements of recharge to both aquifers can be categorized into:

- Deep percolation of precipitation in outcrop areas;
- Infiltration of surface water from streambeds of the Russian River and its tributaries; and,
- Recharge from applied irrigation, unlined storage ponds, and percolation ponds of the small water agencies and City of Ukiah Wastewater Treatment Plan (UWWTP).

Through continuous monitoring and implementation of the GSP, along with future studies in the Basin, there should be further clarity on recharge to principal aquifers. By analyzing where regions of Hydrologic Soil Group A are found within the Basin, it can be determined where the greatest potential for recharge in the Basin is located. These may not be areas of ongoing recharge but show soils with the greatest recharge capacity.

Discharge areas within the Basin include discharge to surface water bodies, root uptake and evapotranspiration by vegetation and crops, groundwater withdrawal through municipal, domestic, and agricultural pumping, and discharges from the boundaries of the Basin. Recharge and discharge from the aquifers are discussed in more detail in the water budget section and will be improved upon a better understanding of Basin conditions using additional data and studies.

Surface Water 2.2.1.6

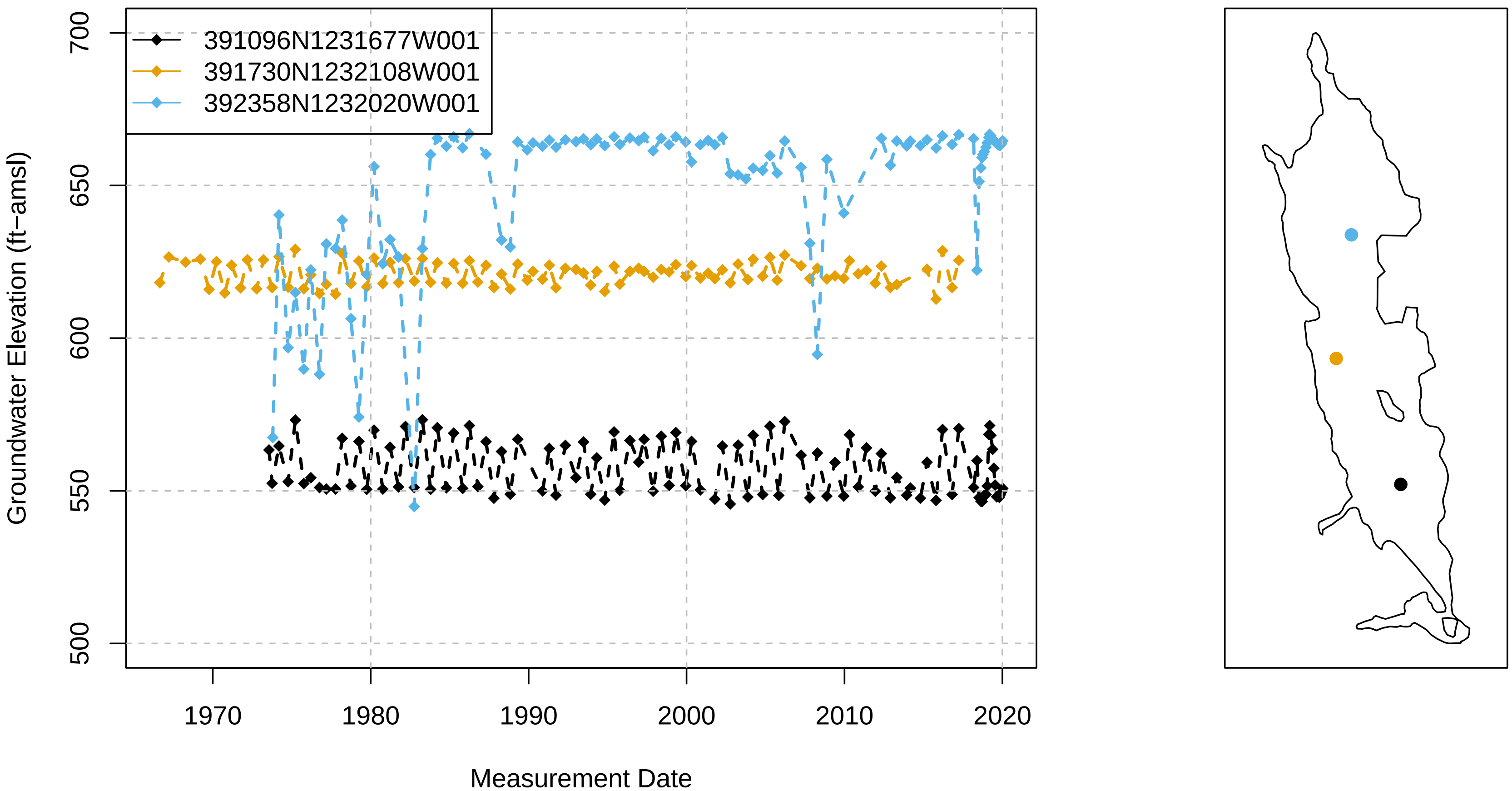
The two major surface water features controlling surface water hydrology within the Basin include Lake Mendocino along with the Russian River and its tributaries. Lake Mendocino is located on the eastern edge of the Basin, just southeast of Calpella. While technically outside of the Basin, releases from Lake Mendocino are significant because the lake is a federal water supply and flood control reservoir managed by Sonoma Water and the United States Army Corps of Engineers (USACE). Sonoma Water is a wholesale water supply and manages water supply storage and releases to maintain minimum instream flows in the Russian River and to meet water supply demands for both Sonoma Water and Russian River water users (SCWA, 2016). It was constructed in 1958 for flood control, water supply, recreation, and streamflow regulation.

The Russian River runs north to south through the center of the Basin. It extends for the entire length of the Basin for approximately 33 miles with several tributaries connecting to it (LACO Associates 2017). Most of the contributing tributaries are seasonal or intermittent but have been shown to be flowing upstream and within the Basin area while disconnected from the Russian River. The West Fork of the Russian River runs through the center of the Basin while the East Fork runs into Lake Mendocino. The East Fork and West Fork meet south of Lake Mendocino and comprise the Russian River. The Russian River exits at the southernmost end of the Basin, just north of Hopland. Significant controls on surface water flows in the Russian River are releases from Lake Mendocino. Headwaters of the Russian River is located 15 miles north of Ukiah. It is habitat to endangered salmonid species and subject to minimum flow requirements established under the Federal Endangered species Act (SCWA, 2016).

ES-2.2.2. Current and Historical Groundwater Conditions (Section 2.2.2)

Groundwater Elevation (2.2.2.1)

Groundwater levels in the Basin have remained relatively stable over the last 30 years while showing small seasonal fluctuations (DWR, 2019d). Seasonal cycling of groundwater levels is noted throughout the Basin, with decreasing levels in the summer months followed by increasing levels in the winter months. Limited availability and spatial coverage of historical data may affect the reliability of these results. Groundwater elevation data is very scarce prior to 2014 and is limited to three DWR wells **(Figure 1)** and periodic measurements of wells with data in the GeoTracker database. For recent and current groundwater elevation evaluation, CASGEM wells have been monitored since 2014-2015 and were exclusively used due to their spatial and depth coverage and their overall data quality. Fall groundwater levels are generally stable, while spring measurements are affected by drought conditions. Levels are generally lower in springs that follow a dry winter. Overall, the Basin is shown to maintain its stable levels despite these fluctuations and rebounds to approximately the same levels as pre-drought conditions once drought conditions subside.



Site Code, south to north: 391096N1231677W001 | Well Depth; 112ft | Assigned as Aquifer II
391730N1232108W001 | Well Depth; 62ft | Assigned as Aquifer II
392358N1232020W001 | Well Depth; 274ft | Assigned as Aquifer II

Figure 1: Historical Groundwater elevations for the three DWR monitoring wells.

Change in Groundwater Storage (2.2.2.2)

Available storage in principal Aquifers was estimated in the existing literature to be 60,000 to 120,000 acre-feet per year (74 to 148 million cubic meters) for Aquifer I and 324,000 acre-feet (275.6 million cubic meters) for Aquifer II (DWR, 2016a; Farrar, 1986).

The Ukiah Valley Integrated Hydrological Model (UVIHM) was used to estimate the historical change in storage of the Basin for water years 1992-2018.8 During this period, as shown in **Figure 2**, storage in the Basin has changed following water year types and precipitation patterns, losing water in storage during dry periods and gaining in storage during above normal to wet periods. These changes to storage are not significant, the estimated cumulative storage change in the Basin does not reach or exceed 1,500 acre-feet during this period (**Figure 3**).

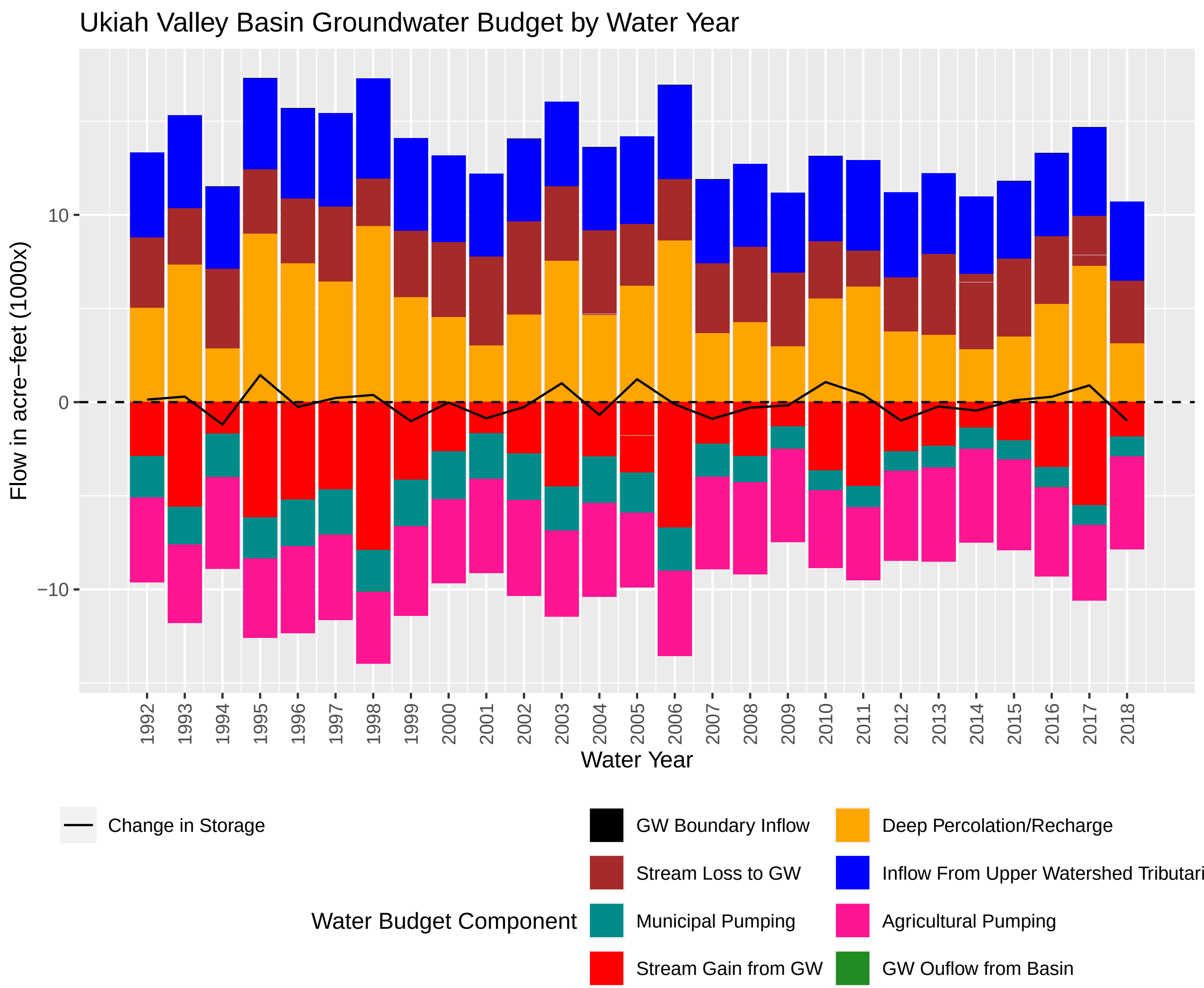


Figure 2: Estimated historical annual groundwater budget for the Basin averaged over 1992-2018.

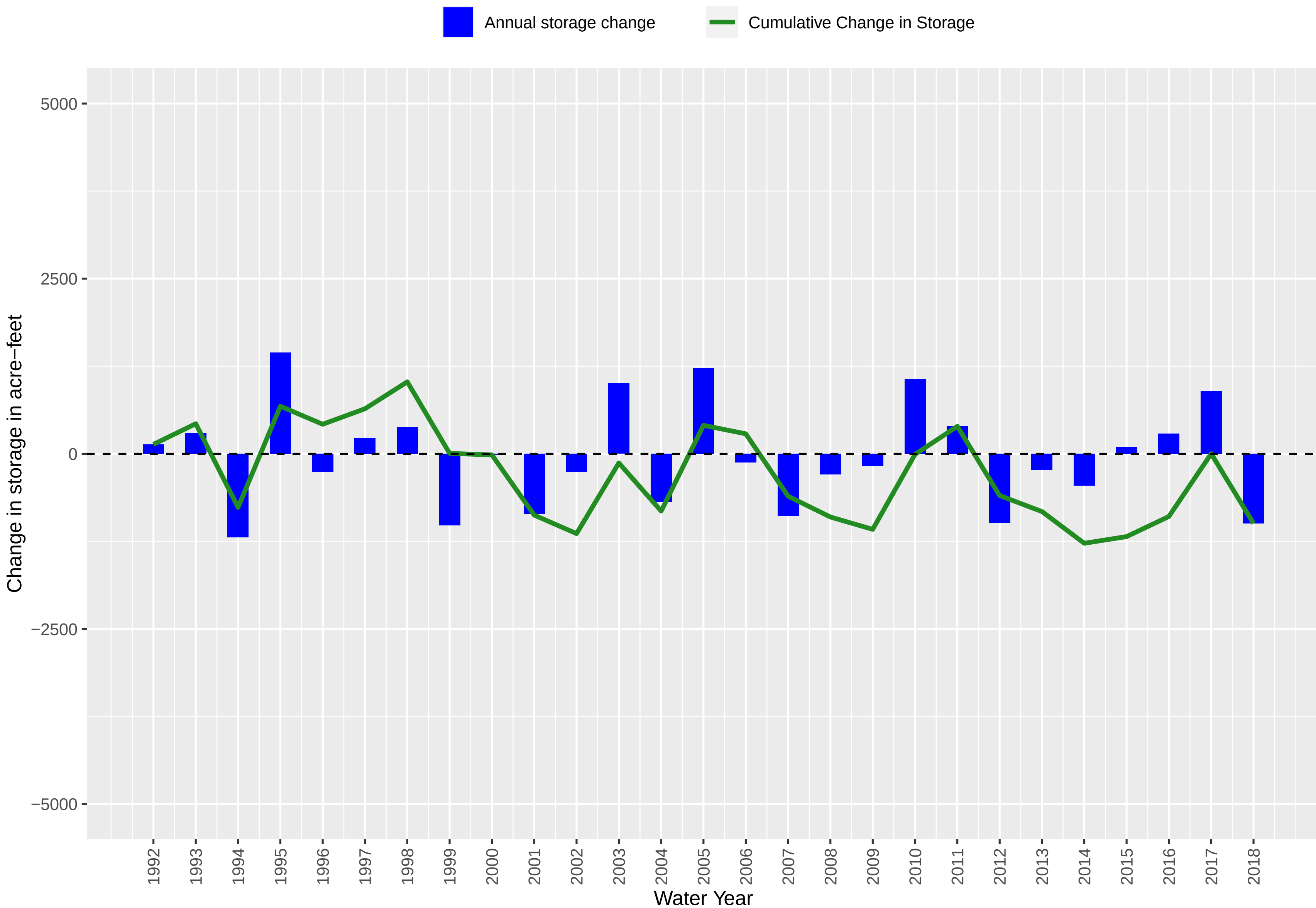


Figure 3: Change in groundwater storage in Ukiah Valley Groundwater Basin in water years 1992-2019.

Seawater Intrusion (Section 2.2.2.3)

Due to the distance between the Ukiah Valley Groundwater Basin and the Pacific Ocean, saltwater intrusion is not evident nor of concern and therefore, is not applicable to the Basin.

Groundwater Quality (Section 2.2.2.4)

Groundwater in the Basin is generally of good quality and has relatively consistent water quality characteristics which meet local needs for municipal, domestic, and agricultural uses. Ongoing monitoring programs show that some naturally occurring constituents, including boron, iron, and manganese exceed water quality standards in parts of the Basin. Exceedances may be caused by geology and natural localized conditions and may not be reflective of regional water quality. The assessment of groundwater quality for the Basin was prepared using available information obtained from the California Groundwater Ambient Monitoring and Assessment (GAMA) Program database, which includes water quality information collected by the California Department of Water Resources (DWR); State Water Resources Control Board (SWRCB), Department of Drinking Water (DDW); and the United States Geological Survey (USGS). Important constituents to sustainable groundwater management in the Basin include boron, iron, manganese, nitrate, and specific conductivity. While the latter two do not historically show exceedances from their regulatory thresholds, they are important for tracking sustainability in the future. The regulatory threshold for Nitrate as N is 10 mg/L while the threshold for specific conductivity is 900 micromhos, under Title 22 of the California Code of Regulations (CCR). Naturally occurring constituents will be monitored during the GSP implementation to demonstrate that the GSP Projects and Management Actions are not contributing to the spread of this constituents in areas where they were not present before.

Land Subsidence Conditions (Section 2.2.2.5)

Land subsidence is the lowering of the ground surface elevation. Land subsidence has not been observed in the Basin historically and generally ranges from 0.01 to -0.02 ft from 2015 to 2019, which is within the limits of measurement errors.

Identification of Interconnected Surface Water Systems (Section 2.2.2.6)

Interconnected surface water (ISW) is defined as surface water that is connected to groundwater through a continuous saturated zone. SGMA mandates an assessment of the location, timing, and magnitude of ISW depletions, and to demonstrate that projected ISW depletions will not lead to significant and undesirable results for beneficial uses and users of groundwater.

The Russian River and its tributaries were analyzed to determine surface water interconnectivity in the Basin between 2014 and 2020. ISWs in the Basin were classified into “likely ISW” and “unlikely ISW” based on the analysis and professional judgment to reflect the inherent uncertainty of the datasets used to complete the analysis, as shown in **Figure 4**. An estimated 45% of assumed stream and river bed segments were classified as likely ISW leaving 55% of surface water segments as unlikely ISW.

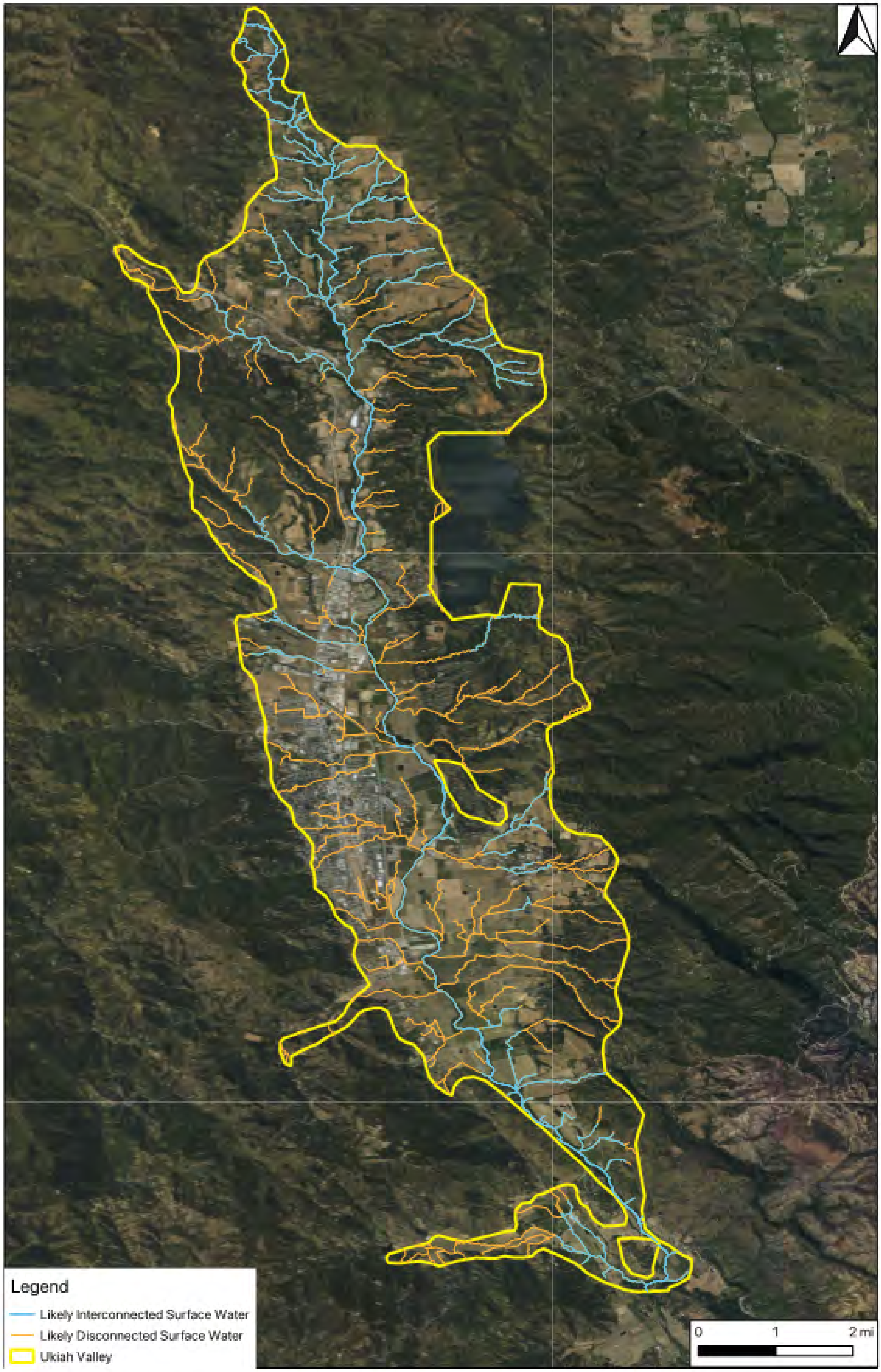


Figure 4: Likely interconnected surface water segments along the Russian River and its tributaries.

Identification of Groundwater Depended Ecosystems (Section 2.2.2.7)

SGMA refers to GDEs as "ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface." This definition includes both areas of vegetation and flowing surface waters supporting aquatic ecosystems.

Environmental beneficial water users of surface water were identified to establish sustainable management criteria for the depletions of surface water sustainability indicator. The CDFW Biogeographic Information and Observation System (BIOS) Viewer was used to identify threatened and endangered species that may be present within the Ukiah Basin. A total of two species are listed as endangered by the State of California. No species that may be present within the Basin are listed as endangered at the federal level though four species are listed as Birds of Conservation Concern and the petition to list the Foothill Yellow-legged Frog is currently under review. It is worth noting that the California Fish and Game Commission determined in their Notice of Findings (March 10, 2020) that listing the Northwest/North Coast clade of foothill yellow-legged frog as threatened is not warranted, which applies to the Basin area. The species is still designated by CDFW as a "Species of Special Concern" but is not listed/protected under the California Endangered Species Act in this region. An additional ten species are listed as Species of Special Concern at the state level with the Baker's Meadowfoam also assigned rare status. Moreover, National Oceanic and Atmospheric Administration (NOAA) Protected Resources App[1] indicates that the Russian River mainstem, Forsythe Creek, Mariposa Creek, and Salt Hollow Creek are critical habitats for threatened-listed Steelhead (Oncorhynchus mykiss). Russian River mainstem is also listed as critical habitat for Chinook Salmon (Oncorhynchus tshawytscha), listed as threatened.

A spatial data analysis procedure which combined data on the mapped location of vegetation, vegetation rooting depths, and depth to groundwater was implemented to identify and categorize potential vegetation GDEs for the Ukiah Basin. Areas with assumed vegetation that appear to have access to groundwater for greater than 50% of the period of record are assumed to be "likely connected" to groundwater. During the period of record, and generally common for the Basin, Spring groundwater levels are higher than Fall levels. Therefore, this criteria translates into the ability of assumed vegetation GDEs to access groundwater during all Springs and their growing period. Areas with assumed vegetation and rooting zone depths that appear to have access to groundwater for less than 50% of the period of record are considered to be "potential GDEs" to account for the uncertainty and data gaps discussed here and in **Appendix 2-E**. Potential GDEs will be re-evaluated upon collection of additional data and information. GDEs that do not have access to groundwater in any season during the period of record are assumed to be "likely disconnected" from groundwater. The distribution of classified GDEs for the Ukiah Basin is presented in **Figures 5**.

[1] https://www.fisheries.noaa.gov/resource/map/protected-resources-app

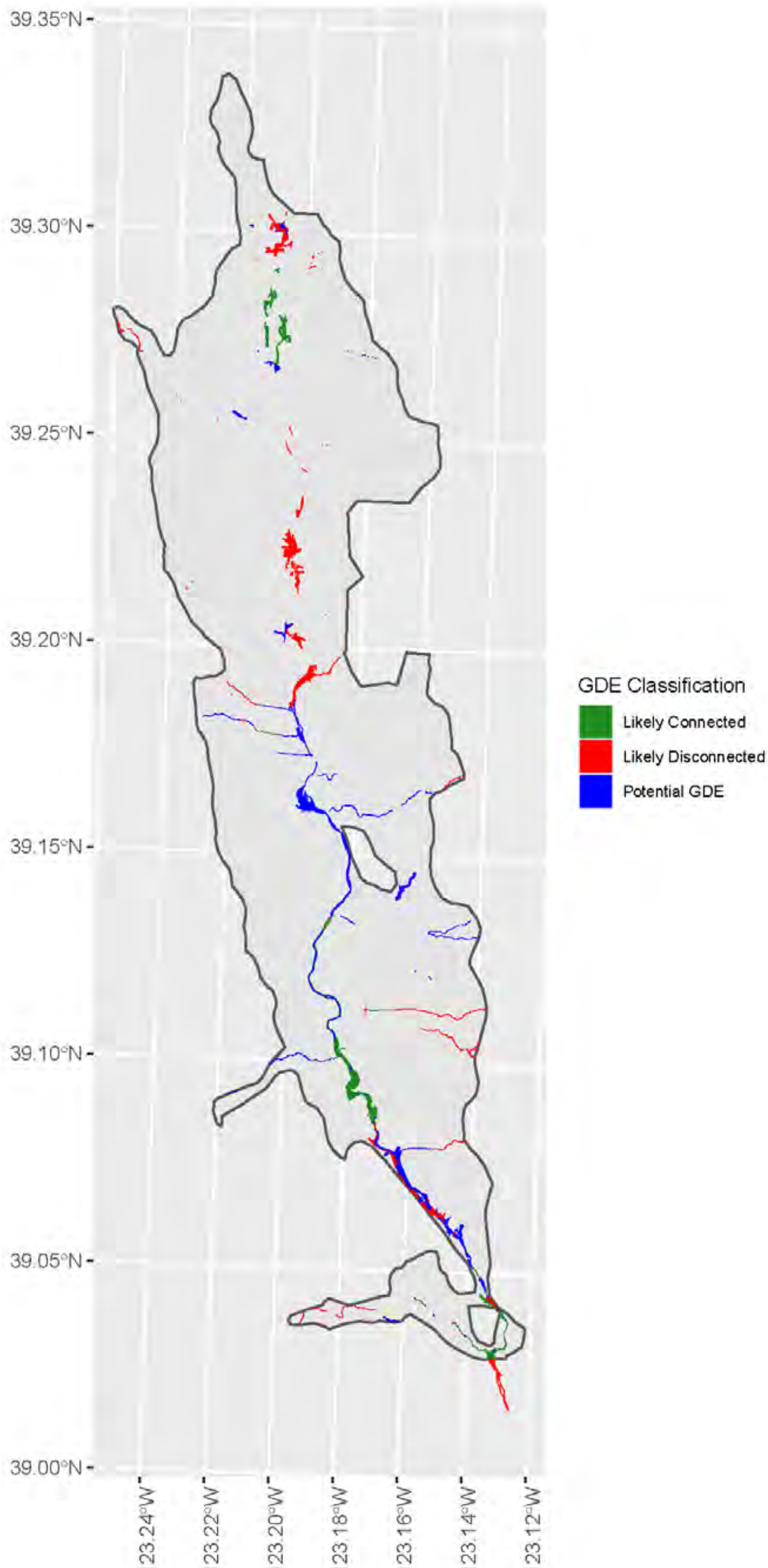


Figure 5: Classification of mapped potential GDEs into likely connected and likely disconnected for the Basin.

ES-2.2.3. Water Budget (Section 2.2.3)

Historical Water Budget

The historical water budget for the Basin was estimated for the period October 1996 through September 2018, using the UVIHM. This integrated model is comprised of Precipitation-Runoff Modeling System (PRMS) to simulate surface hydrology, a Modular Groundwater Flow Model (MODFLOW) to simulate groundwater flow, and an Integrated Water Flow Model Demand Calculator (IDC) program to estimate agricultural demands and soil zone budget.

Groundwater budgets show inflows and outflows to the aquifer from the bottom of the root zone, down through all aquifer layers. The Basin is underlain by two principal aquifers: Aquifer I and Auifer II. Groundwater inflows to the Basin are dominated by deep percolation and recharge from the overlying land surface, streambed recharge from the Russian River and its tributaries including inflow from the outer watershed area that flows through the Basin and is eventually recharged into the aquifer. Groundwater outflows are mainly comprised of pumping for irrigation and municipal uses, discharge to the Russian River and its tributaries including water that flows out of the Basin as part of the Russian River. The difference between groundwater inflows and outflows represents the net change in groundwater storage.

Main inflows to the Basin are deep percolation or recharge from precipitation and agricultural irrigation, stream recharge, and inflow from upper watershed tributaries. All three of these inflows are directly dependent on precipitation. These three sources of inflow provide the entire water input to the groundwater budget and can vary between 15 TAF (1000 Acre Feet) to 20 TAF depending on the water year type and precipitation, as shown in **Table 1**.

Main outflows from the Basin and groundwater budget are groundwater use and production, groundwater loss to stream network, and water that flows out of the Basin through the Russian River stream channel. Agricultural pumping was estimated using the Integrated Water Flow Model Demand Calculator (IDC) program. Agricultural demand estimated by IDC is around 5 TAF and slightly changes due to water year types. Based on observational input from stakeholders in the Basin, more than 60% of the agricultural demand is satisfied using surface water diversions. Therefore, agricultural groundwater pumping is representative of less than 40% of the total demand.

Stream gain from the aquifers normally happens during wet periods (mid-November to mid-June) as shown in **Figure 6**.Stream gain from the aquifers can significantly vary based on the water year type and precipitation pattern, from less than 2 TAF during critical and dry years to more than 6 TAF in wet years. On the other hand, stream loss to groundwater (stream recharge) normally happens during the summer months and in early fall, during irrigation periods. stream recharge is also dependent on the water year types and can vary between 3 TAF to 4.5 TAF.

Table 1: Ukiah Valley Groundwater Basin estimated historical water budget for each water year type based on the average of 1992-2018. Values are in acre-foot.

Water Budget Component	Critical	Dry	Below Normal	Above Normal	Wet
Groundwater Boundary Inflow	5.4	5.3	5.3	5.3	5.3
Deep Percolation/Recharge	3352.3	3777.0	3898.7	5799.3	7879.3
Stream Loss to Groundwater	3992.6	4255.4	3967.4	3414.5	3156.7
Inflow From Upper Watershed	4277.8	4349.6	4497.8	4632.1	4954.9
Municipal Pumping	1233.7	1711.5	2038.6	1752.2	2130.0
Agricultural Pumping	5000.3	4882.3	4872.2	4477.8	4363.0
Stream Gain from Groundwater	1828.7	2205.7	2358.4	3851.7	5913.3
Groundwater Ouflow from Basin	1.0	1.0	1.0	1.0	1.0

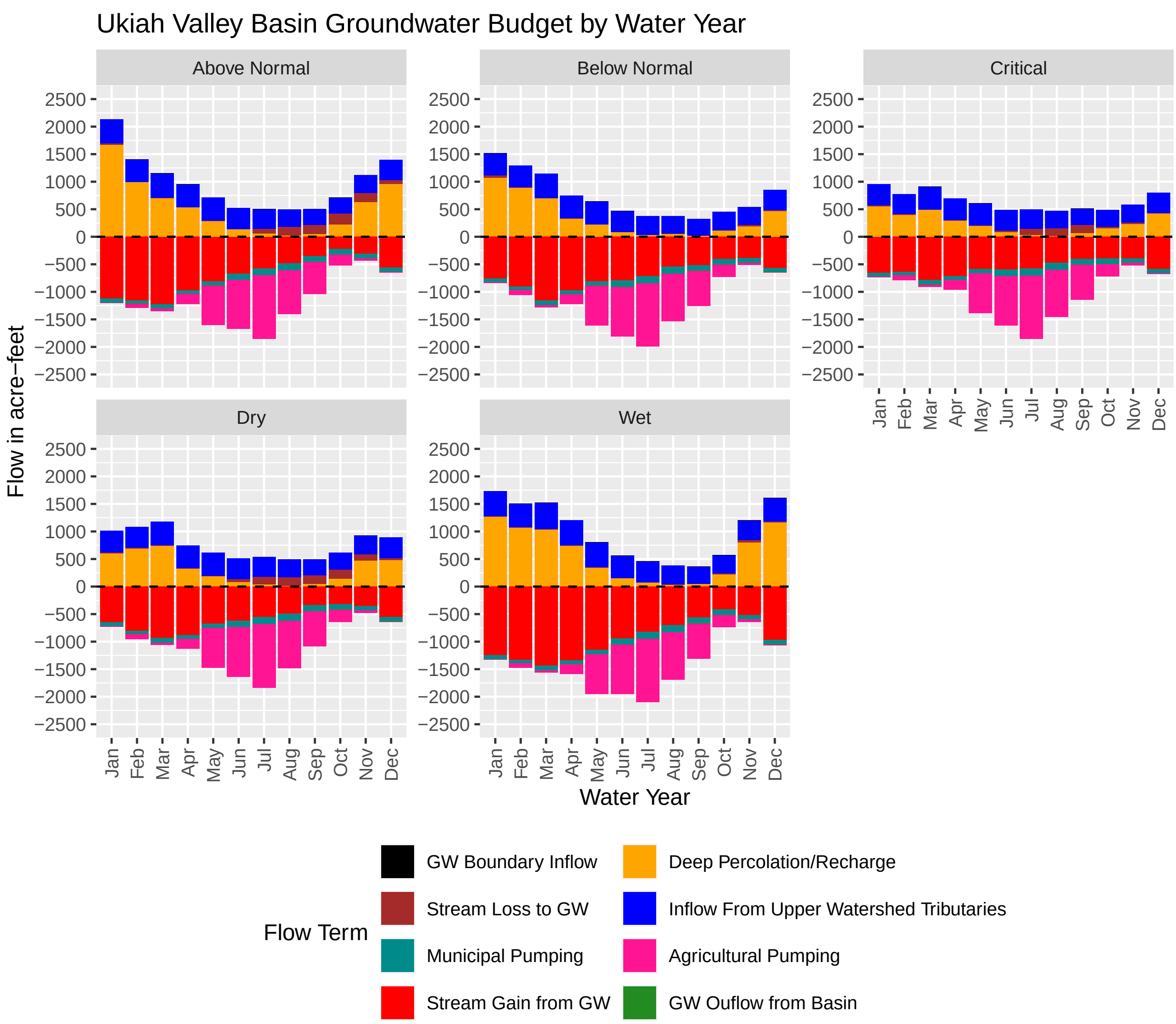


Figure 6: Estimated historical average monthly water budget for the groundwater Basin for each water year type. Water budget components are averaged over the same water year types in the 1992-2018 period.

Current Water Budget

Current period for the Basin is defined as the 2015-2018 water years. For current conditions, municipal demands, including groundwater pumping and surface water diversions, were implemented based on the data available. If data did not exist after 2015, similar demands to the 2015 water year were used for the rest of the period.

Current conditions follow a similar pattern as the historical period. Wetter years lead to more recharge and inflow from the upper Russian River watershed tributaries and higher stream gains from the aquifers (**Table 2**). On a monthly scale, most of the recharge happens from October to June, with the majority of recharge occurring during the December to April period. Groundwater and stream exchange is divided into stream losses from June to November, and stream gain during the rest of the year. This mirrors the primary irrigation season and agricultural use in the Basin.

Table 2: Estimated Ukiah Valley Groundwater Basin monthly water budget averaged over 2015-2018 for current conditions. Values are in acre-foot.

Water Budget Component	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Groundwater Boundary Inflow	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.4	0.5	0.4	0.5
Deep Percolation/Recharge	1602.4	1016.4	1031.1	507.5	271.1	103.5	40.3	18.8	13.0	193.4	372.2	1084.6
Stream Loss to Groundwater	11.3	0.0	7.1	0.0	1.2	88.1	528.2	655.0	535.0	695.2	435.1	181.1
Inflow From Upper Watershed	434.2	413.8	455.1	431.5	433.5	400.1	377.1	341.9	302.4	308.4	319.2	370.8
Municipal Pumping	69.7	55.8	81.7	61.2	76.0	114.0	125.2	126.0	103.1	100.1	79.7	77.0
Agricultural Pumping	4.7	40.7	39.9	249.1	659.3	816.7	1143.0	704.3	526.0	206.9	24.6	13.7
Stream Gain from Groundwater	808.9	1050.9	1112.5	836.6	297.4	16.3	0.0	0.0	0.0	0.0	15.9	325.3
Groundwater Ouflow from Basin	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Projected Water Budget

To inform long-term hydrologic planning, the future projected water budget was developed using Climatic and hydrologic data and input from water years 1965-2018. Water demands including agricultural and municipal pumping and surface water diversions are considered constant and equal to that of the water year 2018. To assess the impacts of climate change, two scenarios were implemented using DWR estimated change factors: 2030 central tendency (near-future) and 2070 central tendency (far future).

Similar to the historical period, the projected water budget is largely dependent on precipitation and water year type, specifically for groundwater recharge, streams and groundwater exchange, and inflow from upper watershed tributaries. **Table 3** shows annual groundwater budgets for all timelines and scenarios averaged over their entire respective periods. Comparison of historical, current, and future baseline periods indicates that less recharge and stream loss to groundwater on average is expected in the future, shrinking the amount of inflow to the Basin. Groundwater discharge to the stream system will also be increased compared to historical and current conditions adding to the increasing difference between inflows and outflows.

Similarly, Near and Far climate change scenarios show a decline in aquifer recharge and stream loss to aquifers. Although this seems to constrain the Basin in the future in average conditions, no significant trend in cumulative storage change could be established from the future baseline conditions, or climate change scenarios. In addition, the uncertainty and unpredictability of climate conditions need to be considered to interpret future baseline and climate change results cautiously since a repeat of the historical period may not be likely.

Table 3: Ukiah Valley Groundwater Basin estimated historical, current, and future water budgets. Future budgets include future baseline, 2030, and 2070 Climate Change Scenarios. Values are in acre-foot.

Water Budget Component	Historical: 1992-2018	Current: 2015-2018	Future Baseline: 2017-2070	Climate Change 2030 Scenario	Climate Change 2070 Scenario
Groundwater Boundary Inflow	5.3	5.3	5.3	5.3	5.3
Deep Percolation/Recharge	5422.8	6254.2	5123.1	1949.4	4100.1
Stream Loss to Groundwater	3660.7	3137.3	818.8	1363.7	1031.8
Inflow From Upper Watershed	4611.7	4588.0	4512.2	4404.4	4183.0
Municipal Pumping	1854.7	1069.5	1069.0	1069.0	1069.0
Agricultural Pumping	4630.0	4429.0	4914.0	4914.0	4914.0
Stream Gain from Groundwater	3632.2	4463.7	4889.5	2152.0	3758.9
Groundwater Ouflow from Basin	1.0	1.0	1.0	1.0	1.0

ES-2.2.5. Projected Sustainable Yield

The sustainable yield “means the maximum quantity of water, calculated over a base period representative of long-term conditions in the Basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result.” (California Water Code Section 10721). The Sustainable Groundwater Management Act explicitly makes the sustainable yield a function of long-term conditions and of the conditions causing undesirable results. The sustainable yield in the Basin is not equal to the historic 1992 – 2018 average groundwater pumping, since those conditions have not resulted in overdraft. Water levels and groundwater storage have been in a dynamic equilibrium with inflows to and outflows from the aquifer system, with no significant, discernable negative trend in water levels or groundwater storage. Also, the sustainable yield cannot be defined for the Basin as a single number that is constant over time, as future conditions may decrease or increase the amount of groundwater that can be withdrawn without causing undesirable results.

In addition, in the Ukiah Valley Basin, protecting against depletion of interconnected surface waters and impacts on GDEs warrants the addition of a spatial and possibly hydrogeological component to the sustainable yield. In other words, a single sustainable yield number may lead to different impacts if the pumping patterns differ significantly.

According to the SGMA definition, the sustainable yield for the Basin is estimated to be at least 6,500 acre-feet, based on the average groundwater pumping of the historical period. The sustainable yield of the Basin may be greater than 6,500 with the current conditions persisting, but cannot be estimated based on the available historical record. Therefore, it is recommended that the sustainability of the Basin is not determined based on the sustainable yield, but rather based on the tracking of sustainable management criteria.

ES-3. Sustainable Management Criteria (Chapter 3)

Chapter 3 builds on the information presented in the previous Chapters and details the key sustainability criteria developed for the GSP and associated monitoring networks.

ES-3.1. Sustainability Goal and Sustainability Indicators (Section 3.1)

The Sustainability Goal of the Basin is to maintain groundwater resources in ways that best support the continued and long-term health of the people, the environment, and the economy in Ukiah Valley, for generations to come.

This includes managing groundwater conditions for each of the applicable sustainability indicators in the Basin so that:

- Groundwater elevations and groundwater storage do not significantly decline below their historically measured range, protect the existing well infrastructure from outages, protect groundwater dependent ecosystems, and avoid significant additional streamflow depletion due to groundwater pumping.
- Groundwater quality is suitable for the beneficial uses in the Basin and is not significantly or unreasonably degraded.

- Significant and unreasonable land subsidence is prevented in the Basin. Infrastructure and agricultural production in Ukiah Valley remain safe from permanent subsidence of land surface elevations.
- Significant and undesirable streamflow depletions due to groundwater pumping are avoided through projects and management actions consistent with existing regulatory requirements.
- The GSA's groundwater management is efficiently and effectively integrated with other watershed and land use planning activities through collaborations and partnerships with local, state, and federal agencies, private landowners, and other organizations, to achieve the broader "watershed goal" of sufficient surface water flows that sustain healthy ecosystem functions.

Table 3 defines undesirable results for each sustainability indicator. Quantifiable minimum thresholds (MT), measurable objectives (MO), and interim milestones (IM) were developed as checkpoints that evaluate progress made towards the sustainability goal and are quantified in Chapter 3 of the GSP. Monitoring wells throughout the Basin will be used to assess conditions relevant to each sustainability indicator. New continuous groundwater data will be collected to expand the current network, to provide a better temporal evaluation of the changes in the system, and will be included in the Ukiah Valley Basin Integrated Hydrologic Model (UVIHM, based on the GSFLOW platform to be consistent with other ongoing modelling effort in the Russian River watershed) for calibration. Monitoring wells were selected based on well location, monitoring history, well information, and well access. The UVIHM and its future updates will be used to monitor and assess the depletions of interconnected surface water. Based on preliminary assessments, the UVIHM model will need to be updated based on the expanded monitoring network and through new research activities, including water level measurements, stream gaging, aquifer assessments, studies of streambed and river profile, isotopes analysis and monitoring of projects and management actions. It represents the scientifically and technologically most accurate and defensible approach to measuring stream depletion due to groundwater use, and the reversal of stream depletion expected in the summer months as a result of projects and management actions suggested in this GSP.

Table 4: Undesirable results defined for the sustainability indicators in the Ukiah Valley Groundwater Basin.

Sustainability Indicator	Undesirable Result Defined
Chronic Lowering of Groundwater Levels	Groundwater level observations in the Fall season (i.e., the minimum elevation in any given water year) in more than third of the RMPs in the Basin fall below their respective minimum thresholds for two consecutive years
Reduction of Groundwater Storage	Similar to chronic lowering of groundwater levels, if the Fall low groundwater level observations in more than a third of the RMPs in the Basin fall below their respective minimum thresholds for two consecutive years.
Degraded Water Quality	Maximum thresholds are exceeded at 50% or more of the groundwater quality monitoring wells sampled in the respective sampling period for any Constituent of Interests (COIs) with a defined maximum threshold.
Depletions of Interconnected Surface Water	Groundwater levels at more than a third of the Representative Monitoring Points (RMPs) falling below their defined minimum thresholds in two consecutive years. The criteria are applicable for the first five years of the GSP implementation and will be revised upon further data collection and availability of sufficient information. Revised undesirable results will be defined based on the volume and/or rate of depletion at monitoring transect and streamgage locations calculated by the UVIHM.
Seawater Intrusion	Not applicable for the Basin.
Land Subsidence	Groundwater pumping induced subsidence is greater than the minimum threshold of 0.1 ft (0.03 m) in any single year.

ES-4. Projects and Management Actions (Chapter 4)

Chapter 4 describes past, current, and future projects and management actions used to achieve the Ukiah Valley Basin sustainability goal.

To achieve the sustainability goals for Ukiah Valley by 2042, and to avoid undesirable results over the remainder of a 50-year planning horizon, as required by SGMA regulations, multiple projects and management actions (PMAs) have been identified and considered in this GSP.

PMAs are categorized into two tiers of implementation, as follows:

Tier I: Existing PMAs that are currently being implemented and are anticipated to continue to be implemented.

Projects and management actions in Tier I include general plans for Mendocino County and Ukiah Valley area, conceptual modeling of watershed hydrology, plans related to Lake Mendocino's management and water supply, Ukiah City storm water and water management plans, Sonoma County water resources plans, and more.

Tier II: PMAs planned for near-term initiation and implementation (2022–2027) by individual member agencies, as well as additional PMAs that may be implemented in the future, as necessary (initiation and/or implementation 2027–2042).

Tier II PMAs fall into the following subcategories: supply augmentation projects, demand management water conservation, and other management actions.

Tier II supply augmentation projects include conjunctive use projects, managed aquifer recharge and injection wells, and projects to reduce evaporative losses from existing surface water storage. Demand management and water conservation projects include installing new pump(s) for potable water intertie, possible implementation of conservation easements, conservation programs and green infrastructure, irrigation efficiency improvements, voluntary land repurposing, farming alternative lower ET crops, and municipal supply and use efficiency improvements. Lastly the projects which fall into the other management actions category include monitoring activities needed for better implementation of the GSP and achieving its sustainability goal including establishing a well inventory program, implementing drought mitigation measures, forbearance, projecting the future of the Basin for enhanced management, design and implementation of a voluntary well metering program, and conducting outreach and education to beneficial users and impacted parties.

Projects and management actions are further outlined for GSP implementation in the full body of Chapter 4.

ES-5. Plan Implementation (Chapter 5)

Chapter 5 details key GSP implementation steps and timelines. Cost estimates and elements of a plan for funding GSP implementation are also presented in this chapter.

Implementation of the GSP will focus on the following several key elements:

1. GSA management, administration, legal and day-to-day operations.
2. Reporting, including preparation of annual reports and 5-year evaluations and updates.
3. Implementation of the GSP monitoring program activities.

4. Technical support, including UVIHM model updates, SMC tracking, and other technical analysis.
5. Implementation of PMAs
6. Ongoing outreach activities to stakeholders

Implementation of the GSP over the 20-year planning horizon is projected to cost $140,000-$405,000 per year (present dollar value) based on the best available information at the time of Plan preparation and submittal. Actual cost of GSP implementation for each year will depend on the specific tasks that need to be conducted during that year. This estimated amount excludes major capital projects.

The GSAs will pursue various funding opportunities from state and federal sources for GSP implementation. As the GSP implementation proceeds, the GSAs will further evaluate funding mechanisms through its rate fee study PMA and may perform a cost-benefit analysis of fee collection to support consideration of potential refinements. At the start of the GSP implementation, the GSA will be funded through member agency contributions. Member agency contribution will continue during the first 5-year implementation period until a fee structure is implemented to support and fund GSA activities. Upon such action, member agency contributions will be reduced to cover the needed costs that are not funded through the implemented fee structure.

Chapter 1

Introduction

List of Appendices

The Ukiah Valley Groundwater Sustainability Agency (UVBGSA) is the sole Groundwater Sustainability Agency (GSA) for the Ukiah Valley groundwater basin (UVB or Basin) located in Mendocino County (County). UVBGSA consists of the County of Mendocino (County), the City of Ukiah, the Upper Russian River Water Agency, and the Russian River Flood Control and Water Conservation and Improvement District (RRFC). The UVBGSA developed this Groundwater Sustainability Plan (GSP or Plan) in accordance with the California Department of Water Resources (DWR) Sustainable Groundwater Management Act (SGMA) of 2014. The purpose of the Plan is to roadmap the process to achieving sustainable groundwater management, as defined by SGMA, in the Basin.

SGMA is a three-bill legislative package comprised of Assembly Bill (AB) 1739 (Dickinson), Senate Bill (SB) 1168 (Pavley), and SB 1319 (Pavley) signed into law in 2014 and codified in Section 10720 of the California Water Code. SGMA took effect on January 1, 2015 and California for the first time in its history had a framework for sustainable, locally led groundwater management. Under SGMA, the Department of Water Resources published Bulletin 118 ranking all of the groundwater basins in California. The Ukiah Valley Basin was designated a medium priority basin and SGMA regulations state all overdrafted basins designated medium and high priority must form a GSA and be managed according to a GSP by January 31 of 2022 ensuring sustainable management of groundwater for future generations. This GSP is the result of years of collaborative effort to understand the Ukiah Valley Basin by the local water agencies, regulating bodies, technical experts, and tribal and agricultural stakeholders that all hold interest in preserving the health of the Basin.

SGMA expands the role of DWR to support local implementation of GSPs and allows for intervention by the State Water Resources Control Board (SWRCB) at specific points throughout the process if local agencies are not willing or able to manage groundwater sustainably. In addition to the one Assembly Bill and two Senate Bills, SGMA is partially defined by the "emergency regulations" (adopted by the DWR and incorporated into the California Code of Regulations, Sections 350 – 354.4) and a number of other documents.[1]

SGMA required critically-overdrafted high and critically-overdrafted medium priority basins to be managed under a GSP by January 31, 2020, and all other groundwater basins designated as high or medium priority basins to be managed under a GSP by January 31, 2022. Additionally, SGMA requires demonstrated sustainability within 20 years of GSP implementation, and continued sustainability through the 50-year planning and implementation horizon.

It is the belief of the UVBGSA that groundwater management by a local entity will best ensure the local communities' needs are met and voices are heard while striving toward optimized groundwater management, consistent with the belief of former California Governor Jerry Brown who emphasized in his signing statement that "groundwater management in California is best accomplished locally."

To facilitate such sustainable groundwater management, this Plan provides:

- Agency information and management structure (**Chapter 1**);
- All pertinent background information (**Chapter 2**) including description of the Plan Area and Basin setting, historical conditions, and current conditions;
- Modeled water budget information (**Section 2.2.3**) including the estimated sustainable yield and discussion on how the value may change over time as a result of changes in climate;
- Sustainable management criteria (**Chapter 3**) that will serve as the basis for evaluation of the sustainability of groundwater management in the Basin and the efficacy of this Plan;

[1] https://water.ca.gov/Programs/Groundwater-Management/SGMA-Groundwater-Management

- Description of the existing monitoring network and protocol (**Section 3.3**), assessment of the existing network and protocol with respect to its ability to generate the data necessary to sufficiently evaluate the sustainability of groundwater management in the Basin, and planned improvements;
- Projects and management actions planned to achieve sustainability, i.e., meet the sustainable management criteria (**Chapter 4**); and
- GSP implementation information (**Chapter 5**) including estimated cost, implementation schedule, annual reporting protocol, and periodic evaluation protocol for evaluating the Plan's efficacy and amending the Plan as needed to achieve sustainability.

Groundwater is a key driver of economic activity within California and supports nearly one-third of all activities within the state including a robust agricultural industry to which Mendocino County contributes 320 million dollars of agricultural products as of 2018 (2018 Crop Report).[2] The Ukiah Valley Basin is in the south-east corner of Mendocino County and is home to City of Ukiah, the County seat. The Basin as of 2010 had a population of 32,262 people. In normal years, the primary sources of water in the Basin are the diversions of surface water from the Russian River and releases from Lake Mendocino and the remaining demand is supplied from groundwater. There has been no chronic decline noted in the groundwater levels even after extensive use during drought years (Marquez, 2017).

The majority of water in the Basin is supplied in normal years from the Russian River and distributed by the major water purveyors who also operate pumping wells and recharge practices (DWR, 2019d). The work done by the UVBGSA is to safeguard water supply and water quality within the Basin. However, the location of the Basin as part of the Upper Russian River Watershed puts it in a position to protect downstream groundwater and overall water health not only for Mendocino County but also for Sonoma and Marin Counties.

In June of 2017, The UVBGSA notified the public of its intent to form a GSA. In July of 2018, the UVBGSA filed the initial notification with DWR to initiate development of a GSP for the Ukiah Valley Groundwater Basin.

1.1 Purpose of the Groundwater Sustainability Plan

The purpose of this Plan is to ensure that "sustainable groundwater management" in the Basin by the UVBGSA is achieved by 2042 and maintained thereafter. Sustainable groundwater management is the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing "undesirable results." Undesirable results are one or more of the following effects caused by groundwater conditions occurring throughout a groundwater basin:

1. Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods.

[2] https://www.mendocinocounty.org/home/showdocument?id=30868

2. Significant and unreasonable reduction of groundwater storage.
3. Significant and unreasonable seawater intrusion (not applicable to Ukiah Valley).
4. Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.
5. Significant and unreasonable land subsidence that substantially interferes with surface land uses.
6. Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

The goal of SGMA is to avoid undesirable results of the six sustainability criteria defined by DWR. To complete a specific local definition of undesirable results, the GSA worked with technical advisors, informed stakeholders, and consultants to model the flow of water within the basin and created Sustainable Management Criteria within the thresholds designated by DWR (DWR, 2017). This GSP is a result of a three-year effort and has resulted in clear monitoring criteria for the basin, and criteria for long-term management to protect groundwater. UVBGSA engaged stakeholders to develop a description of what would be considered “significant and unreasonable” impacts associated with each of the five undesirable results categories in the Basin. This requirement of the Plan is set forth in SGMA.

The purpose of this Plan, as implemented by the GSA, is as follows:

- to facilitate groundwater management in the Basin with the objective of eliminating impacts associated with groundwater level declines, groundwater storage reductions, water quality degradation, land subsidence, and surface water depletions that result from groundwater extraction and are locally considered to be significant and unreasonable; and,
- to prevent any such impacts from occurring by 2042 and thereafter.

This purpose serves as the basis of the intention of the sustainability goal described in the following section.

1.2 Sustainability Goal

The Joint Powers Agreement of the GSA states that “The Members have determined the sustainable management of the Basin…best be achieved through cooperation of the Members.” The sustainability goal for the Basin, created by the UVBGSA as required by the SGMA regulations is a collaborative effort between each of the members of the GSA, technical advisory groups, consultants, and public commenters. The goal fulfills the regulations put forward by the DWR to develop a sustainability goal that “…culminates in the absence of undesirable results within 20 years….” (23 CCR § 354.24).

The UVBGSA strives for equal access to groundwater for all current and future members of the Basin and that the water will be put to beneficial uses while being able to sustainably meet demand and avoid any undesirable results. The overall sustainability goal of groundwater management in the Basin, as outlined on **Chapter 3**, is to maintain groundwater resources in ways that best support the continued and long-term health of the people, the environment, and the economy in Ukiah Valley, for generations to come. This includes managing groundwater conditions for each of the applicable sustainability indicators in the Basin so that:

- Groundwater elevations and groundwater storage do not significantly decline below their historically measured range, protect the existing well infrastructure from outages, protect groundwater dependent ecosystems, and avoid significant additional streamflow depletion due to groundwater pumping.
- Groundwater quality is suitable for the beneficial uses in the Basin and is not significantly or unreasonably degraded.
- Significant and unreasonable land subsidence is prevented in the Basin. Infrastructure and agricultural production in Ukiah Valley remain safe from permanent subsidence of land surface elevations.
- Significant and undesirable streamflow depletions due to groundwater pumping are avoided through projects and management actions consistent with existing regulatory requirements.
- The GSA's groundwater management is efficiently and effectively integrated with other watershed and land use planning activities through collaborations and partnerships with local, state, and federal agencies, private landowners, and other organizations, to achieve the broader "watershed goal" of sufficient surface water flows that sustain healthy ecosystem functions.

Chapter 3 of this Plan contains the details of the Basin Sustainability Goal. Sustainable management criteria are developed for chronic lowering of groundwater levels, reduction in storage, depletion of interconnected surface waters, degradation of groundwater quality, and subsidence. In addition, monitoring networks are designed to track these sustainability indicators. It is worth mentioning that the basin has not had significant issues historically concerning any of the sustainability indicators except occasional seasonal surface water depletion during drought periods. Seawater intrusion is not considered for the basin and this GSP as the basin is geographically disconnected from the ocean.

Projects and management actions (PMAs) currently included in the GSP include an artificial groundwater recharge pilot in the City of Ukiah as well as a recycled water program providing alternative irrigation supplies for farmers, parks, schools, golf course, and other uses. These actions will provide supply reliability and groundwater recharge in the Basin to combat any excessive groundwater pumping by individuals or agricultural and industrial operations. Additional PMAs are also developed as concept proposals or pilot projects that will be further designed and implemented to help achieve the sustainability goal of the GSP. The Basin water budget demonstrates that given current seasonal recharge rates and the limited population growth within the Basin, few management actions will need to be undertaken in the short term by the GSA. However, possible future scenarios such as changes in licensing of the Potter Valley Project would significantly change the water system of the upper Russian River Watershed and the basin and will need to be considered for their direct impact on the basin groundwater recharge capability.

1.3 Agency Information (Section 354.6)

In April of 2017, the UVBGSA was formed through a Joint Powers Agreement (JPA). The initial members of the Agency are as follow: County of Mendocino, City of Ukiah, Upper Russian River Water Agency, and Russian River Flood Control and Water Conservation Improvement District. These are the principal public agencies that extract groundwater from, regulate groundwater, and/or conduct land use activities within the basin. The board formed by these agencies elected to assign membership seats to agricultural and tribal beneficial use in the basin, leading to a six-member board for the GSA.

1.3.1 Member Agency Descriptions

Brief descriptions of the six member agencies are provided below.

1.3.1.1 Mendocino County Water Agency

The Mendocino County Water Agency is a special district that encompasses all of Mendocino County and represents the County on the Board of the GSA. Created in 1949 by the state legislature as the Mendocino County Flood Control and Water Conservation District (The District), it originally provided civil engineering and hydrologic consulting to water districts within the County before it was renamed in 1987. It has since transitioned to primarily provide regulatory compliance related to stormwater, water quality, and groundwater elevation monitoring, and water-related interagency and community relations and coordination.

1.3.1.2 City of Ukiah

The first settlers moved to Ukiah in 1856 and the town was named as early as 1859. The town was incorporated in 1876. The City of Ukiah Water Treatment Department currently administers a supply of high-quality water to residents of the City of Ukiah (City). The City provides water to the 16,000 people with 7,000 residential and commercial connections and over 90 miles of water mains.

The City is well served by a variety of water sources. A majority of its water supply comes from surface water diversions from the Russian River with two appropriative rights to divert 16,480 acre-feet annually. There is also a capability to withdraw 4,000 acre feet annually from the groundwater aquifer below the City that is routinely recharged. The City began implementing a recycled-water program in 2019 that can help save over 1,000 acre-feet of water annually which is part of ongoing drought resiliency efforts. The City was able to meet its water needs in 2014-2015, the driest year on record. The supply's resilience during a significant period of stress indicates long-term ability to meet demand.

1.3.1.3 Russian River Flood Control & Water Conservation Improvement District

The Russian River Flood Control is tasked with the proactive management of water resources in the Upper Russian River Watershed for the benefit of the people and environment of Mendocino County.

The District serves 52 agricultural customers and approximately 4,500 connections in five water districts' purveyors or retailers service areas throughout the Ukiah Valley. Additionally, the District provides Redwood Valley with surplus water, when available, for agricultural customers and municipal or domestic/commercial connections. It has water rights to directly divert 28 cfs and diversion to storage of 82,600 acre feet per year. The District's right to stored water in Lake Mendocino represents the County of Mendocino's share of the water from the reservoir.

1.3.1.4 Upper Russian River Water Agency

The Upper Russian River Water Agency was created in 2017 under a JPA representing the four water districts in the north of the Ukiah Valley Basin. These water districts include the Calpella County Water District (CWD), Millview CWD, Redwood Valley CWD, and Willow CWD. This Agency was created to bring economies of scale to the agricultural and residential communities as well as providing a pathway for eventual consolidation of the districts into one regional water agency.

1.3.1.5 Tribal Seat

The Ukiah Valley Basin is home to six tribal nations who collectively appoint a tribal representative to the UVBGSA. The six tribes are identified as: Redwood Valley Rancheria, Coyote Valley Reservation, Pinoleville Pomo Nation, Potter Valley Rancheria, Guidiville Rancheria, and the Hopland Reservation. Tribal representatives are a key stakeholder within the Basin bringing to the table a wealth of cultural practices and historical knowledge as well as forward thinking water management practices geared to preserve these ecosystems.

1.3.1.6 Agricultural Seat

Agricultural stakeholders are appointed to the Board of the UVBGSA (one member) to participate in groundwater management activities. Mendocino County is a predominantly agriculture-focused county with the majority of proceeds deriving from wine grapes and timber. Agricultural operations can have an impact on water quality and agricultural operators are an important constituent in the Basin.

1.3.2 Organization and Management Structure of the Groundwater Sustainability Agency

The GSA is governed by a six-member Board of Directors consisting of representatives from each of the agencies as well as representatives of the Tribal and Agricultural interests in the Basin. The current Board Members can be found on the UVBGSA's website.[3] The board is comprised of:

- one representative from the Mendocino County Board of Supervisors appointed by the Mendocino County Board of Supervisors;
- one representative from the Ukiah City Council appointed by the Ukiah City Council;
- one representative from the Board of Trustees of the Russian River Flood Control appointed by the Board of Trustees of the Russian River Flood Control;
- one representative from the Board of the Upper Russian River Water District appointed by the Board of the Upper Russian River Water District;
- one Agricultural Stakeholder Director determined by the Board of Directors; and,
- one Tribal Stakeholder Director appointed by the six tribes exercising jurisdiction over Indian lands within the Ukiah Valley Basin identified as Redwood Valley Rancheria, Coyote Valley Reservation, Pinoleville Pomo Nation, Potter Valley Rancheria, Guidiville Rancheria and the Hopland Reservation.

[3] https://www.mendocinocounty.org/government/affiliated-agencies/ukiah-valley-basin-gsa

The Plan Manager for the GSP is Amber Fisette. Ms. Fisette's contact information is as follows:

Amber Fisette
Mendocino County Water Agency
340 Lake Mendocino Drive
Ukiah, CA 95482
Phone: (707) 463-4363
Email: fisettea@mendocinocounty.org

The mailing address for the UVBGSA is as follows:

Ukiah Valley Basin Groundwater Sustainability Agency
c/o Mendocino County Water Agency
Attention: Plan Manager
340 Lake Mendocino Drive
Ukiah, CA, 95482
Email: uvbgsa@mendocinocounty.org

1.3.3 Communication and Engagement Plan

UVBGSA developed a Stakeholder Communication and Engagement Plan (C&E Plan) to educate interested parties about local SGMA implementation, describe the phases of GSP development, encourage public participation in the process, and address noticing and communication requirements in the law. The C&E Plan describes how the local GSA was formed, the support role played by technical and facilitation consultants, and the process by which the GSA board of directors (GSA Board) with support from a stakeholder advisory committee gathers, considers, and responds to needs and interests of constituents throughout the community. Consensus building is a foundational principle of all committee discussions, and membership is intended to reflect the diversity of beneficial groundwater uses and users in UVB. The C&E Plan is included in **Appendix 1-A**.

1.3.4 Legal Authority of the GSA

The UVBGSA has the legal authority to perform duties, exercise powers and accept responsibility while sustainably managing groundwater within the Ukiah Valley Groundwater Basin. Legal authority afforded the GSA derives from SGMA, the JPA effective April 17th, 2017 (**Appendix 1-B**) and the GSA Bylaws (**Appendix 1-C**) effective November 9th, 2017. These laws and documents taken together, gives the UVBGSA the legal authority to develop, implement and manage a Groundwater Sustainability Plan for the Ukiah Valley Basin.

1.3.5 Estimated Cost of Implementing the GSP and the GSA's Approach to Meet Costs

Upon creation, the UVBGSA was funded by its member agencies through a one-time capital contribution based on an equitable cost sharing model. The members agreed to the cost sharing within the Bylaws of the UVBGSA and each provided 5,000 dollars to the Agency. These 20,000 dollars of investment allowed the agency to pursue grants from DWR for plan development. An additional

3,000 dollars was provided by each of the Member Agencies in December of 2020 for a total of 12,000 dollars in additional funding for ongoing Administrative Costs.

The Mendocino County Water Agency sourced two separate grants from the Department of Water Resources for the development and implementation of the GSP. On May 7th, 2018, under the Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Proposition 1) Funding, the Mendocino County Water Agency accepted 764,255.00 dollars for the improvement of sustainable groundwater management infrastructure.

On April 20th, 2020, under the California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access for All Act of 2018 (Proposition 68), the Mendocino County Water Agency accepted 1,233,800.00 dollars to assist in financing the Ukiah Valley Basin Groundwater Sustainability Plan (GSP) Development Support to improve sustainable groundwater management, pursuant to Water Code Section 79700 et seq.

The cost breakdown for implementing and managing the GSP is presented by category below but also includes a fiscal reserve for unexpected and miscellaneous costs. The major cost categories are:

- Agency administration and operations
- GSP reporting (annual and 5-year reports)
- Monitoring, data collection, and technical Support
- Technical work and model maintenance
- Outreach, coordination, and education
- Legal support
- Projects and management actions

The total estimated cost of GSP implementation over the next 20 years (2022 to 2042) is estimated to be in the range of 220,000 to 365,000 dollars (present dollar value), annually, based on the best available information. A detailed description and breakdown of the estimated costs are provided in **Chapter 5**.

The GSA will pursue various available funding opportunities to assist in covering the yearly costs. As part of the implementation, the GSA will conduct a rate fee study to analyze and choose the best available option for fee collection. It is expected that the GSA will manage the implementation and reporting of the GSP with support from other entities, as needed. The GSA will be funded through member agency contribution during the first five-year implementation period until a fee structure is implemented to support and fund GSA activities. Upon such action, member agency contributions may be reduced to cover the needed costs that are not funded through the implemented fee structure. This updated fee structure will be continually used to fund the GSA and GSP implementation up to the end of the 20-year period.

1.4 GSP Organization

The UVB Groundwater Sustainability Plan is organized based upon DWR's GSP Annotated Outline. Content requirements requiring additional information was sourced from the Preparation Checklist for GSP Submittal (DWR, 2016b). The GSP is organized as follows:

Executive Summary: This chapter presents an overview of the GSP, a background of the groundwater conditions within the Basin, a timeline of the GSP Development process, and key information from each of the GSP sections.

Chapter 1 Introduction: This chapter states the purpose of the GSP, the Basin's Sustainability Goal, information on the GSA and its member agencies and the organization of the GSP.

Chapter 2 Plan and Basin Settings: This chapter describes the Ukiah Valley Basin Groundwater Plan, current conditions within the Basin, and a historical baseline and models for future scenarios. This historic and projected data provides context to be able to sustainably manage the basin into the future. This chapter also provides the Basin water budget as context for achieving long-term sustainability within the Basin.

Chapter 3 Sustainable Management Criteria: This chapter discusses the Basin's Sustainability Goal as well as the requirements for the six Sustainability Management Criteria laid out in SGMA and the associated Minimum Thresholds and Measurable Objectives created for the UVB. These indicators provide the framework for actions (management actions or otherwise) to be undertaken by the GSP in the event of a threat to the sustainability of the Basin.

Chapter 4 Projects and Management Actions to Achieve Sustainability Goal: This chapter provides a description of projects and management actions necessary to achieve Basin sustainability and provides a response plan to simulated future Basin scenarios.

Chapter 5 Plan Implementation: This chapter provides an estimate of GSP operating costs and the implementation schedule for management actions. It also outlines the procedural requirements for the annual and five-year evaluations to the GSP and the associated steps necessary to update the GSP if necessary.

Chapter 6 References and Technical Studies: This chapter presents a compiled list of all technical reports and associated reference studies used to prepare this GSP.

1.4.1 Public Review of the GSP

The GSA published a public draft of the GSP for public review on August 16, 2021, and provided a 40-day comment period up to September 24, 2021. Two public meetings were held to facilitate the public commenting process. One public meeting was held before the comment period starts on July 15, 2021, to explain the commenting process and provide an introduction to the GSP and its organization. At the end of the comment period, the second public meeting was held on September 21, 2021, to receive in-person feedback and comments and respond to questions and concerns. Public comments received were collected and organized by the GSA and responded to in a timely manner. Important comments were discussed during four consecutive GSA Board and Technical Advisory meetings in October and November of 2021. A comment matrix including all comments made during the public commenting process and GSA's responses are included in **Appendix 1-D**.

1.4.2 Preparation Checklist for GSP Submittal

This GSP was prepared to meet the regulatory requirements established by DWR, as shown in the completed GSP Elements Guide, provided in **Appendix 1-E**, which is organized according to the California Code of Regulation Sections of the GSP Emergency Regulations.

Chapter 2

Plan Area and Basin Setting

List of Appendices

2.1 Description of the Plan Area

2.1.1 Summary of Jurisdictional Areas and Other Features

The Basin is located in Mendocino County and underlies the Ukiah Valley, the Redwood Valley, and the tributaries located within their boundaries **(Figure 2.1)**. Under the 2018 Basin prioritization conducted by the California Department of Water Resources (DWR), the Ukiah Valley groundwater Basin (DWR Basin 1-052) was designated as medium priority (DWR, 2019d). Elevations in the Basin vary from approximately 500 feet (ft) (150 meters (m)) above mean sea level (amsl) in the southern part of the Ukiah Valley to over 1000 feet (305 m) amsl in the Redwood Valley. The Basin encompasses a surface area of 37,500 acres (59 square miles (mi^2)) and is 22 mi (35.4 km) long and 4.6 mi (7.4 km) at its widest section just north of the City of Ukiah, which is the major municipality within the Basin with population of 16,075 (U.S. Census Bureau, 2018). The majority of the land within the Basin is privately owned except for small California Tribal Reservations and Rancheria areas, land owned by the State of California, and land in the proximity of Lake Mendocino that is owned by the federal government **(Figure 2.2)**. The Russian River flows through the entire length of the Basin and is joined by several smaller tributaries. Lake Mendocino borders the eastern side of the Basin and provides managed releases to the East Fork of the Russian River through the operation of Coyote Dam. The east and west forks of the Russian River merge north of the City of Ukiah and flow southward towards the Basin drainage and Hopland. The Basin is bounded by the Mendocino Range of the Coastal Ranges and is bordered by the Sanel Valley Groundwater Basin (1-053) to the south. The Mendocino Range is predominantly composed of the thick, late Mesozoic and Cenozoic sedimentary rocks of the Franciscan formation.

Figure 2.1 shows the Basin and the neighboring groundwater basins. The Sanel Valley groundwater basin is located immediately south of the Ukiah Valley groundwater Basin and the McDowell Valley groundwater basin is located in the east of the Sanel Valley. Both groundwater basins are located in the Russian River watershed (Watershed) and Sanel Valley has a direct hydraulic connection with the Ukiah Valley groundwater Basin. The Potter Valley groundwater basin is also located in the Watershed but to the northeast of the Basin. Potter Valley does not have a direct hydraulic connection to the Basin but provides water that may flow to the Ukiah Valley groundwater Basin through the tributary system within the Watershed. Anderson Valley and Little Lake Valley groundwater basins are located outside the Watershed to the southwest and northwest of the Ukiah Valley groundwater Basin, respectively. All of the neighboring basins are categorized as very low priority under the 2018 Basin prioritization conducted by the DWR and are not preparing groundwater sustainability plans.

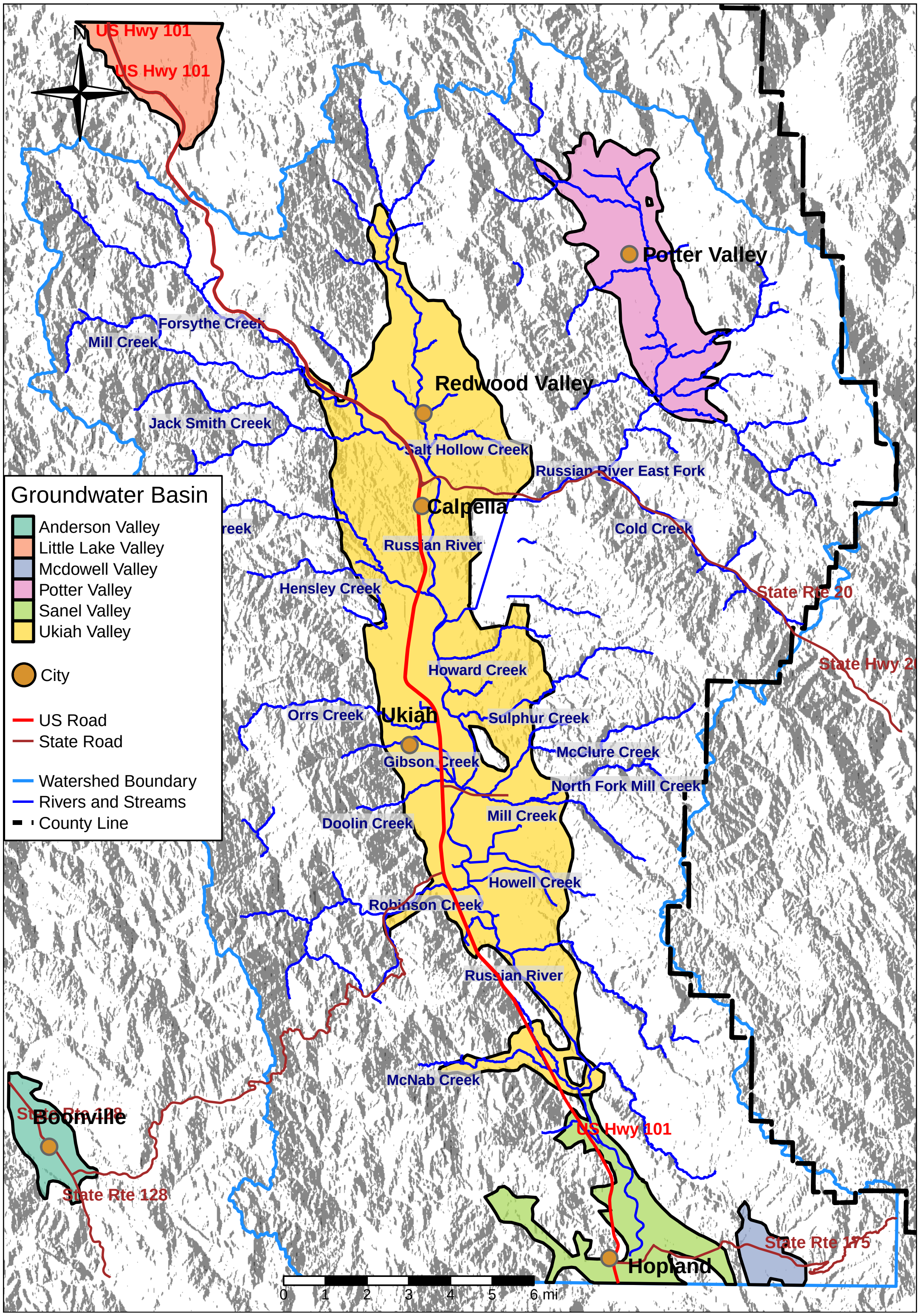


Figure 2.1: Ukiah Valley groundwater Basin bulletin 118 Basin boundary and surrounding area.

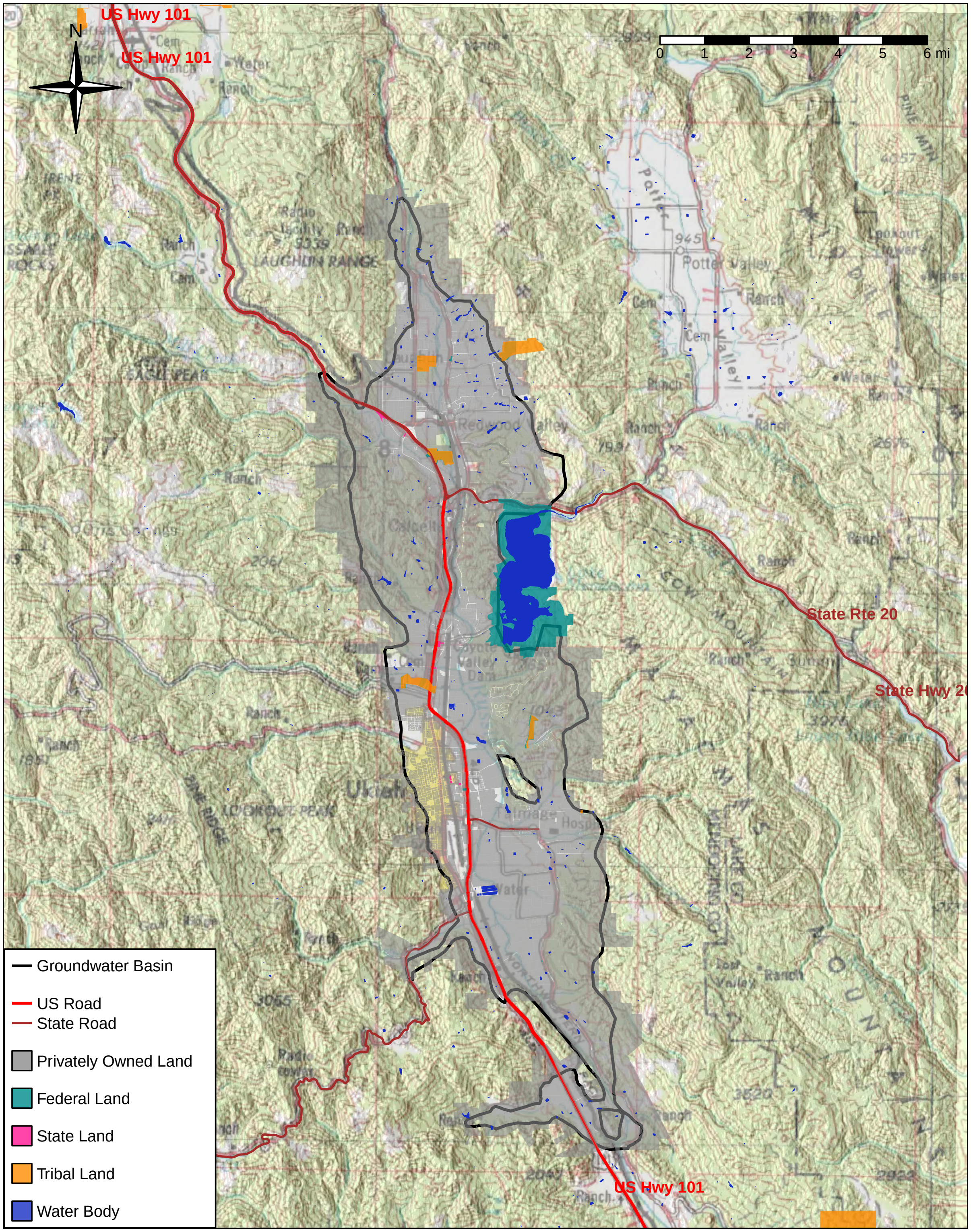


Figure 2.2: Land jurisdiction and topography in the Ukiah Valley Groundwater Basin.

2.1.1.1 Jurisdictional Areas and Land Use

The Ukiah Valley Basin Groundwater Sustainability Agency (UVBGSA or GSA) is the sole GSA for the Basin and is responsible for the entire area covered by this GSP (**Figure 2.1**). The GSA consists of the County of Mendocino (County), the City of Ukiah, the Upper Russian River Water Agency, and the RRFC (**Figure 2.3**). The County exercises land use authority on the land overlying the Basin. The City of Ukiah (City) is a local municipality that exercises water supply, water management, and land use authority within its boundaries. The Upper Russian River Water Agency is a joint powers authority (JPA) representing Millview County Water District (CWD), Willow CWD, Calpella CWD, Redwood Valley CWD, and Ukiah Valley Sanitation District within the Ukiah Valley Basin. The RRFC is a special district created by State Statute (State of California Statue § Act 4830) that exercises water supply and water management authority within the Basin. Rogina Water Company also provides water supply within the Basin but is not a GSA member. The boundaries of these agencies and UVBGSA are shown in **Figure 2.3** and **Figure 2.4**.

The Basin boundary fully encompasses the City of Ukiah. Four small portions of the Basin are designated federal tribal lands and are not subject to SGMA requirements **(Figure 2.2)**. These tribal lands are owned by the Guidiville Rancheria Tribe, Pinoleville Pomo Nation, Coyote Valley Tribe, and Redwood Valley Little River Band of Pomo Indians. However, one tribal representative sits on each the UVBGSA Board and the Technical Advisory Committee (TAC). A majority of communities within the Basin are designated as either Disadvantaged Communities (DACs) or Severely Disadvantaged Communities (SDACs), as shown in **Figure 2.5**. Communities with an annual median household income (MHI) of less than 80% of the average annual MHI in California are classified as DACs, while communities with annual MHIs of less than 60% of California's annual MHI are considered SDACs. According to DWR's DAC Mapping Tool (DWR, 2019a), the statewide annual MHI for 2012-2016 is $63,783, leading to the designation of the City of Ukiah as a DAC with its annual MHI of $38,686. Moreover, the U.S. Census American Community Survey (ACS) further delineates census tracts within the Basin, each of which are designated as DAC or SDAC. The MHI (DWR, 2019a) for each of these tracts is as follows:

- Tract 06045010900, population 5,044 – $44,296 (qualifies as DAC)
- Tract 06045011300, population 5,703 –$36,310 (qualifies as SDAC)
- Tract 06045011500, population, 6,616 – $38,662 (qualifies as DAC)
- Tract 06045011600, population 5,814 – $26,122 (qualifies as SDAC)
- Tract 06045011800, population 2,171 – $49,485 (qualifies as DAC)

All of the census tracts that are wholly within or intersect the Ukiah Valley Basin are designated as either a DAC or SDAC. In addition, the combined population of these DAC and SDAC census tracts is 25,348, or approximately 85% of the estimated 2010 population of the Ukiah Valley Basin (29,671), which includes the Ukiah Census County Division (CCD), the Calpella Census Designated Place (CDP), and the Redwood Valley CDP. Therefore, throughout the GSP, all analyses and impact assessments were conducted, and all decision-making processes were undertaken with the consideration that they would directly impact DACs and SDACs in the Basin, including Basin's tribal communities.

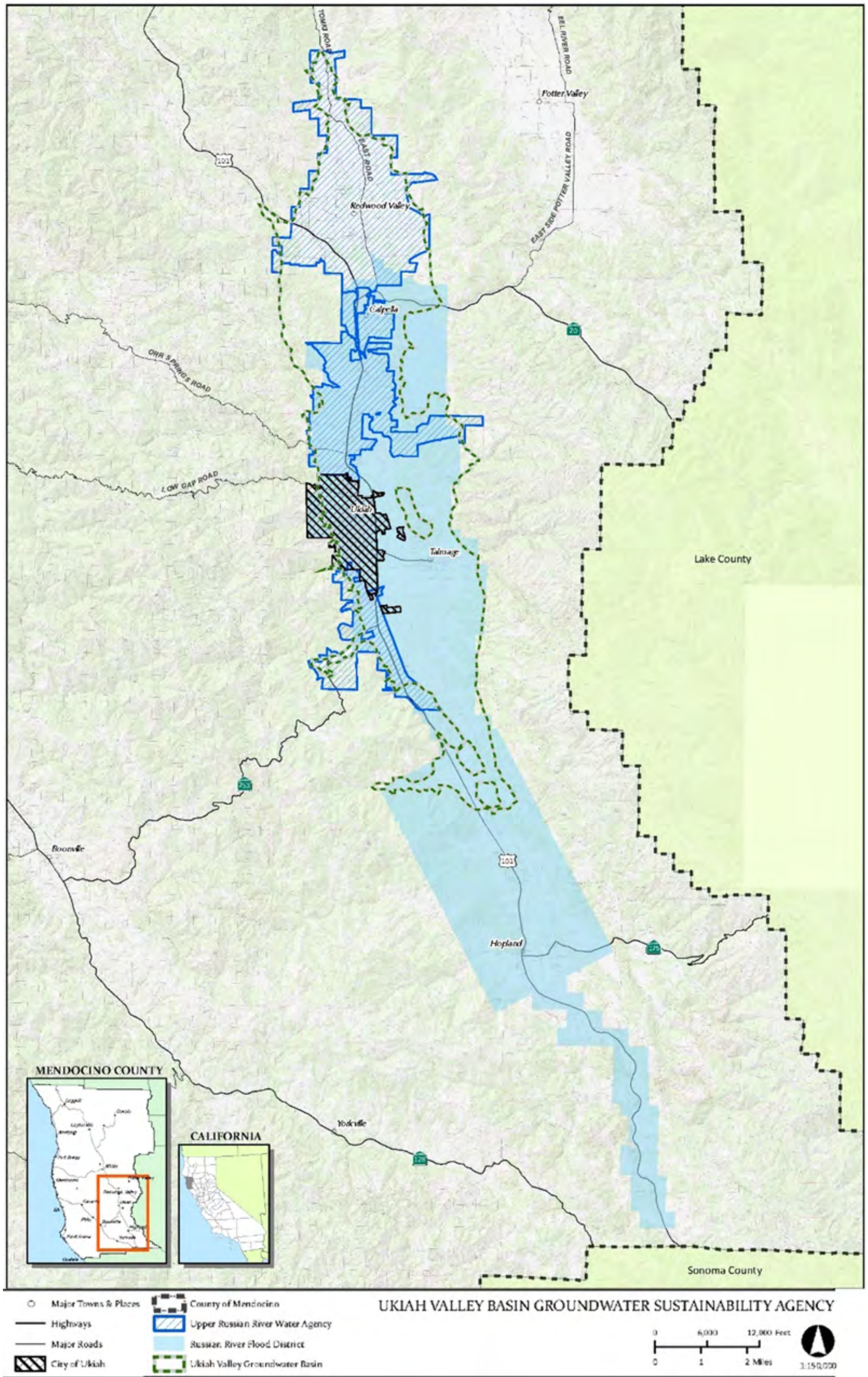


Figure 2.3: UVBGSA JPA members and their respective boundaries

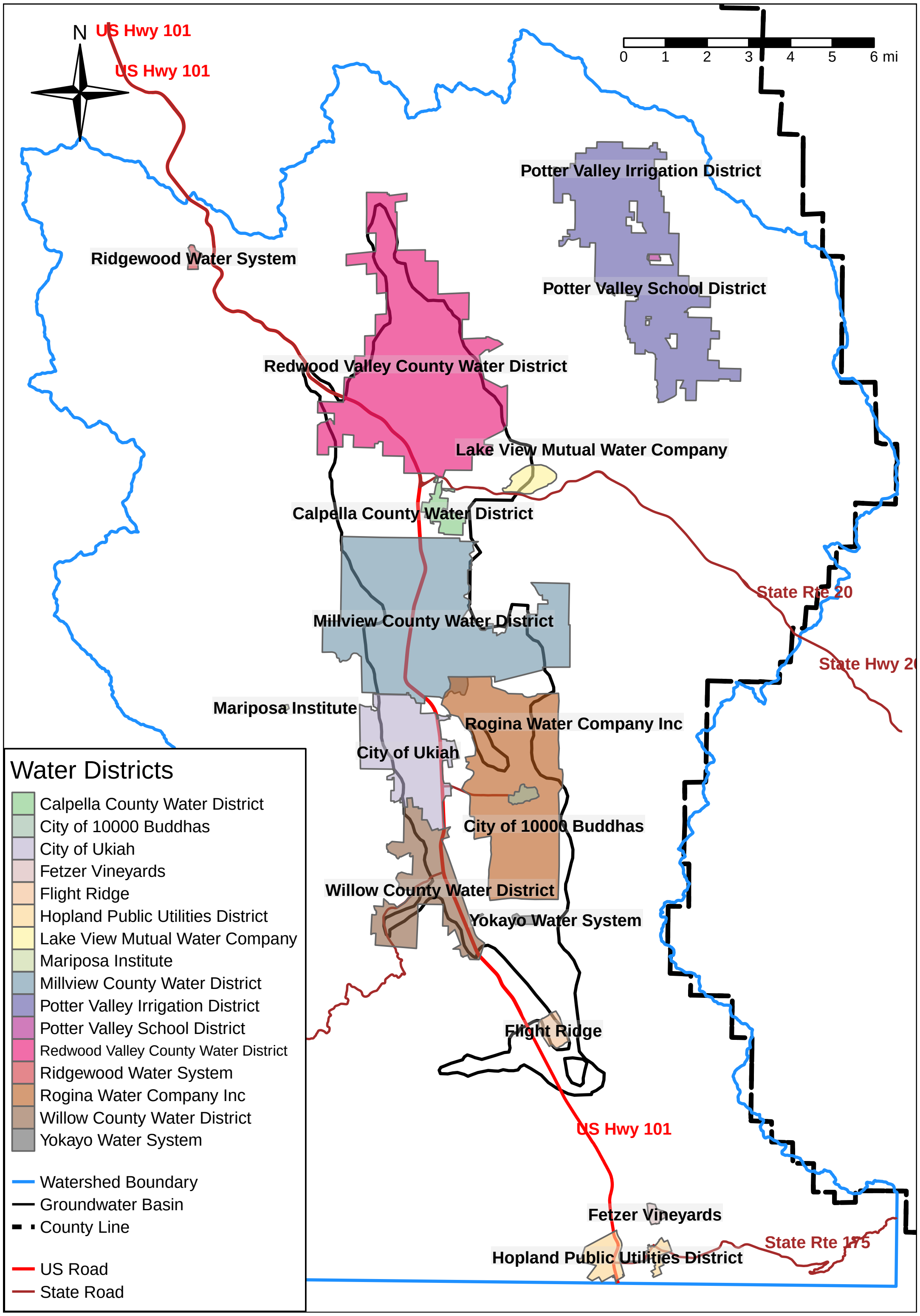


Figure 2.4: Water districts in the Ukiah Valley Groundwater Basin.

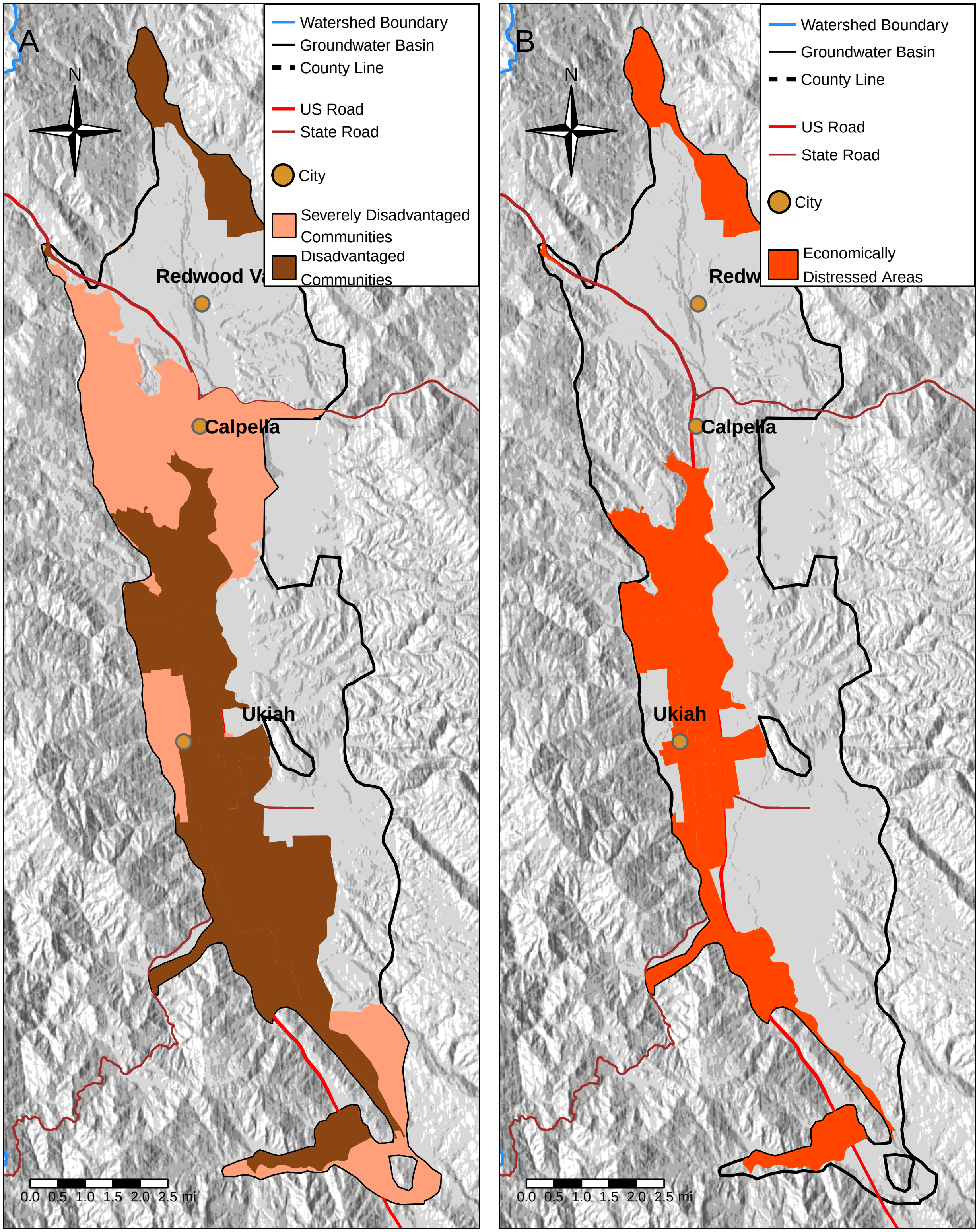


Figure 2.5: Map of (A) disadvantaged and severely disadvantaged communities , and (B) economically distressed areas in the Ukiah Valley Groundwater Basin (order of overlay: census place, census tract, census blocks).

Water Agencies

Water agencies in the Basin are shown in **Figure 2.4**. A description of the major water agencies located in the Basin and their services is provided below.

Russian River Flood Control and Water Conservation Improvement District

The RRFC encompasses almost all of the Ukiah Valley, except small portions of Millview CWD and Willow CWD. Along with the Sonoma Water,[1] the RRFC was formed to serve as the local sponsor for the development of Coyote Dam and Lake Mendocino. Water right license 13898 authorizes the RRFC to divert 7,960 acre-feet (9,818,501 cubic meters) per year for domestic, municipal, irrigation and recreational purposes within the RRFC service area. This water is diverted and sold as raw water to public water systems for municipal use and to private agricultural entities, which use it for irrigation and frost protection purposes. As of October 2021, 6,914 acre feet (8,528,281 cubic meters) has been contracted to public water systems and agricultural entities, with surplus going mostly to Redwood Valley CWD. The surplus water is sold to the Redwood Valley CWD for municipal and agricultural purposes.

City of Ukiah

The City of Ukiah (City) is the largest public water service provider in the Ukiah Valley, providing roughly half of the public water supply in the area to approximately 5,800 connections. The City's raw water supply is obtained from groundwater and Russian River underflow. The City has water rights for direct diversion of up to 14,480 acre-feet (about 17.85 million cubic meters) per year, at a maximum diversion rate of 20 cubic feet (0.57 cubic meters) per second, from January 1 through December 31 of each year. Out of this, 2,027 acre-feet (approximately 2.5 million cubic meters) per year, at a maximum diversion rate of 2.8 cubic feet (0.08 cubic meters), is classified as a pre-1914 water right considered to be senior to the Lake Mendocino water right, which is when the rights of overlying and non-overlying users were redefined. Extended dry and critically dry years may jeopardize allocating both pre- and post-1914 water rights.

Millview County Water District

The Millview CWD, located between Calpella and the City of Ukiah, provides water to about 1,300 residential connections and 210 commercial connections within its service area, and wheels treated water to Calpella County Water District (Calpella CWD). Millview CWD has five appropriative water rights to surface water from the Russian River. The most significant of these water rights allows for the direct diversion of up to 1,440 acre-feet (about 1.78 million cubic meters) per year between November 1 and July 1, at a maximum diversion rate of three cubic feet (0.08 cubic meters) per second, when the Russian River flows equal or exceed 150 cubic feet (4.25 cubic meters) per second at the point of diversion. The remaining four water rights collectively provide up to 82 acre-feet (101,078 cubic meters) per year for seasonal direct diversions.

All of these water rights are junior to those of Lake Mendocino and the pre-1914 water right holders, which potentially cause extended dry and critically dry years to prevent Millview CWD from practicing its water rights. Millview CWD has been engaged in negotiations with Masonite to allow it to increase its water supply by approximately 4,000 acre-feet (4.93 million cubic meters). It is also engaged in negotiations that could lead to the acquisition of a pre-1914 water right of up to 1,400 acre-feet (about 1.73 million cubic meters). However, the validity of both of these water rights has been contested by multiple parties and who have initiated the litigation process. To en-

[1] Formerly called Sonoma County Water Agency.

sure adequate supplies during extended dry periods, Millview CWD contracts with RRFC for 1,159 acre-feet (1,429,603 cubic meters) per year of water.

Redwood Valley County Water District

While the Redwood Valley CWD, located immediately north of the Ukiah Valley, does not provide water to the Ukiah Valley area, it withdraws water directly from Lake Mendocino and purchases surplus water from the RRFC, which could be used to satisfy future water demands of the Ukiah Valley area public water service providers and other RRFC water contractors. The Redwood Valley CWD currently delivers approximately 750 acre-feet (925,110 cubic meters) of water from Lake Mendocino for residential and commercial uses, and 1,450 acre-feet (1.79 million cubic meters) for agricultural purposes.

Redwood Valley CWD has a largely un-exercisable water right to divert up to 4,900 acre-feet (6,044,052 cubic meters) directly from Lake Mendocino, between November 1 and April 30 of each year, when stream flows in the Russian River at the confluence of the East and West forks exceed 150 cubic feet (4.25 cubic meters) per second and Lake Mendocino storage exceeds 72,000 acre-feet (88,810,560 million cubic meters). These conditions provide a relatively narrow window of opportunity for Redwood Valley CWD to exercise its water right, which is estimated to be as much as 70 days in wet years and one or two days in dry years.

Rogina Water Company Inc

As a private entity, the Rogina Water Company, located approximately one-half mile east of the City of Ukiah, provides water service to approximately 990 residential service connections. Its water supply consists of 400 acre-feet (493,392 cubic meters) per year surface water purchased from the RRFC, and four groundwater wells.

Willow County Water District

The Willow CWD, located immediately south of Ukiah, provides water service to approximately 990 residential and 60 commercial connections. Willow CWD has two appropriative water rights that are both junior to those of Lake Mendocino and the pre-1914 water right holders. One appropriative water right allows for the direct diversion of up to 1,400 acre-feet (1,726,872 cubic meters) per year between November 1 and July 1, at a maximum diversion rate of three cubic feet (0.08 cubic meters) per second, when stream flows in the Russian River equal or exceed 150 cubic feet (4.25 cubic meters) per second at the point of diversion. The other appropriative water right allows for the diversion of up to 728 acre-feet (897,973 cubic meters) per year, at a maximum diversion rate of one cubic foot (0.03 cubic meters) per second, from January 1 through December 31. To ensure adequate supplies during extended dry periods, the district purchases 515 acre-feet (635,242 cubic meters) per year from the RRFC.

Calpella County Water District

The Calpella CWD, located in the northwest corner of the Ukiah Valley, provides water to approximately 140 residential and 25 commercial connections in Calpella CWD and its surrounding area. Calpella CWD's water supply consists of groundwater from one well with a capacity of 40 acre-feet (49,306 cubic meters) per year, and 51 acre-feet (62,866 cubic meters) per year from surface water. The surface water portion of the water supply is from a contract from the RRFC for up to 85 acre-feet (104,846 cubic meters) per year and wheeled to Calpella CWD by Millview CWD, which also provides surface water treatment services to Calpella CWD.

City of 10,000 Buddhas, Flight Ridge, Lake View Mutual Company, and Yokayo Tribe Water System

The City of 10,000 Buddhas, Flight Ridge, Lake View Mutual Company, and Yokayo Tribe Water System also serve small populations in the Basin. Further details about these four water suppliers including their connection number, their supply and demand, and their source of water is considered a data gap at the moment despite outreach efforts from the GSA.

Wastewater Management

Ukiah Wastewater Treatment Plant

The City of Ukiah operates a wastewater collection system that covers the majority of the City's service area. The Ukiah Valley Sanitation District (UVSD) operates a wastewater collection system for the remaining portion of the service area. The City of Ukiah Wastewater Treatment Plant (UWWTP) receives wastewater from the City and UVSD wastewater collection systems including primary, secondary, and tertiary treatment facilities (Advanced Wastewater Treatment – AWT – System), as well as solids handling facilities.

The UWWTP's effluent discharges are regulated by a National Pollutant Discharge Elimination System (NPDES) permit – Order No. R1-2018-0035, NPDES No. CA0022888. The permit was adopted on September 6, 2018 and expires on October 31st 2023. This permit identifies the secondary wastewater treatment design flow to be 3,360 acre-feet (4.14 million cubic meters) per year for average dry weather treatment capacity and 27,443 acre-feet (approximately 33.83 million cubic meters) per year for peak wet weather treatment capacity.

On a year-round basis, the UWWTP discharges disinfected secondary effluent to three percolation/evaporation ponds located at the UWWTP, and discharges disinfected tertiary effluent to the Russian River as needed during wet weather months. The UWWTP is only permitted to discharge disinfected, tertiary wastewater to the Russian River from October 1 through May 14 at a rate of up to one percent of the total Russian River flow at latitude 39.118611º North and longitude 123.191111º West. The Water Quality Control Plan for the North Coast Region prohibits the discharge of treated wastewater from the UWWTP from May 15 through September 30.

During dry weather months, wastewater flows to the UWWTP are low enough that the full flow is stored in the percolation ponds and the AWT System is not in operation. During wet weather flows, the AWT System is operated and produces tertiary treated effluent that meets Title 22, Division 4, Chapter 3 California Code of Regulations (CCR) recycled water requirements. The tertiary treated effluent is therefore available to be delivered to future recycled water customers.

While the AWT has the maximum capacity of providing an average annual flow of approximately 7,841 acre-feet (9.67 million cubic meters) per year, the City is unlikely to produce recycled water at full capacity because both wastewater flow and recycled water demand are considerably lower than the full capacity of the AWT.

2.1.1.2 Adjudicated Areas, Other Groundwater Sustainability Agencies, and Alternative Plans

This GSP covers the entire Basin as shown in **Figure 2.1**. There are no adjudicated subareas within the Basin and no alternative plans have been submitted for any part of the Basin.

2.1.1.3 Current Land Use

Land use within the Basin is divided into three major categories: agricultural, urban, and native vegetation, which includes forests and riparian vegetation (**Figures 2.6** and **2.7**). **Table 2.1** shows the acreages associated with different land uses within the Basin according to the 2010 Land Use Survey (DWR, 2019b). Major agricultural crops within the Basin are wine grapes (vineyards), fruits and nuts, and grain and hay.

Table 2.1: Acreage and percentage of total Basin area covered by each land use category according to 2010 Land Use Survey

Land Use Description	Percentage (%)	Area (acre)
Agricultural-Undeveloped	0.08	861
Citrus and Subtropical	0.00	6
Field Crops	0.00	7
Fruits and Nuts	0.12	1,214
Grain and Hay	0.02	201
Idle	0.05	519
Native and Riparian Vegetation	97.89	1,001,103
Nursery and Berry	0.00	31
Pasture	0.03	274
Urban	0.78	7,968
Vineyard	0.80	8,153
Water	0.23	2,366

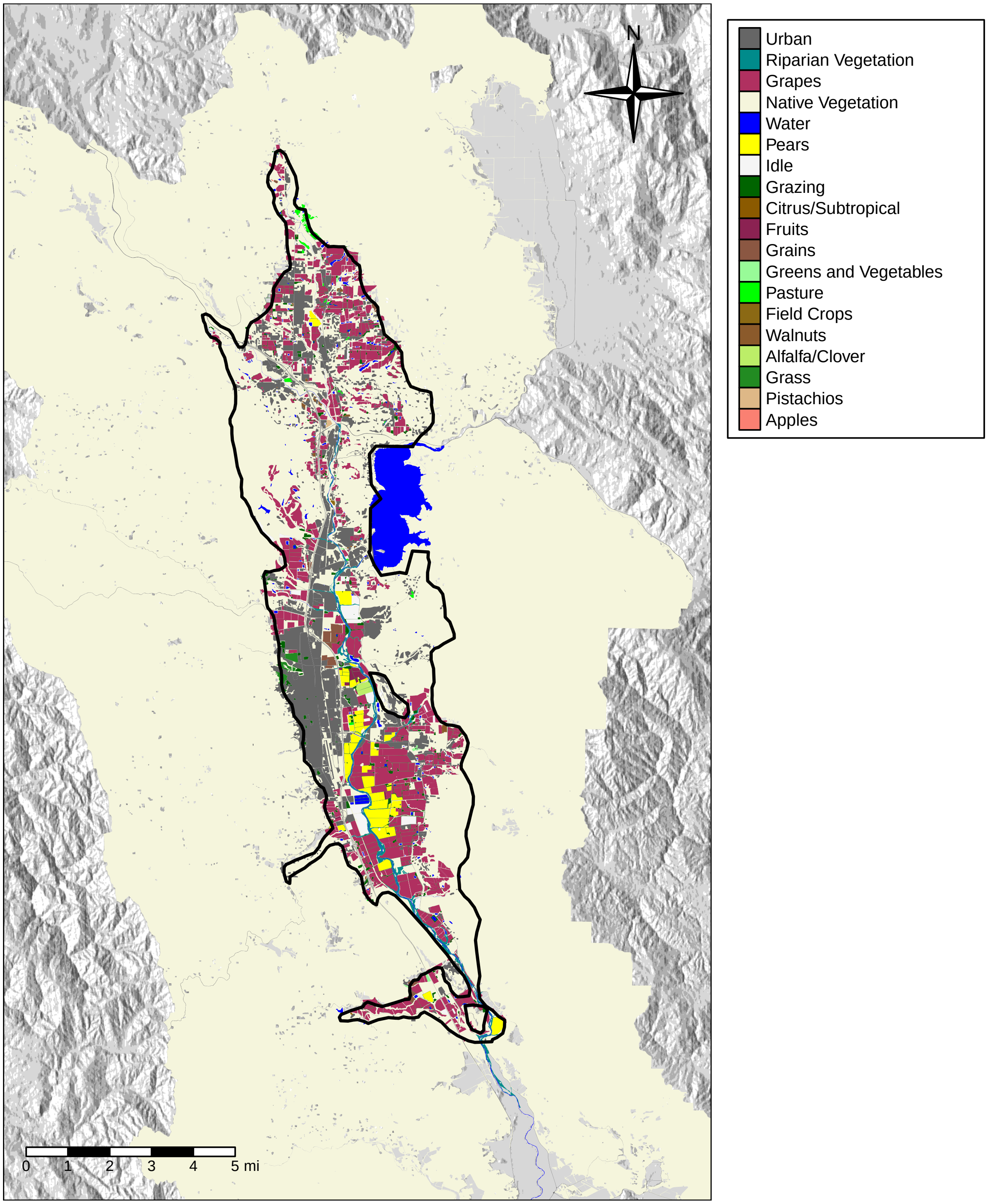


Figure 2.6: Land use in the Ukiah Valley Groundwater Basin according to 2010 Land Use Survey.

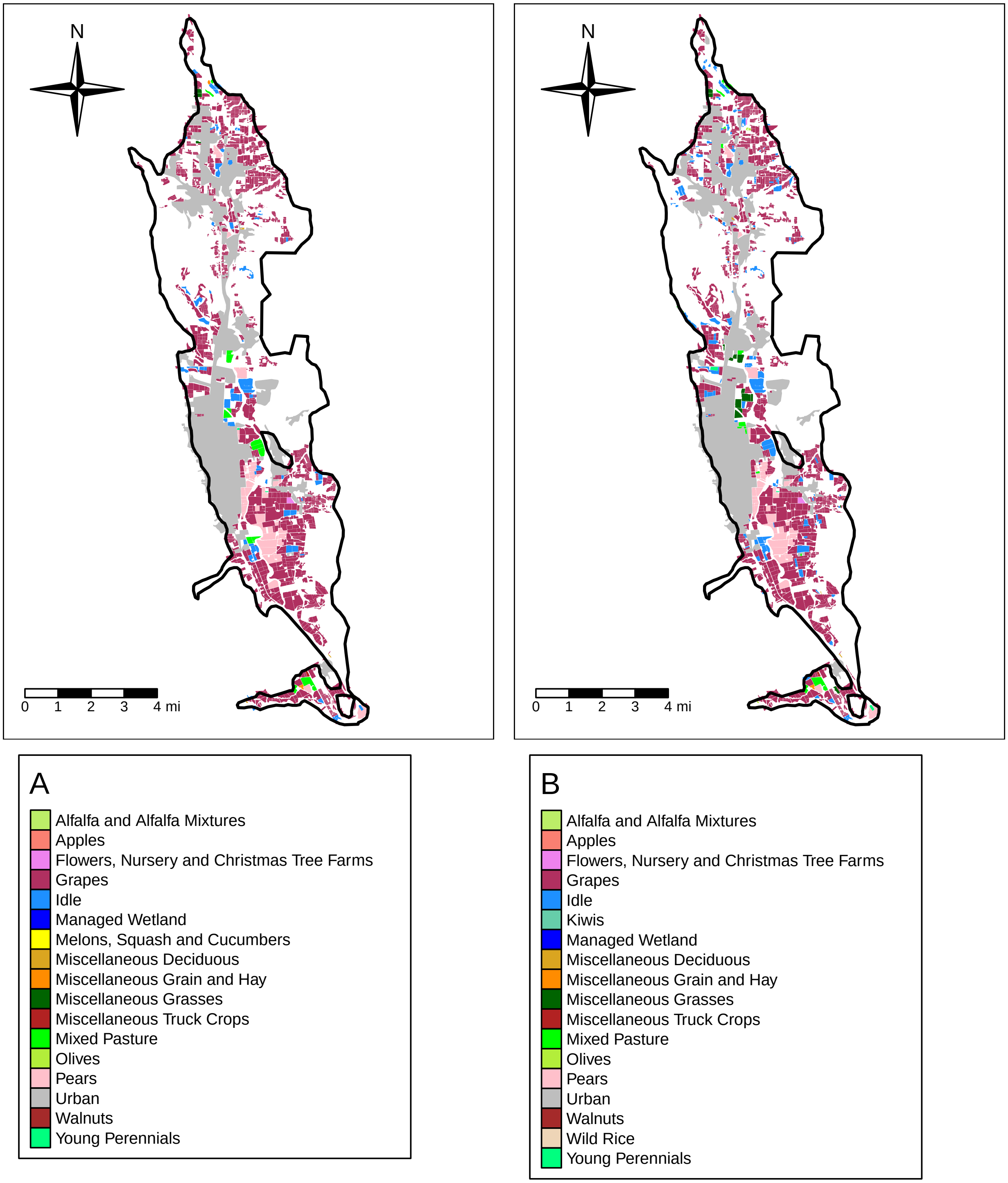


Figure 2.7: Spatial distribution of crops in the Ukiah Valley Groundwater Basin according to (A) 2014 and (B) 2016 DWR Crop Map Surveys.

Table 2.2: Number of wells per recorded use category in the Ukiah Valley Groundwater Basin according to OSWCR (DWR 2019b)

Row Labels	Sum of Count of WCRNumber
Agriculture	117
Destructed	5
Domestic	1058
Industrial	11
Injection	46
Monitoring	344
Unclassified*	1148
Public/Municipal	70
Remediation	33
Grand Total	2832

* Other uses include: cathodic protection, fire or frost protection, vapor extraction, test wells, unused wells, and unknown or not specified uses. Vapor Extraction (30 wells) are not included in the analysis.

2.1.1.4 Well Records

Public data regarding wells is limited in the Basin. Using data from the DWR Online System for Well Completion Reports (OSWCR) (DWR, 2019c), it is possible to visualize the approximate distribution (i.e., well density in wells per square mile) of domestic, agricultural production, and public drinking water wells in the Basin, aggregated to each Public Land Survey System (PLSS) section **(Figures 2.8 and 2.9)**. Because OSWCR represents an index of Well Completion Report (WCR) records dating back many decades, this dataset may include abandoned wells, destroyed wells, or wells with quality control issues such as inaccurate, missing or duplicate records, but is nevertheless a valuable resource for planning efforts. The primary uses of the wells reviewed are shown in **Table 2.2**.

During the development of the Initial Hydrogeologic Conceptual Model (IHCM) (LACO Associates, 2017) by the GSA, a database of 2,490 WCRs (WCR Catalog) was obtained from DWR and analyzed. However, the number of WCRs that were located within the Basin and could be reliably located were lower. From the WCRs obtained, only 214 were selected and georeferenced to be used in the development of the IHCM (LACO Associates, 2017). GSA analyzed and georeferenced 41 additional WCRs in the next phase of the development of the Hydrogeological Conceptual Model (HCM) outlined in this report in **Section 2.2.1**. While the number of WCRs in each category of recorded use in the WCR Catalog is different from **Table 2.2**, the top categories remain consistent in their order of significance; domestic, monitoring, agricultural, and public/municipal.

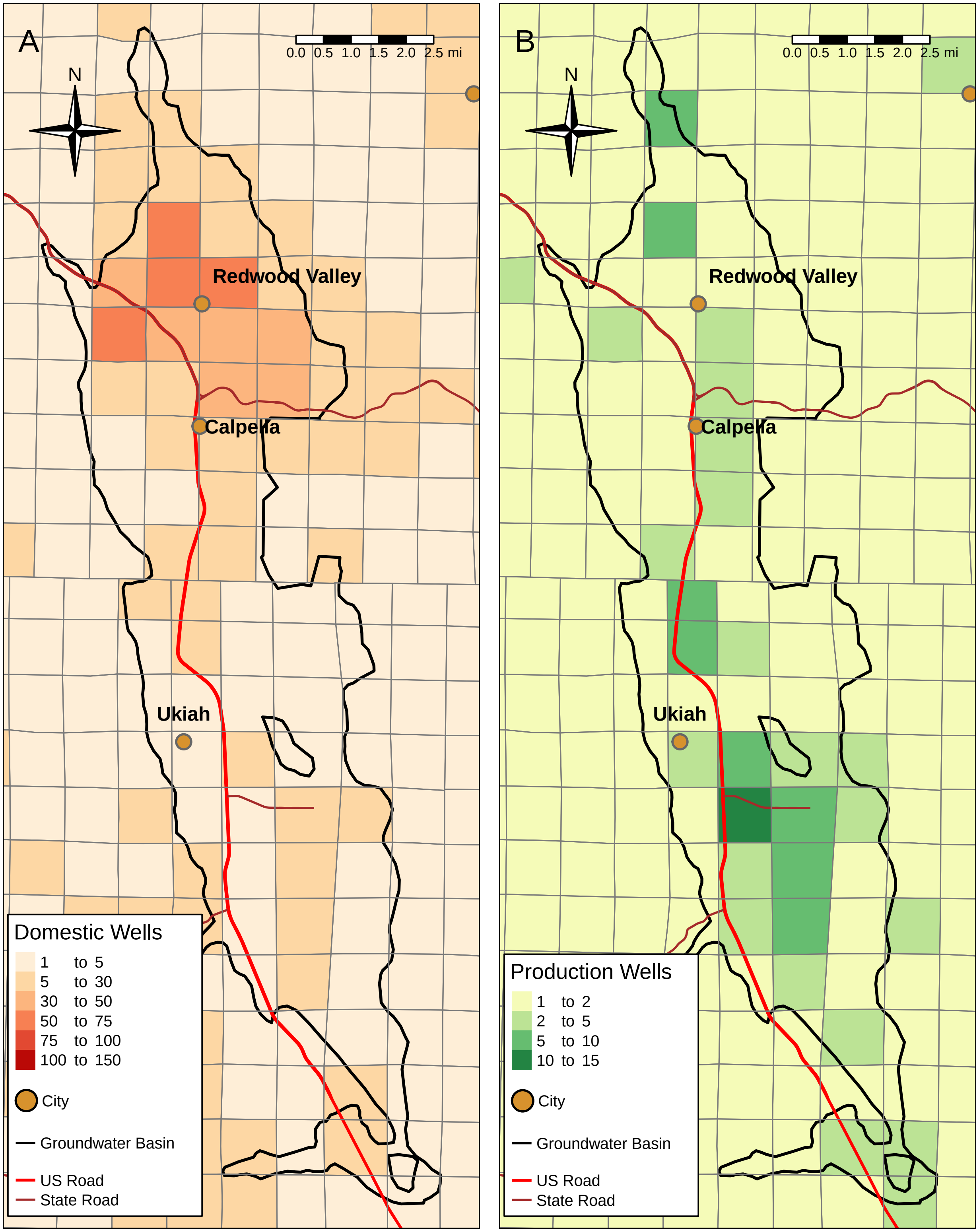


Figure 2.8: Number of wells within the Ukiah Valley Groundwater Basin present in each Public Land Survey System (PLSS) section, based on data taken from OSWCR (DWR 2019b) per well type: (A) domestic wells, (B) production wells. PLSS sections delineated on maps are nominally one square mile.

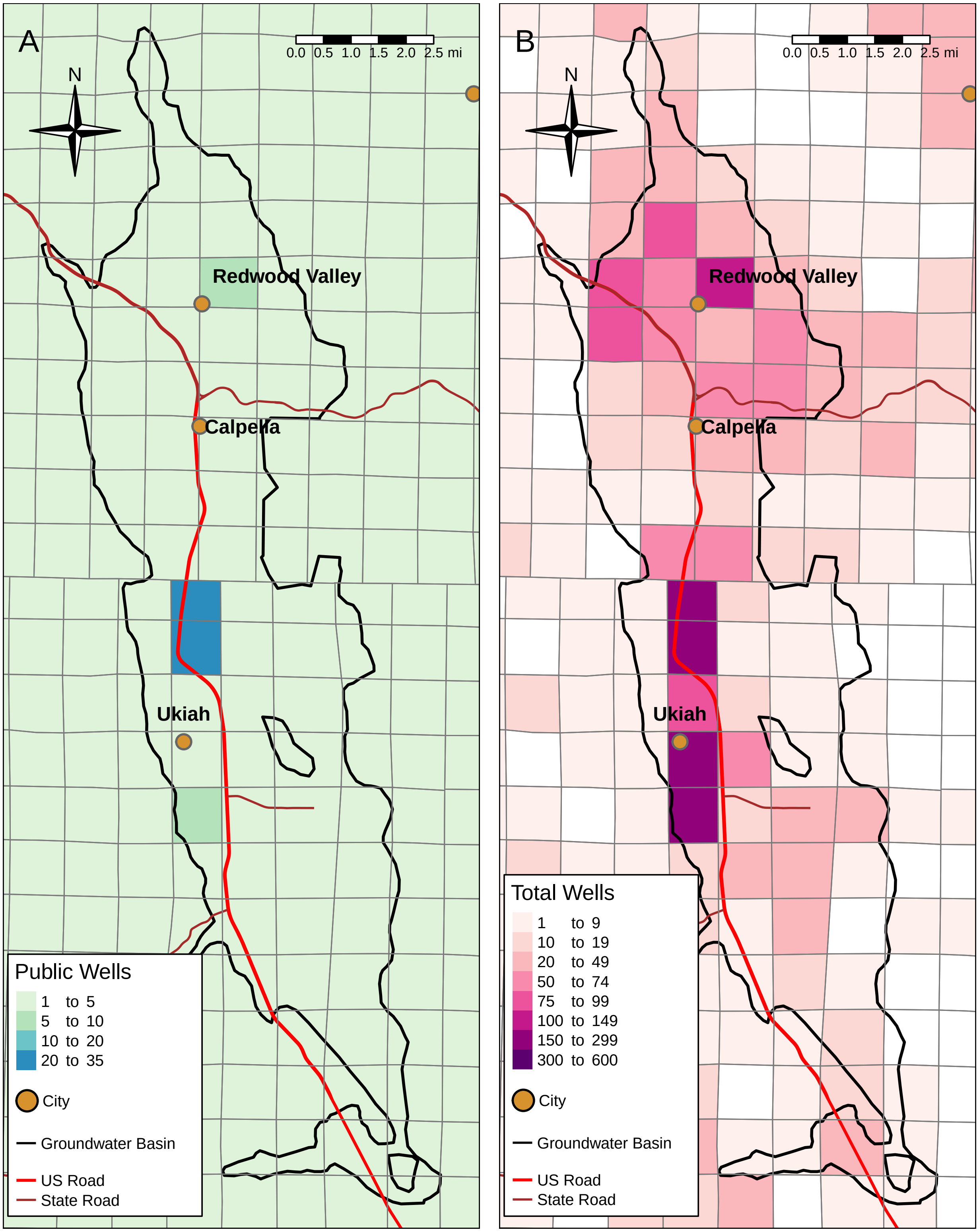


Figure 2.9: Number of wells within the Ukiah Valley Groundwater Basin present in each PLSS section, based on data taken from OSWCR (DWR 2019b) per well type: (A) public wells (B) total wells. PLSS sections delineated on maps are nominally one square mile.

2.1.2 Water Resources Monitoring and Management Programs

There is historical and ongoing work in the Basin and the Russian River watershed related to monitoring and management of surface water and groundwater resources. This section first lists the ongoing statewide, regional, and local monitoring programs. Next, it describes monitoring and management programs relevant to this GSP and outlines the current understanding of (a) how those programs will be incorporated into GSP implementation and (b) how they may limit operational flexibility in GSP implementation.

2.1.2.1 Overview of Monitoring and Management Programs

Statewide Monitoring Agencies and Programs

- California Department of Pesticide Regulation (CDPR) Groundwater Protection Program
- Department of Water Resources
  - California Statewide Groundwater Elevation Monitoring (CASGEM) Program
  - California Data Exchange Center (CDEC)
  - Water Data Library
- California Department of Fish and Wildlife (CDFW)
- California State Water Resources Control Board (SWRCB or State Water Board)
  - Division of Drinking Water (DDW)
  - Cannabis Cultivation Program
  - Groundwater Ambient Monitoring and Assessment Program (GAMA)
  - Agricultural Lands Discharge Program (ALDP)
  - Frost Protection Regulation: Water Demand Management Program
- United States Geological Survey (USGS)

Regional Monitoring Programs

- California North Coast Regional Water Quality Control Board (NCRWQCB)
  - National Pollutant Discharge Elimination System Permits, Waste Discharge Requirements (WDRs), Recycled Water Permits
  - Total Maximum Daily Loads (TMDLs)
- Russian River Regional Monitoring Program (R3MP)

Local Monitoring Agencies and Programs:

- Mendocino County Resource Conservation District (MCRCD)
- Mendocino County Water Agency
- City of Ukiah
- California Land Stewardship Institute (CLSI)
- The Russian River Flood Control and Water Conservation and Improvement District (RRFC)

The Mendocino Frost Program, managed by the CLSI, involves the maintenance of eight stream flow gages within and seven gages outside the Basin. Additionally, Mendocino Groundwater Monitoring Program, also managed by the CLSI, involves the maintenance of five continuous recording well gages from private wells in the Basin.

2.1.2.2 Detailed Monitoring and Management Programs, Agencies, and Databases

California Department of Pesticide Regulation Groundwater Protection Program

The CDPR obtains groundwater sampling data from other public agencies and through its own sampling program. Monitoring data includes those collected by the USGS, SWRCB, SWRCB DDW, CDPH, US Fish and Wildlife Services (USFWS), and the CDPR. These data are reported annually along with the actions taken by CDPR and SWRCB to protect groundwater from contamination by pesticides. The CDPR samples groundwater to determine (1) whether pesticides with the potential to pollute groundwater are present in groundwater, (2) the extent and source of pesticide contamination, and (3) the effectiveness of regulatory mitigation measures.[2] The CDPR website was accessed in December 2018 and a dataset consisting of groundwater quality data for 155 chemical compounds in 24 monitoring wells for a period between August 1977 through the end of 2018 was obtained to support the analysis for the Basin.

Department of Water Resources

California Statewide Groundwater Elevation Monitoring Program

The CASGEM Program aims to establish a permanent and locally-managed program to track seasonal and long-term groundwater elevation trends in groundwater basins statewide. On November 4th 2009, the State Legislature amended the Water Code with SBx7-6, which mandates collaboration between local monitoring entities and DWR. The primary task of the monitoring entity is to collect groundwater elevation data and report this data to DWR. The collection and evaluation of such data on a statewide scale is an important fundamental step toward improving the management of California's groundwater resources.

The County has been officially recognized by the SWRCB, as of August 2014, as the monitoring entity for the Ukiah Valley Groundwater Basin and is currently in compliance with the requirements of SBx7-6. The County is coordinating the monitoring for the basins conducted throughout the County, which involves collecting well data from the local agencies that are conducting the well monitoring and then formatting and uploading the information to the State system. The MCRCD has been contracted to perform the monitoring in the Basin.

As of December 2019, 42 wells have been incorporated into the Program within the Basin. Of the 42 wells, seven are under voluntary status meaning that the owners have contributed water level measurements to the program but the wells are not enrolled in the CASGEM Program. This leaves 35 wells that are currently enrolled in the CASGEM Program. CASGEM monitoring is ongoing within the Basin and the County has made a continuous effort to recruit additional wells into the Program. Measurements are normally carried out twice per year, once during spring (usually in May) and once in fall (usually in November).

California Data Exchange Center

[2] CDPR Website: https://www.cdpr.ca.gov/docs/emon/grndwtr/gwp_sampling.htm

DWR installs, maintains, and operates hydrologic and meteorological data collection networks throughout the state. The data collected include river stage and streamflow, precipitation, reservoir storage and operations, snowpack, etc., and are made available to the public through a centralized internet location called the California Data Exchange Center (CDEC). The CDEC also receives and exchanges data with various Federal and State agencies including the National Weather Service (NWS), U.S. Bureau of Reclamation (USBR), U.S. Army Corps of Engineers (USACE), Pacific Gas & Electric (PG&E), and USGS. As of December 2019, the CDEC hosts a variety of meteorological and hydrologic data for two stations within the Basin: Lake Mendocino (CDW) and Russian River near Ukiah (RRU).

California Department of Fish and Wildlife

As trustee for the State's fish and wildlife resources, the the CDFW has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and the habitat necessary for biologically sustainable populations of such species. [FGC §§ 1802 and 711.7(a).] CDFW has an interest in the sustainable management of groundwater, as many sensitive ecosystems and public trust resources depend on groundwater and interconnected surface waters. Accordingly, CDFW encourages thoughtful groundwater planning that carefully considers fish and wildlife and the habitats on which they depend. This groundwater planning considerations document focuses on impacts to groundwater dependent ecosystems (GDEs) and interconnected surface waters (ISW), both of which may provide habitat for fish and wildlife.

California State Water Resources Control Board

Division of Drinking Water

The State Water Resources Control Board's (SWRCB; State Water Board) DDW, monitors public water system wells per the requirements of Title 22 of the California Code of Regulations relative to levels of organic and inorganic compounds such as metals, microbial compounds, and radiological analytes (this effort was formerly performed by the CDPH). Data are available for active and inactive drinking water sources, for water systems that serve the public, and wells defined as serving 15 or more connections, or more than 25 people per day. In the Basin, DDW wells are monitored according to Title 22 requirements.

Cannabis Cultivation Program

Through Order No. WQ 2019-0001DWQ (Cannabis Cultivation Activities General Order) and the Cannabis Cultivation Policy, the SWRCB requires selective monitoring of cannabis cultivation sites and associated facilities to ensure that dischargers to waters of the state do not adversely affect the quality and beneficial uses of such waters.

Groundwater Ambient Monitoring and Assessment Program

The GAMA Program was created by the SWRCB in 2000 and is utilized to integrate existing monitoring programs and design new programs as necessary to monitor and assess groundwater quality in basins that account for 95% of California's groundwater use. GAMA provides a centralized information hub for groundwater quality data for the public and decision-makers to help protect groundwater resources and improve statewide groundwater monitoring. The GAMA Program receives data from a variety of monitoring entities including DWR, USGS, and SWRCB. GeoTracker is a database and geographic information system (GIS) used by the GAMA program that was initially developed in 2000. It contains records for sites that require cleanup, such as leaking underground storage tank (LUST) sites, Department of Defense sites, and cleanup program sites. GeoTracker also contains records for various unregulated projects as well as permitted facilities associated with the Agricultural Lands Discharge Program (ALDP), oil and gas production, permitted underground storage tanks, and land disposal sites. GeoTracker GAMA is a module that was added to the GeoTracker system to compile and share groundwater data regarding water quality, water levels, contaminant sources, and groundwater publications. Data are submitted to GeoTracker GAMA by CDPH, USGS, DWR, CDPR, the Lawrence Livermore National Laboratory (LLNL), State Water Board, and Regional Water Boards.

Water Demand Management Program

On September 20, 2011, the SWRCB adopted a Frost Protection Regulation for the Russian River watershed and required, starting in 2015, that any diversion of water for frost protection between March 15 and May 15 to be regulated and operated under an approved Water Demand Management Program (WDMP). WDMPs require the management of instantaneous water demand on the Russian River stream system during frost events to prevent stranding and mortality of salmonids. This is achieved partially through monitoring and reporting of: (1) the quantity of water diverted from the river system through a direct diversion or pumping of a well that is connected to the subterranean channel during each frost event; and, (2) the stream stage at an appropriate location. Currently, three WDMPs within the Basin are approved and used to conduct the required monitoring:

- California Land Stewardship Institute - WDMP for diversions in Mendocino County
- North Coast Resource Management (Individual WDMP for Dutra Vineyards) - WDMP for diversions from the West Fork of the Russian River in Mendocino County.

United States Geological Survey

The USGS monitors and collects streamflow data from three gages within the Basin (11461000, 11462000, 11462080) and one just south of the Basin near Hopland (11462500, which, for the purposes of this analysis, represents the drainage from the Basin). Station 11462000 is representative of the East Fork Russian River and releases from Lake Mendocino, while Station 11461000 represents the West Fork Russian River up to the north of the City of Ukiah and before the confluence of the East Fork and West Fork. Station 11462000 is no longer monitored by USGS. It is currently operated by a contractor for the USACE is monitored for reporting to CDEC under Site ID CDM.

California North Coast Regional Water Quality Control Board

National Pollutant Discharge Elimination System Permits, Waste Discharge Requirements, and Recycled Water Permits

Stormwater and wastewater discharges to surface water bodies are regulated under NPDES Permits. Within the Basin area, the City of Ukiah is a co-permittee to the stormwater Phase I Municipal Separate Storm Sewer System (MS4) Permit in the North Coast Region (Order No. R1-2015-0030). Discharges from County of Mendocino jurisdictions are regulated under the Phase II Small MS4 Program (Order No. 2013-0001 DWQ, permit WDID 438918 1 23M2000162). Both orders require monitoring and reporting of pollutants including but not limited to organics, inorganics and metals, pesticides, indicator bacteria, and toxicity at outfalls and receiving water bodies during dry and wet weather. The City of Ukiah Wastewater Treatment Plant (UWWTP) is regulated under Order No. R1-2018-0035 (NPDES Permit No. CA0022888) and is required to monitor pollutants in its in influent and effluent, upstream and downstream of its discharge to the Russian River, and in five groundwater wells as prescribed in the Order's Monitoring and Reporting Plan (MRP).

Total Maximum Daily Loads (TMDL)

A Total Maximum Daily Load (TMDL) for pathogens/fecal indicator bacteria is under development for the Russian River and its tributary creeks. Actions have been proposed in the NCRWQCB Staff Workplan under the TMDL Implementation Policy Statement for Sediment Impaired Receiving Waters in the North Coast Region (Sediment TMDL Implementation Policy) but no mandatory monitoring has been required. Lake Mendocino is listed as impaired under Section 303 (d) of the Clean Water Act for mercury and is expected to be regulated under a statewide Mercury TMDL. A temperature TMDL has been proposed by NCRWQCB, but has not yet been adopted or scheduled. To summarize, no required TMDL monitoring is required within the Basin as of the period of GSP development.

Russian River Regional Monitoring Program

The San Francisco Estuary Institute (SFEI) is leading the development of a governing body for the Russian River Regional Monitoring Program (R3MP) in coordination with the NCRWQCB and with support from the Russian River Watershed Association (RRWA). The R3MP's goal is to develop a coordinated, standardized, cost effective monitoring program that collects data and communicates information about surface water quality in the Russian River Watershed for the purpose of addressing management questions driven by regulatory goals and objectives.The R3MP will initially focus on surface water monitoring within the Russian River Watershed to benefit the current MS4 co-permittees under their watershed-based NPDES permit.

2.1.2.3 Incorporating Existing Monitoring Programs into the GSP

The GSA will leverage data provided by current monitoring programs and available historical data for the sustainable management of the Basin. As discussed in **Chapter 3**, an existing monitoring network with additional wells and stream gages is proposed in this GSP to be used to monitor all of the sustainability indicators as required by SGMA. Additional wells and stream gages will be installed as part of the GSP implementation through use of DWR Technical Support Services Grant (TSS) and GSA funding. The designed monitoring network will be used to assess the six sustainability indicators as described bellow:

- **Chronic Lowering of Groundwater Levels:** A selected set of groundwater wells from the CASGEM Program will be used to monitor groundwater elevations throughout the Basin for the two principal aquifers (see **Section 2.2.1.4** for principal aquifers' definitions).
- **Reduction of Groundwater in Storage:** Municipal production wells and groundwater withdrawals by water districts and water purveyors that operate within the Basin will be used annually to estimate the extracted groundwater volume within the Basin. If any small water system and non-de minimis users report their extraction, those reports will be included in the estimation. If not, non-metered production will be calculated using the Land Use information and the methodology outlined in *Appendix 2-D* of this GSP.
- **Degraded Groundwater Quality:** Groundwater quality data from the existing federal, state, and local programs outlined above will be downloaded and used to evaluate the groundwater quality within the Basin.
- **Depletion of Interconnected Surface Water:** Existing and proposed representative sets of shallow groundwater monitoring wells and streamflow gages throughout the Basin will be used

to monitor groundwater elevation and stream stages and volumes. Groundwater elevation, streamflow, and stream stage will be used as proxies to evaluate the sustainability indicator.

- **Land Subsidence:** Interferometric Synthetic Aperture Radar (InSAR) published by DWR will be used to evaluate this indicator.
- **Seawater intrusion:** This sustainability indicator does not apply to this GSP.

2.1.2.4 Limits to Operational Flexibility

The existing monitoring programs are not anticipated to limit the operational flexibility of this GSP.

2.1.3 Land Use Elements or Topic Categories of Applicable General Plans

2.1.3.1 The County of Mendocino General Plan

The County of Mendocino General Plan (General Plan) (PMC, 2009) serves to chart a land use and development course for County government over the next 20 years. The goals, policies, and programs in the General Plan represent the County's statement of how it should grow or change in the coming decades (or where/how it should remain the same) and how today's challenges will be met. The General Plan identifies overarching principles that provide the basis for the goals and policies included in the rest of the plan. The principles embody key issues identified by the residents of Mendocino County, such as stewardship of County resources, planning for growth, and the efficient and equitable provision of public services. The components of the General Plan with the most relevance to the GSP include the Development Goals and Policies and the Resource Management Element. There are also community-specific policies defined for the Redwood Valley Area that are relevant to this GSP. Many of the objectives and policies within the General Plan align with the goals of the GSP and significant changes to water supply assumptions within these plans are not anticipated.

The General Plan outlines development goals related to various topics including land use, infrastructure, water/sewer, flooding/inundation, and geologic conditions that are relevant to this GSP. All these goals follow the aforementioned principals and in turn lead to policies and objectives for the development of the County. The General Plan aims: (1) for land use patterns to preserve the County's natural resources (Goals DE-1 and DE-3 of the General Plan); (2) to provide sufficient, efficient, and adequate water and sewer service infrastructure for existing and future development (Goals DE-7 and DE-16); and (3) to protect life and property while also protecting and managing natural drainage ways, floodplains, and flood retention basins and maintain flood-carrying capacity in harmony with environmental, recreational, and open space objectives (Goals DE-18 and DE-19). These goals are in line with the purpose of the GSP.

The Resource Management Element of the General Plan emphasizes the vital role of water for a healthy environment and economy. It recognizes the importance of watersheds, groundwater and aquifer recharge, water supply, water quality, ecosystem stability, biological resources, freshwater and marine resources, open spaces, rural landscapes, and scenic resources (among others) as the pillars of the element, provides an overview of each topic and its existing condition and role within the County, and aims at protecting and enhancing these resources. The Resource Management Element defines the County's goals as follows:

- Goal RM-1 (Watersheds): Land uses, development patterns, and practices that facilitate functional and healthy watershed ecosystems.
- Goal RM-2 (Water Supply): Protection, enhancement, and management of the water resources of Mendocino County.
- Goal RM-3 (Water Quality): Land use development and management practices that protect or enhance water quality.
- Goal RM-4 (Ecosystems): Protection and enhancement of the county's natural ecosystems and valuable resources.
- Goal RM-7 (Biological Resources): Protection, enhancement, and management of the biological resources of Mendocino County and the resources upon which they depend in a sustainable manner.

- Goal RM-8 (Marine Resources): Protection, restoration, and enhancement of Mendocino County's freshwater and marine environments.
- Goal RM-9 (Agriculture): Protection of agriculture as a basic industry important to the economy and quality of life and food security of the county by maintaining extensive agricultural land areas and limiting incompatible uses.

As a result of these goals, the County continues to outline policies for resource management that align with the objectives of this GSP. To provide a few examples, Policy RM-6 under Water Resources Policies intends to "promote sustainable management and conservation of the County's water resources." Furthermore, Policy RM-12 under the same section requires that "the County supports the creation of a comprehensive plan for surface and groundwater resources in Mendocino County." These highlighted Policies are just two of a long list of policies outlined in this Element of the General Plan that promote sustainable management, protection, and enhancement of water, habitat, and ecosystem resources.

2.1.3.2 Ukiah Valley Area Plan

The Ukiah Valley Area Plan (UVAP) (Mendocino County, 2011) provides comprehensive, long-term policy direction for growth and development by refining and supplementing the policies in the County's General Plan to focus on issues of importance in the Ukiah Valley. Land use and community development, water management, and open space and conservation sections are the most relevant sections of the plan to this GSP. The Land Use and Community Development Section aims at creating communities that can achieve its principles of sustainability. The Water Management Section promotes efforts to protect and increase water supply storage and capacity, reclamation and conservation of water, and protection of water quality. As a result, the UVAP is founded upon similar principles as the General Plan and this GSP and therefore, presents visions and goals that align with the objectives of this GSP.

2.1.3.3 Well Permitting

Water well permitting is administered by the County's Environmental Health Division and under the Mendocino County Well Ordinance §16.04 and regulations of the State of California as they pertain to water well construction and destruction. Well permit applications require information from the applicant, from an authorized well contractor, as well as payment of a fee.

2.1.4 Additional GSP Elements

2.1.4.1 Control of saline water intrusion

There is no evidence of saline water intrusion within the Basin. This is discussed in more detail in Section 2.2.2 as an undesirable result under SGMA.

2.1.4.2 Well construction policies, wellhead protection, well abandonment, and well destruction program

As mentioned in Section 2.1.3, all well permitting, well construction, well abatement, and well destruction within the County and the Basin is conducted according to the Mendocino County Well Ordinance §16.04, and appropriate state standards and federal suggested practices.

2.1.4.3 Migration of contaminated groundwater

Migration of contaminated groundwater from point sources, such as leaking fuel tanks, is managed through coordination with NCRWQCB or DTSC. Open cleanup sites are discussed in **Section 2.2.2.4**, subsection "Contaminated Sites." Management of non-point sources of contaminated groundwater by the GSA is described further in **Section 2.2.2.4**.

2.1.4.4 Replenishment of groundwater extractions

Recharge practices are undertaken by the Calpella CWD, Millview CWD, and Rogina Water Company in the Basin. UWWTP percolation ponds are another significant source of recharge that exists in the Basin. More details about these practices and relevant data gaps are provided in Section 5.7 of Appendix 2-D. Outside of these practices conducted by the water agencies and the City, no other artificial recharge practices are currently implemented in the Basin.

2.1.4.5 Conjunctive use and underground storage

No conjunctive use projects are currently operated within the Basin. The UWWTP owns and operates effluent and recycled water percolation ponds that subsequently recharge the groundwater aquifer beneath them and augment the streamflow in the Russian River. Discharges to the percolation ponds are carried out in accordance with the UWWTP NPDES Permit and required monitoring data are reported to NCRWQCB via the California Integrated Water Quality System (CIWQS).

2.1.4.6 Efficient water management practices

The County has adopted County Ordinance §16.24 – Water Conservation that outlines specific requirements for conservation devices to be met in order for a building permit to be issued. Water conservation and use efficiency are also included as the main goals of the County General Plan and UVAP.

In addition, the City conducts an ongoing water conservation program according to the City's Urban Water Management Plan (Carollo Engineers, 2011). The program consists of a variety of demand management measures for conserving water following the Memorandum of Understanding Regarding Urban Water Conservation in California (the City is not a signatory). The City has also advocated for emphasis on recycled water use and has expanded its recycled water program to deliver 1,000 acre-feet per year (AFY; 1.2 million cubic meters per year) to customers.

The City will further expand its recycled water delivery capacity to 1,400 AFY (1.7 million cubic meters per year) upon completion of Phase IV of its recycled water project.

2.1.4.7 Relationships with State and federal regulatory agencies

In the Basin, the USACE, and CDFW are major landowners. the USACE manages the Coyote Dam on Lake Mendocino for the purposes of flood protection. The U.S. Environmental Protection Agency (USEPA) Region 9, SWRCB, NCRWQCB, DWR, and CDFW are major regulatory agencies involved within the Basin and the Russian River Watershed.

2.1.5 Notice and Communication

A Communication and Engagement Plan (CommPlan or C&E Plan) was developed to promote the efficient and effective coordination of internal/external communications and stakeholder engagement in the GSA effort to develop a GSP.

The CommPlan will serve as the primary guideline for addressing the requirements outlined in DWR GSP Regulations Section § 354.10:

"Each Plan shall include a summary of information relating to notification and communication by the GSA with other agencies and interested parties including the following:

- *a. A description of the beneficial uses and users of groundwater in the Basin, including the land uses and property interests potentially affected by the use of groundwater in the Basin, the types of parties representing those interests, and the nature of consultation with those parties.*
- *b. A list of public meetings at which the Plan was discussed or considered by the GSA.*
- *c. Comments regarding the Plan received by the GSA and a summary of any responses by the GSA.*
- *d. A communication section of the Plan that includes the following:*
  - *1. An explanation of the GSA's decision-making process.*
  - *2. Identification of opportunities for public engagement and a discussion of how public input and response will be used.*
  - *3. A description of how the GSA encourages the active involvement of diverse social, cultural, and economic elements of the population within the Basin.*
  - *4. The method the GSA shall follow to inform the public about progress implementing the Plan, including the status of projects and actions."*

The CommPlan serves as the communication and engagement plan for this GSP and was developed in response to the following requirement of the DWR evaluation criterion in the GSP Regulations Section § 355.4.b.(4):

"Whether the interests of the beneficial uses and users of groundwater in the Basin, and the land uses and property interests potentially affected by the use of groundwater in the Basin, have been considered."

The CommPlan will be updated as needed throughout GSP development and implementation. This will ensure that up-to-date information related to project communication is contained in the CommPlan. The CommPlan will be executed by members of the GSA through the lifetime of the GSP. The GSA will communicate GSP updates through the GSP page on the County of Mendocino website[3], the County of Mendocino social media channels and periodic public meetings. This CommPlan will serve as a repository for all mailing lists, outreach and engagement activities and stakeholder communications.

While the CommPlan included in the GSP is focused on outreach and engagement throughout the development process, the GSA is in the process of updating this plan to focus on the implementation period and continuing the GSA's outreach and engagement efforts. This update will not be

[3] https://www.mendocinocounty.org/government/affiliated-agencies/ukiah-valley-Basin-gsa/groundwater-sustainability-plan

finalized by the submittal data of the GSP (January 31, 2021), and the GSA will publish its updated version during the first year of the GSP implementation, as outlined in **Chapter 5**.

The GSA sought to build broad support for key elements of the GSP and facilitate the effective engagement of stakeholders and beneficial users of groundwater to achieve the best outcome for its GSP. The following are the guiding principles of the GSP communication strategy:

- Inform the public with balanced information to assist them in understanding the issues to be addressed, alternative management measures, opportunities, and/or solutions.
- Consult with the public by obtaining feedback and public comments on analyses and decisions. GSA encouraged the public to be involved in the decision-making process since they are affected by the GSP and can influence the outcome.
- Involve beneficial users and work with them throughout GSP development to ensure that their concerns, aspirations, and their overall input is understood and considered.
- Collaborate with stakeholders in the decision-making process including the development of management alternatives and identification of preferred solutions.
- Empower the members of the GSA by fully considering their priorities and sufficiently implementing them in the GSP.
- Inform all engaged parties on how their input affected the decision.
- Ensure process integrity and transparency.
- Utilize facilitation and outreach methods that minimize the cost and environmental impacts of travel.
- Leverage available technological platforms to increase collaboration and efficiency.
- Maintain appropriate alignment between engagement, content development, and project management.

2.1.5.1 GSA Organization

In May 2017, the GSA was created by a JPA to serve as the official GSA for the Basin to comply with SGMA. Under the agreement, GSA shall take actions deemed necessary to ensure sustainable management of the Basin, as required by SGMA.[4]

The GSA consists of a variety of local public agencies with water supply, water management and land use responsibilities. These include the County of Mendocino, the City of Ukiah, the Upper Russian River Water Agency, and the Russian River Flood Control and Conservation Improvement District.

The boundaries of these agencies are shown in **(Figure 2.3)**. The GSA Board also includes a tribal representative and an agricultural representative, as noted in **Table 2.3**. Representation by these stakeholder groups on the Board of Directors was a decision made by the members of the JPA.

The GSA Board of Directors (the Board) is shown in **Table 2.3**. The Board acts as the GSP's overall Project Management Team (PMT) and is scheduled to meet on the second Thursday of every other month at 1:30 PM in the Mendocino County Board of Supervisors Chambers. All meetings are

[4]The resolution of the election of GSA can be found here:
https://sgma.water.ca.gov/portal/service/gsadocument/download/3980
The JPA forming GSA can be found here and **Appendix 1-B**:
https://sgma.water.ca.gov/portal/service/gsadocument/download/4159

Table 2.3: GSA Board of Directors

Member Agency	Director	Alternative Director
County of Mendocino	Glenn McGourty (Chair)	
City of Ukiah	Douglas F. Crane (Vice Chair)	
Russian River Flood Control and Water Conservation Improvement District	Alfred White	John Reardan
Upper Russian River Water Agency	Ross LaRue	
Tribal Seat	Eddie Nevarez	
Agricultural Seat	Zachary Robinson	Levi Paulin

open to the public with notices, agendas, and minutes posted on the County's website[5]. Public engagement is encouraged at the Board's meetings and an e-Notification capability will be offered by the County to reinforce this purpose for interested parties. Draft deliverables, draft GSP chapters and other important development milestones are scheduled to be discussed at the scheduled Board meetings in order to promote transparency regarding the decision-making process.

[5]https://www.mendocinocounty.org/government/affiliated-agencies/ukiah-valley-Basin-gsa

Table 2.4: GSA TAC members

Member Agency	Director
County of Mendocino	James Linderman
City of Ukiah	Sean White
Upper Russian River Water Agency	Ken Todd
Russian River Flood Control and Conservation Improvement District	Elizabeth Salomone
Tribal Representative	Javier Silva
Agricultural Representative	Levi Paulin
Sonoma Water	Don Seymour
Mendocino County Resource Conservation District	Mike Webster
California Land Stewardship Institute	Laurel Marcus

2.1.5.2 Standing Technical Advisory Committee (TAC)

The GSA has convened a TAC to provide input and recommendations on the technical aspects of the GSP development process. TAC members and the represented agencies are shown in **Table 2.4**. TAC meetings are scheduled at a similar frequency to the Board's meetings, on the second Wednesday of every other month, at 1:30 PM. All meetings are open to the public with notices, agendas, and minutes posted on the County's website . Subscribers to the e-Notification system will be notified automatically about the TAC meetings.

2.1.5.3 DWR Point of Contact

All high and medium priority groundwater basins in California are assigned a Point of Contact (POC) by a DWR Regional Office. POCs assist GSAs and stakeholders in the Basin to connect with the statewide Sustainable Groundwater Management Program and to locate resources for assistance. Mr. Dominic Gutierrez from the Division of Integrated Regional Water Management DWR North Central Region Office is the POC for this GSP and can be reached via email at: Dominic.Gutierrez@water.ca.gov.

2.1.5.4 GSA Decision-Making Process

The general voting procedure of the GSA is outlined in the JPA. Each member of the Board has one vote. Unless otherwise specified, all affirmative decisions of the Board require the affirmative vote of a simple majority of all the Board's Directors participating in voting, provided that, if a Director is disqualified from voting on a matter before the Board because of a conflict of interest, that Director shall be excluded from the calculation of the total number of Directors that constitute a majority. The Board of Directors shall strive for consensus among all members on all items.

With respect to the GSP development, the above-mentioned procedure was used for all subjects that require the Board's action. An effort was made so that discussions and/or presentations were conducted in the TAC and Board public meetings to facilitate input from stakeholders and interested parties. Key documents were made available in advance of meeting on either the County's website or via the Communication and Engagement (C&E) Tool, whichever was determined appropriate, as a working draft document. Comments made by the TAC, the Board, or by the public were addressed in a reasonable timeline (if possible, by the next public meeting) and the final draft of the deliverable was presented and an action taken by the Board in the next scheduled meeting. During all public meetings, time-limited opportunities were offered to the public to comment on all public agenda items. In addition, an opportunity for public comment on items not on the agenda was provided.

2.1.5.5 Communications Strategy

The GSA used a multitude of communication methods to convey information and obtain input from stakeholders. The communication strategy is divided into external and internal communications as explained below. the GSA implemented a comprehensive communication and engagement plan to meet SGMA requirements and optimize its strategies in external and internal communications to maximize their benefits.

Internal communication is defined as any communication among the GSA Board Members, Mendocino County, the TAC or convened subcommittees, and the consultants and contractors. Internal communications were performed using the preferred method of the engaged parties. If a meeting was arranged notes were taken and kept on record by an assigned member among the participants.

External communication is defined as any communication of the GSA, TAC, or convened subcommittees with the public. These communications occurred through emails and newsletters, public meetings, mailed flyers/brochures/advertisement, handouts, group informational interviews, and radio broadcasts.

For all public meetings, including but not limited to the regular Board and TAC meetings, the agenda for the meeting was posted online on the County website and subscribers to the e-Notification system. An electronic flyer for the meeting was also included in the newsletter and interested parties were notified through their preferred contact method. Meeting minutes were recorded as a normal procedure of the Board and the TAC and were posted afterward on the County Website.

Online and web-based resources including the County Website and County Social Media outlets were occasionally utilized for informing the public of GSP development status, posting draft GSP chapter, publishing notices, receiving public comments, demonstrating how public input is being implemented, disclosing results and data, and sharing news and updates.

2.1.5.6 Stakeholder Involvement in the GSP Development Process

SGMA and GSP Regulations Section § 354.10.(a) collectively require the GSA to consider interests of all beneficial uses and users of the groundwater Basin and provide a description of those users and uses, the types of parties representing those interests, and the nature of consultation with those parties. **Table 2.5** summarizes the list of stakeholders identified by the GSA

Table 2.5: Identified stakeholders and interested parties for the Basin

Category of Interest	Stakeholder Groups	Contact Person
GSA Board of Directors		
Land Use	County of Mendocino	Glenn McGourty
Land Use/Urban Use	City of Ukiah	Douglas F. Crane
Integrated Water Management	Russian River Flood Control	Alfred White
Urban Use	Upper Russian River Water Agency	Ross LaRue
California Native American tribes	Tribal Seat	Eddie Nevarez
Agricultural Use/ Private Users	Agricultural Seat	Zachary Robinson
TAC Members		
Land Use	County of Mendocino	James Linderman
Land Use/Urban Use	City of Ukiah	Sean White
Urban Use	Upper Russian River Water Agency	Ken Todd
Integrated Water Management	Russian River Flood Control	Elizabeth Salomone
Land Use	Sonoma Water	Don Seymour
Urban/ Agricultural Use	Mendocino County Resource Conservation District	Mike Webster
General Public/Land Use	California Land Stewardship Institute	Laurel Marcus
Agricultural Use/ Private Users	Agricultural Representative	Levi Paulin
California Native American tribes	Tribal Representative	Javier Silva
Public Water Systems		
	Redwood Valley County Water District	
	Millview County Water District	
	Willow County Water District	
Agricultural Use/ Private Users	Calpella County Water District	
	Private Water Companies	
	City of 10,000 Buddhas	
Urban Use	Rogina Water Company	
	Yokayo Water Systems	
California Native American Tribes		
	Redwood Valley Rancheria	Tribal Representative on UVBGSA and the TAC
	Coyote Valley Reservation	
	Pinoleville Pomo Nation	
California Native American tribes	Potter Valley Rancheria	
	Guidiville Rancheria	
	Hopland Reservation	
Agriculture		

Table 2.5: Identified stakeholders and interested parties for the Basin *(continued)*

Category of Interest	Stakeholder Groups	Contact Person
Agricultural Use	Mendocino County Farm Bureau Mendocino Winegrowers Inc (MWI) Pear Growers Cannabis Cultivation*	Agricultural Representative on UVBGSA and the TAC
State Entities		
Environmental and Ecosystem	UC Davis Cooperative Extension	
State Lands	Department of Water Resources (DWR)	
State Lands/Environmental and Ecosystem	North Coast Regional Water Quality Control Board California Department of Fish and Wildlife (CDFW)	
Federal Entities		
Federal Lands/Environmental and Ecosystem/Integrated Water Management	US Army Corps of Engineers (USACE)	
Federal Lands/Environmental and Ecosystem	US Fish and Wildlife Service (USFWS)	
Environmental and Ecosystem	NOAA Fisheries Forest Service	
General Public		
	Disadvantaged Communities Citizen Groups Basin Residents	

* Cannabis is not an agricultural commodity, but it is an agricultural product with increasing water use within some areas of the Basin.

2.1.5.7 Methods for Promoting Active Stakeholder Engagement

As the GSA moved towards developing its GSP, the effort focused initially on stakeholder identification and assessment. Stakeholder interviews were conducted at the outset of the planning effort to understand the interests, concerns, opportunities, and resources that exist in the stakeholder community. During the GSP development process, the GSA evolved its outreach efforts by identifying additional stakeholders, understanding their interests and concerns, and providing a transparent and responsive communication venue for their engagement. This was achieved through the following approach:

- Developing and maintaining an interested parties' list through the GSA stakeholder identification and outreach, voluntary subscription, and e-Notification system.
- Conducting interviews with key stakeholders at the outset of the GSP development effort.
- Holding regular public meetings of the GSA Board and the TAC, encouraging public participation through the County website and the C&E Tool.
- Convening a collaborative decision-making process through public meetings to build a shared understanding and reduce conflicts. This provided an additional venue for interested parties to get involved in the more technical side of the development and the implementation of the GSP.
- Providing alternative opportunities for stakeholders or interested parties that face additional barriers to participation. Additional opportunities for engagement accomplished were provided through the use of group informational interviews, translated materials, evening meetings, etc.
- Using the C&E Tool as the web-based tool to provide increased access to data and information in a user-friendly form. Sending emails/newsletters to interested parties updating them on newly developed documents or information and seeking their participation and/or comments.

2.1.5.8 Use of Public Input and Comments

The GSA realizes that recognizable consideration of public input boosts engagement and increases the trust in the process and the GSP. Therefore, the GSA attempted to respond to constructive public comments and concerns and to demonstrate how they shaped the outcome. Efforts included:

- Making draft deliverables provided for TAC or the GSA review available to the public to promote more fruitful public discussion during the public meetings scheduled for making decisions on those deliverables.
- Publishing Board-approved draft final GSP chapters for public comment and providing reasonable comment periods. If necessary, responses to comments were published to elaborate on how they were implemented or considered in the revision of documents.
- Continued implementation of the methods for promoting active engagement of the public with a focus on obtaining comments and responding to concerns.

At key C&E milestones described in the C&E Implementation Timeline Section, the GSA evaluated the effectiveness of its communication strategy by answering the following questions:

- Is there a shared understanding of the GSP's goals and its implementation timeline?

- Are stakeholders educated about the GSP development process and their own role?
- Has the GSA received positive press coverage?
- Do diverse stakeholders feel included?
- Has there been behavioral changes related to the program goals? Or, is improved trust/relationships in evidence among participants?
- Has the CommPlan been implemented and updated?
- Has the interested parties' list been expanded?
- Have there been well-attended and robust public hearings at all of the necessary junctures?
- Are all established venues for stakeholders open and effective?
- Are there formal mechanisms to assess outcomes and make improvements?

Reviewing these results helped identify the strengths and weaknesses of the communication strategy and how to improve it.

Public Meetings

All of the GSA Board and TAC meetings were open to the public and designed to encourage input, discussion, and questions from public audience members. The minutes of the GSA Board and TAC meetings reflect the questions and comments raised by members and the general public. Additionally, five public meetings were scheduled as presented in **Table 2.6**.

Table 2.6: Ukiah Valley Groundwater Basin GSP: Meeting Tracker

No	Meeting Date	UVBGSA TAC Meeting	UVBGSA Board Meeting	Specific Stakeholder/Public Meetings
1	13 September 2019		Project Schedule Communication Plan TAC and GSP Process	
2	8 August 2018	Phase 1 Reports Review and Comments Data Management System Outline	Communication Plan Data Management System Outline	Stakeholder Interviews: Sonoma Water, MCRCD, UCCE, RRFCD, URRWA, County of Mendocino, Agricultural Representatives, Tribal Representative, Farm Bureau, CLSI
3	14 February 2019	Cancelled	Phase 1 GSP Deliverables Data Acquisition And Confidentiality Data Management Plan TAC Meeting Schedule	
4	16 April 2019	Phase 1 GSP Deliverables Data Acquisition and Confidentiality Data Management Plan TAC Meeting Schedule Overview of GSP GSP Chapters Data Availability		
5	13 June 2019	HCM Update TSS Application Prop 68 Application Meeting Schedule	Review of Phase 1 TAC comments Prop 68 Application TSS Application	
6	15 October 2019	DMS Draft Delivery Draft HCM Delivery Commenting and Review Prop 68 Update TSS Update	DMS Update HCM Update Prop 68 Update TSS Update	
7	9 January 2020	TAC Meeting Schedule Review and Commenting Water Budget Discussion Introduction to SMC Development	Water Budget and Integrated Model Update Chapter 2.1 Draft Review and Commenting Introduction to SMC Development	Stakeholder Interviews with: Elizabeth Salomone (RRFCD) Deborah Edelman (MCRCD) Devon Jones (Farm Bureau) and Agricultural Group

Table 2.6: Ukiah Valley Groundwater Basin GSP: Meeting Tracker *(continued)*

No	Meeting Date	UVBGSA TAC Meeting	UVBGSA Board Meeting	Specific Stakeholder/Public Meetings
8	24 February 2020			Working Group Meeting: Groundwater levels and ISW SMC
9	11, 12 March 2020	GSP Development Update Sustainability Goal Development Survey Review of SMCs Current WQ Conditions	GSP Development Update Sustainability Goal Development Survey Review of SMCs	Tom Daugherty from NOAA (March 13)
10	25 March 2020			Working Group Meeting: Groundwater levels and ISW SMC
11	13 May 2020	Historical Trends of GW Elevation Integrated Model Updates Preliminary Water Budget SW/GW SMC Introduction Subsidence SMC		
12	10, 11 June 2020	Summary of Sustainability Goal Survey Integrated Model Update Preliminary SW/GW Interaction Discussion Introduction to Scenario Development	Integrated Model Updates Summary of Sustainability Goal Survey GSP Writing Update WQ SMC Subsidence SMC	
13	9, 10, 29 September 2020	Future Scenarios Current and Future Baseline Water Budget	Introduction to Scenario Development Future Scenarios Current and Future Baseline Water Budget WQ SMC Delivery	Tribal Outreach Meeting
14	29 September 2020			Public Meeting #1
15	14, 28 October 2020	GSP Writing Groundwater Level SMC Future Scenarios		
16	12, 18 November 2020	Monitoring Networks Future Scenarios Groundwater Level SMC	GSP Writing Groundwater Level SMC Future Scenarios	Working Group Meeting: Groundwater levels and ISW SMC
17	16 December 2020			Outreach Meeting with Upper Russian River Water Managers

Table 2.6: Ukiah Valley Groundwater Basin GSP: Meeting Tracker *(continued)*

No	Meeting Date	UVBGSA TAC Meeting	UVBGSA Board Meeting	Specific Stakeholder/Public Meetings
18	13 January 2021	UVIHM ISWs and GDEs PMAs		
19	3, 8, 10, 11 February 2021	Monitoring Networks ISWs and GDEs PMAs Water Budget	Monitoring Networks ISWs and GDEs PMAs	Working Group Meeting: Groundwater levels and ISW SMC (3 Feb 2020) PMAs (8 Feb 2020)
20	23 February 2021			Public Meeting #2
21	10, 11 March 2021	Funding Mechanism PMAs Groundwater Level SMC	PMAs	
22	9, 13, 14 April 2021	Exploratory Scenarios by UVIHM Domestic Wells Impact Analysis ISW SMC	Monitoring Networks GSP Cost Estimate UVIHM	Working Group Meeting: Groundwater levels and ISW SMC
23	11, 19 May 2021	Future Scenarios Initial SMCs PMAs	Water Budgets Initial SMCs GSP Writing PMAs	
24	25 May 2021			Public Meeting #3
25	9, 10 June 2021	GSP Review Process and Schedule	GSP Review Process and Schedule	
26	7, 8 July 2021	Draft GSP Review	Draft GSP Review	
27	15 July 2021			Public Meeting #4
28	13 August 2021		Appointment of Directors Monitoring Network Implementation GSA Funding Mechanism	Stakeholder Interview with Board Ag Representative and Farm bureau
29	9 September 2021	Draft GSP Public Review Comments		Stakeholder Interviews in September 2021: City of Ukiah and Sonoma Water
30	21 September 2021			Public Meeting #5
31	13, 20, 21 October 2021	Public Comments	Public Comments	Stakeholder Intervies in October 2021: TAC Tribal Representative and RRFC

Table 2.6: Ukiah Valley Groundwater Basin GSP: Meeting Tracker *(continued)*

No	Meeting Date	UVBGSA TAC Meeting	UVBGSA Board Meeting	Specific Stakeholder/Public Meetings
32	9, 10 November 2021		Communication Plan GSA Funding Mechanism	Stakeholder Intervies in November 2021: Farm bureau and RRFC
33	15 December 2021		GSP Adoption	

2.1.5.9 Venues for Engaging

The GSA utilized multiple outreach venues as wells as broader communication tools to allow for stakeholder engagement at different levels that are best suited to stakeholder needs:

- Public meetings of the the GSA Board and TAC: open to all interested parties and advertised and announced through appropriate means such as email newsletters, interested parties' subscription lists, e-Notification system, flyers and banners, etc.
- Stakeholder informational interviews and/or work group meetings;
- Community or regional forums;
- Public workshops/briefings;
- Digital venues; and,
- Mailing services.

In accordance with County and State health orders, the venues were hosted virtually via Zoom due to COVID-19 pandemic. This arrangement remains in place until the County's new incidences are reduced to levels allowing the return of in person meetings.

2.1.5.10 C&E Implementation Timeline

Implementation of the C&E Plan (CommPlan) followed the timeline shown in **Figure 2.10**.

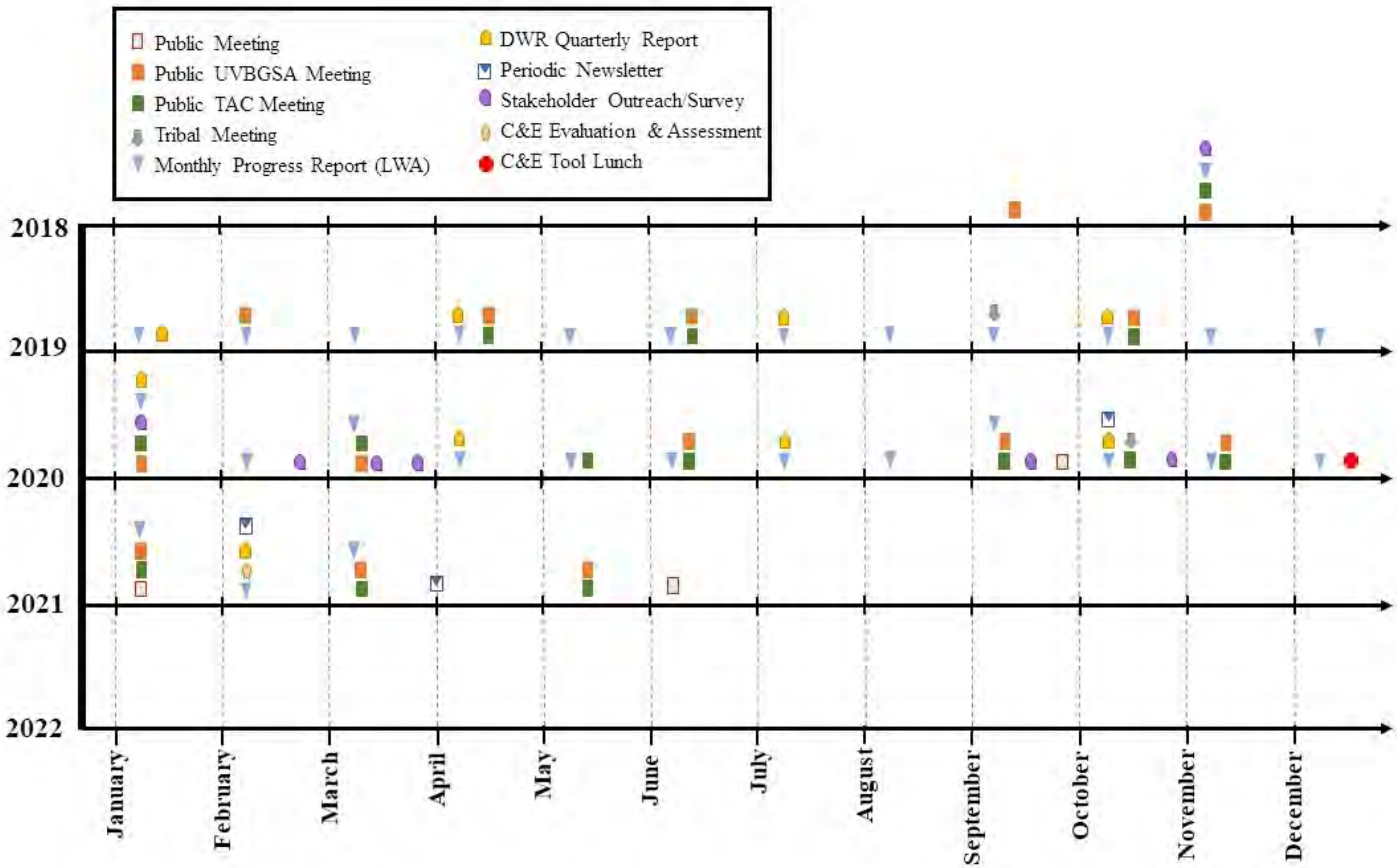


Figure 2.10: Communication and Engagement Implementation Timeline.

2.2 Basin Setting

2.2.1 Hydrogeologic Conceptual Model

This Hydrogeologic Conceptual Model (HCM) has been developed by GEI Consultants (GEI) for the Ukiah Valley Basin Groundwater Sustainability Agency for inclusion in the Groundwater Sustainability Plan (GSP) under the requirements of the Sustainable Groundwater Management Act (SGMA). The purpose of this HCM is to meet the regulatory requirements mandated by SGMA along with establishing a framework hydrogeologic model with which to guide development of the GSP and management of the Ukiah Valley Groundwater Basin, including future modeling efforts and monitoring programs. Requirements of an HCM under SGMA Regulations Chapter 1.5, Article 5, Subarticle 2: 354.14, and sections of this document that meet said requirements, are found in **Table 2.7**.

The HCM describes the Basin setting, general geology, hydrology, and hydrogeology of the Basin. Organization of the HCM is as follows:

1. **Basin Setting:** Description of the geographic setting, topography, climate, and general hydrology of the Basin. Identifies Basin boundaries and public entities within the Basin.
2. **Soils:** General soil types found throughout the Basin and their general location. Broken into hydrologic and taxonomic groups.
3. **Regional Geology:** Geologic formations found throughout the Basin, and their descriptions, along with major geologic structures. Development and discussion of three cross sections within the Basin.
4. **Principal Aquifers and Aquitards:** Major aquifers, water bearing formations, and aquitards within the Basin. Regional hydrogeologic characteristics.
5. **Groundwater Recharge and Discharge:** Regions of significant recharge to the Basin's groundwater supply and understanding of the flow of groundwater through the Basin.
6. **Surface Water:** Surface water characteristics, flow, and infrastructure within the Basin. Groundwater and surface water interactions and monitoring. Sources and infrastructure for imported water supply.
7. **Data Gaps:** Significant gaps in the understanding of the Basin groundwater and surface water characteristics.

Development of the HCM was based primarily on the *Initial Groundwater Sustainability Plan Hydrogeologic Conceptual Model* (IHCM) (LACO Associates, 2017) by LACO Associates (LACO), provided in **Appendix 2-A**, and informed by DWR's HCM Best Management Practices (BMP) document (DWR, 2016c) provided in **Appendix 2-B**. The literature review and analysis done under the IHCM provided the foundation for this updated HCM. Data collected and analyzed under the IHCM were used for this HCM and supplemented with available data from public entities, such as the California State Groundwater Elevation Monitoring (CASGEM) and GeoTracker programs, where applicable. There are ongoing studies in the Basin, such as the work carried out by the USGS on both the presence of Sonoma Volcanics and the geochemistry of the Basin (Sonoma Water, personal communication., 2020), that will provide further clarification on the geology and hydrology of the Basin. This information shall be included in subsequent updates to the GSP as applicable.

Table 2.7: SGMA cross-reference table

SGMA Section	Requirements	Section
§ 354.14.a	Each Plan shall include a descriptive Hydrogeologic Conceptual Model of the Basin based on technical studies and qualified maps that characterizes the physical components and interaction of the surface water and groundwater systems in the basin.	X
§ 354.14.b	The hydrogeologic conceptual model shall be summarized in a written description that includes the following:	X
§ 354.14.b.1	The regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency	2, 2.1, 4
§ 354.14.b.2	Lateral basin boundaries, including major geologic features that significantly affect groundwater flow	2, 2.1, 4.3.1
§ 354.14.b.3	The definable bottom of the basin	2.1
§ 354.14.b.4	Principal aquifers and aquitards, including the following information	5
§ 354.14.b.4.A	Formation names, if defined	5.1, 5.2, 5.3
§ 354.14.b.4.B	Physical properties of aquifers and aquitards, including the vertical and lateral extent, hydraulic conductivity and storativity, which may be based on existing technical studies or other best available information	5.1, 5.2, 5.3, 5.5
§ 354.14.b.4.C	Structural properties of the basin that restrict groundwater flow within the principal aquifers, including information regarding stratigraphic changes, truncation of units, or other features	4.3.1, 5.3, 5.5
§ 354.14.b.4.D	General water quality of the principal aquifers, which may be based on information derived from existing technical studies or regulatory programs	5.1.1, 5.2.1, 5.3.1, 5.5
§ 354.14.b.4.E	Identification of the primary users or uses of each aquifer, such as domestic, irrigation, or municipal water supply	5.5
§ 354.14.b.5	Identification of data gaps and uncertainty within the hydrogeologic conceptual model	8
§ 354.14.c	The hydrogeologic conceptual model shall be represented graphically by at least two scaled cross-section that display the information required by this section and are sufficient to depict major stratigraphic and structural features in the basin	4.4, 4.4.1, 4.4.2

Table 2.7: SGMA cross-reference table *(continued)*

SGMA Section	Requirements	Section
§ 354.14.d	Physical characteristic of the basin shall be represented on one or more maps that depict the following	X
§ 354.14.d.1	Topographic information derived from the U.S Geological Survey or another reliable source	2, 2.1, Figure 1
§ 354.14.d.2	Surficial geology derived from a qualified map including the locations of cross-sections required by this Section	4.2, Figure 4, Figure 5
§ 354.14.d.3	Soil characteristics as described by the appropriate Natural Resources Conservation Service soil survey or other applicable studies	3, 3.1, 3.2, Figure 2, Figure 3
§ 354.14.d.4	Delineation of existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas, including significant active springs, seeps, and wetlands within or adjacent to the basin	6, Figure 9
§ 354.14.d.5	Surface water bodies that are significant to the management of the basin	7.1, Figure 10
§ 354.14.d.6	The source and point of delivery for imported water supplies	7.3, Figure 11

Notes: X, Section addressed by HCM in its entirety.

2.2.1.1 Basin Setting

The UVGB underlies the Redwood Valley and Ukiah Valley, along with their tributary valleys, in Mendocino County, California. It is approximately 22 miles long and 5 miles wide at its widest point with a total area of 37,500 acres. Groundsurface elevation of the Basin ranges from approximately 500 ft-amsl in the south to 1,000 feet amsl in the north (DWR, 2004). USGS topographic data along with location and extent of the UVGB are shown in **Figure 2.11**. The Basin is bounded on all sides by the Coastal Ranges, primarily the Mendocino Range (Farrar, 1986). Highway 101 runs the entire length of the Basin and connects with Highway 20, which enters the Basin from the east, at Calpella (DWR, 2004). Ukiah is the only incorporated city within the Basin. The Russian River, and its tributaries, along with Lake Mendocino are the major surface water features within the Basin. The Russian river runs through the entire length of the Basin with many smaller tributaries contained within the Basin. The east fork of the river flows into Lake Mendocino and enters the Basin just south of the lake. The west fork originates to the north towards Redwood Valley and each fork merges into the main stem below Coyote Valley Dam. Annual precipitation in the Basin ranges from 45 inches in the north to 35 inches in the south (DWR, 2004).

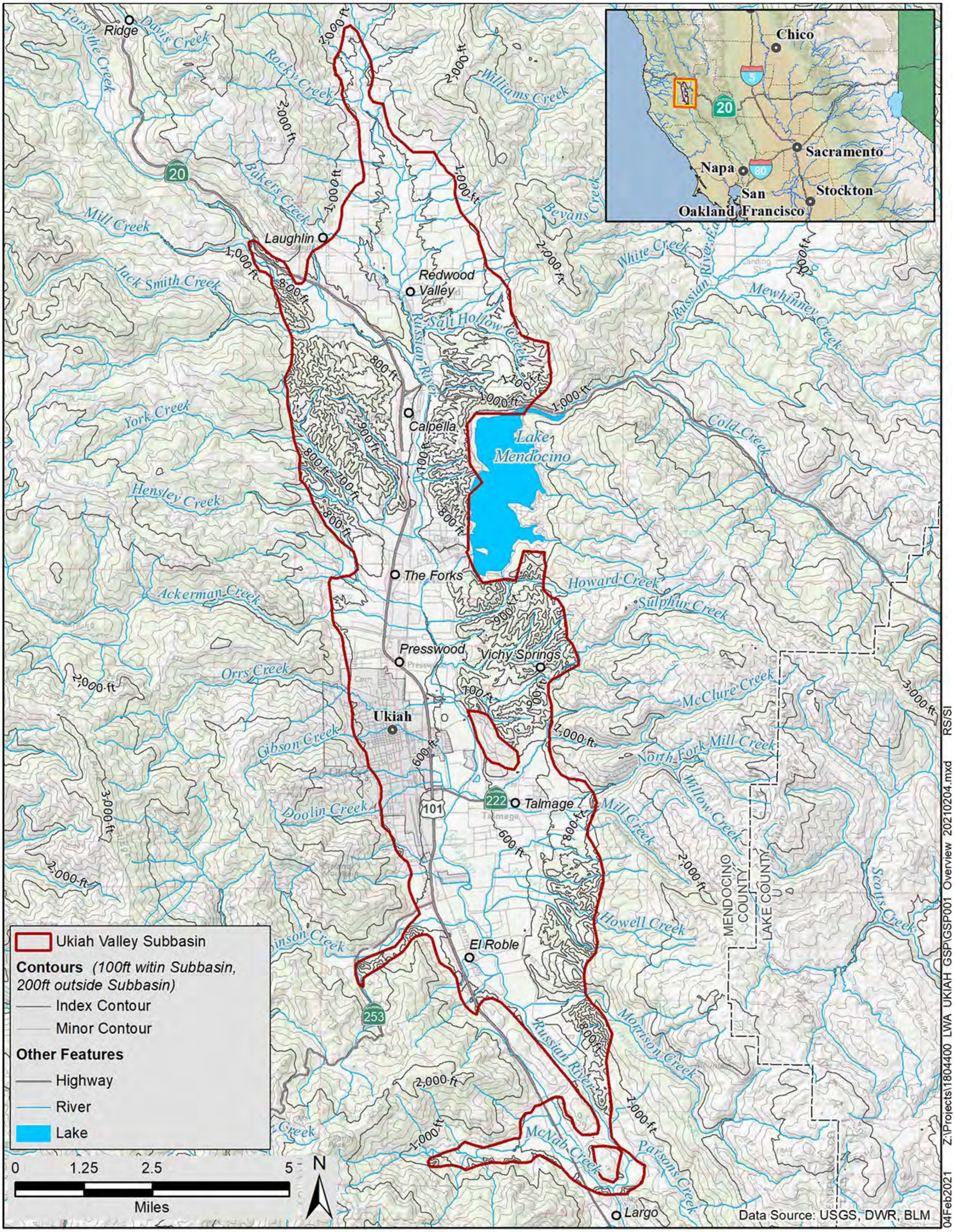


Figure 2.11: Basin setting.

Basin Boundary

The Basin boundary is identified in the 2016 update to DWR's Bulletin 118 (DWR, 2004, 2019d) as Basin 1-052 within the North Coast hydrologic region. The Basin is bounded by the Mendocino Range of the Coastal Ranges which is composed primarily of the Franciscan Complex bedrock (Franciscan Formation). The Basin is bordered by the Sanel Valley Groundwater Basin (1-053) to the south. The Sanel Valley Groundwater Basin and the Ukiah Valley Groundwater Basin are separated just north of Hopland by low hills through which the Russian River has cut a narrow gorge (Farrar, 1986). Inaccuracies in the Bulletin 118 Basin boundary near Lake Mendocino, Robinson Creek, and McNabb Creek were identified in the IHCM. A proposed update to the Basin boundary was presented in the IHCM. The boundary presented by Bulletin 118 in this HCM, shown in **Figure 2.11**, is used as an update to the boundary has not been completed.

The bottom of the Basin is defined by the contact with the Franciscan Formation as it is not considered to be a part of the alluvial Basin. Depth to the Franciscan Formation varies throughout the valley. Depth to Franciscan Formation in this HCM and therefore the Basin bottom was based on a Master's thesis submitted to Humboldt State University titled *Evoution of an Intermontane Basin Along the Maacama Fault, Little Lake Valley, Northern California* (Erickson, 2008). In this thesis, the depth to the Franciscan Formation was determined via a gravity study developed using a LaCoste Romberg model G gravity meter G425 to record gravitational anomalies. A total of 465 locations were surveyed and tied into an existing gravity network. Results were then adjusted to the International Gravity Standardization Network 1971 (IGSN-1971) gravity datum and constrained based on data from the DWR well completion reports.

The Erikson study covered the northern portion of the Basin up to just south of Lake Mendocino. The depth to bedrock in the remainder of the Basin was inferred in the IHCM using well completion reports (WCR's) and gradients established in the Erickson study. Results from the IHCM and Erikson studies are used for this HCM. Additional well logs have confirmed results from these two studies at select locations. The Basin is bounded on the sides by the Franciscan Formation of the Mendocino range and it is inferred that the Ukiah Valley fill is in depositional contact with shallow dipping bedrock on the Ukiah valley margins (Erickson, 2008). The greatest depths to bedrock (Franciscan) for the IHCM cross sections, A-A', B-B' and C-C' presented are 1,950 feet, 1,350 feet, and 1,000 feet, respectively. IHCM cross sections can be found in **Appendix 2-A**, and the location of these cross sections correspond to locations shown on **Figure 2.12**. Raw data from the study was not available for the development of this HCM. There are additional studies planned to determine the Basin bottom. The HCM will be amended to include the findings at a later date.

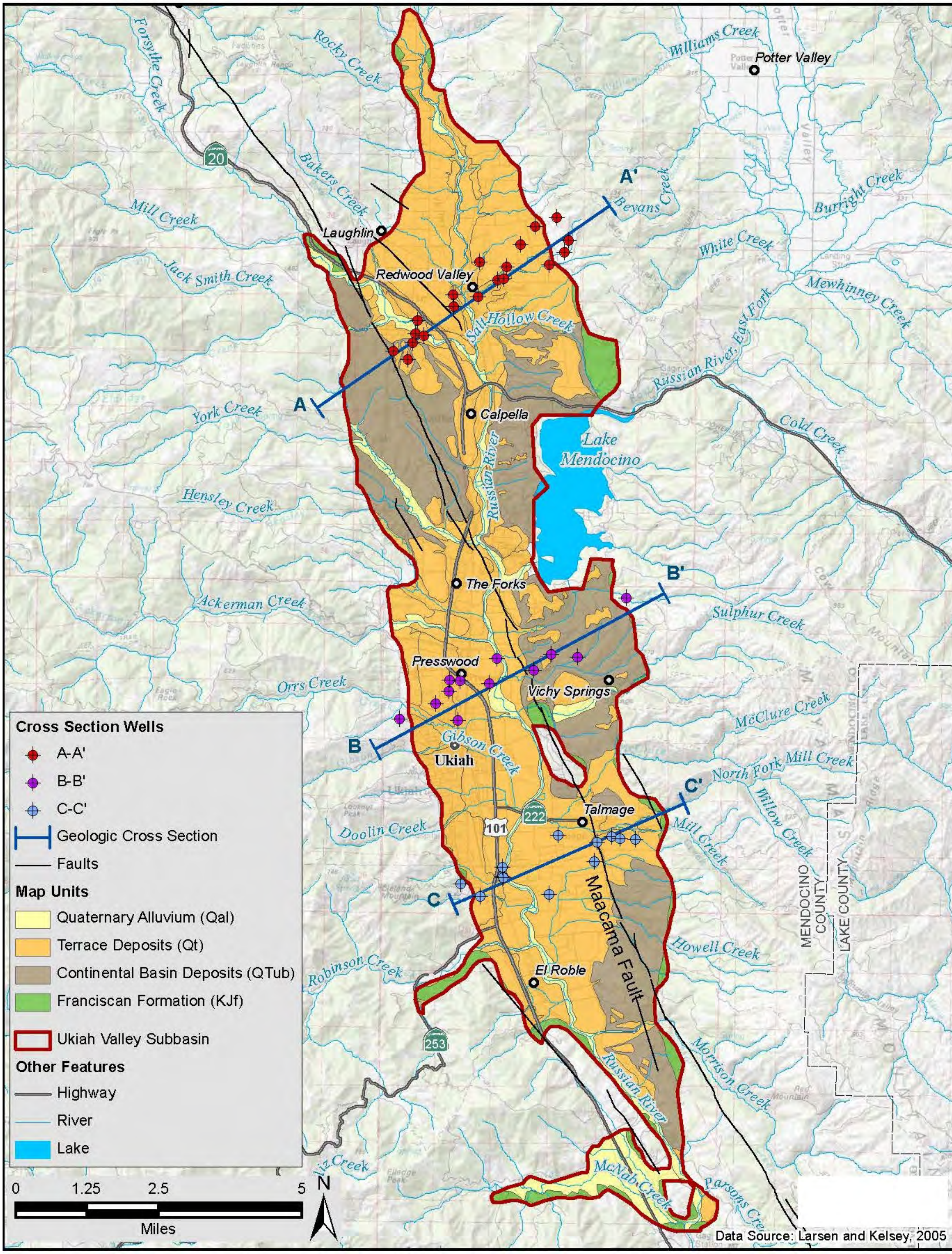


Figure 2.12: Well and cross section locations.

2.2.1.2 Soils

Soils within the Basin were analyzed based on two categories: hydrologic soil groups and taxonomic soil orders. Hydrologic soil groups describe soils ability to transmit water under the saturated conditions while taxonomic soil orders describe general properties and origins of a soil.

Hydrologic Soil Groups

The Natural Resources Conservation Service (NRCS) Hydrologic Soils Group classifications (Soil Survey Staff, 2014) provide an indication of soil infiltration potential and ability to transmit water under saturated conditions. Hydrologic soil groups are developed based on saturated hydraulic conductivities of shallow, surficial soils. Each group has an associated range with higher conductivities (greater infiltration) in Group A and lower conductivities (lower infiltration) in Group D. Hydrologic soil groups are defined below:

- Hydrologic Group A – "Soils in this group have low runoff potential when thoroughly wet. Water is transmitted freely through the soil" (Soil Survey Staff, 2014). Group A soils have high infiltration rates due to presence well drained sands or gravelly sands and have the highest permeability and recharge potential.

- Hydrologic Group B – "Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission is unimpeded" (Soil Survey Staff, 2014). Group B soils are moderately well drained due to moderately fine to coarse textures. They have the second highest potential permeability and recharge potential among the soil groups.

- Hydrologic Group C – " Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission is somewhat restricted" (Soil Survey Staff, 2014). This group has restricted potential to contribute to groundwater recharge. Group C soils have low infiltration rates due to their fine texture or because of a layer that impedes downward movement of water.

- Hydrologic Group D – "Soils in this group have high runoff potential when thoroughly wet. Water transmission is very restricted." (Soil Survey Staff, 2014). This group has a very limited capacity to contribute to groundwater recharge.

Dual hydrologic groups (A/D, B/D, C/D) are assigned to characterize runoff potential under drained and undrained conditions. The first letter represents runoff potential under drained conditions and the second letter is for undrained conditions. Hydrologic soil groups are presented in **Figure 2.13**. High infiltration soils, Group A, are located primarily in small bands along the rivers. Moderate infiltration soils, Goup B, occupy the majority of the Basin and are primarily in the central portion of the Basin. Slow infiltration soils, Group C and Group D, occupy the northern and southern portions as well as the eastern edge of the Basin.

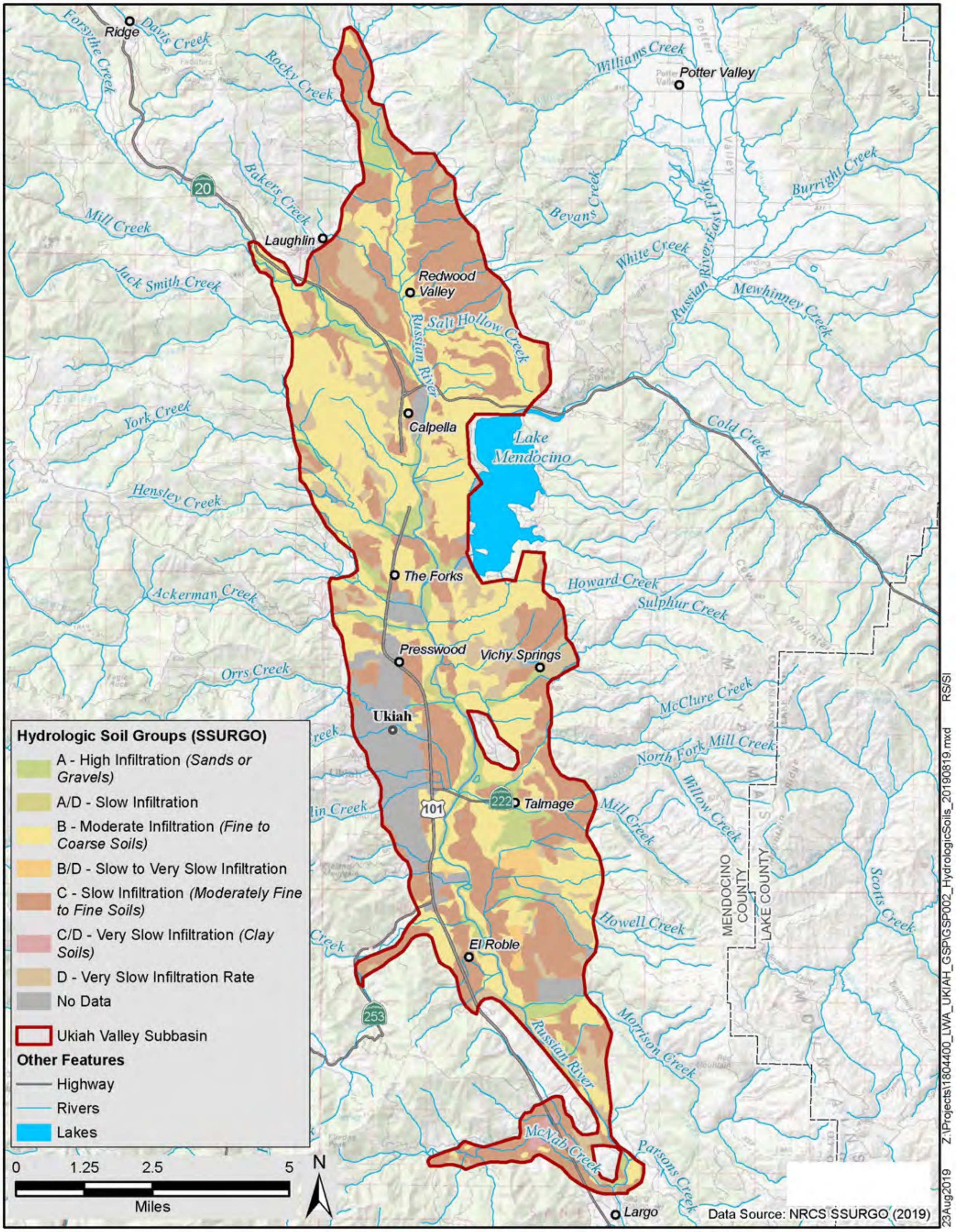


Figure 2.13: Hydrologic soil groups.

Taxonomic Soil Orders

Taxonomic soil orders are presented in **Figure 2.14**. Taxonomic orders were identified using the Soil Survey Geographic Database database from the NRCS. A total of 5 taxonomic orders are present within the Basin. Soil orders within the Basin, along with descriptions from the NRCS publication Keys to Soil Taxonomy (Soil Survey Staff, 2014), include:

- Alfisol – Strongly weathered mineral soils. Most often, Alfisols develop under native deciduous forests or in some cases, such as California, under savannas (mixed trees and grass). They are characterized by a subsurface horizon in which silicate clay has accumulated through illuviation.

- Entisol – Weakly developed mineral soils. Entisols show little to no development of soil horizons. Within the Basin these soils are likely recently deposited alluvium.

- Inceptisol – Weakly developed mineral soils. Inceptisols have very little soil development but are distinguished from Entisols by evidence of a soil horizon.

- Mollisol – Formed primarily through the accumulation of calcium-rich organic matter. Characterized by a thick humic (organic) horizon. Contain swelling type clays and a granular/crumb structure.

- Vertisol – Identified by shrink swell clays. They are formed through continued shrinking and swelling during wet and dry periods. Most Vertisols are dark and even black in color. They typically develop from limestone, basalt, or other calcium- and magnesium-rich parent material.

The most prominent soils groups within the Basin include Mollisols and Inceptisols. Mollisols are found throughout the Basin and primarily along the low-lying middle of the Basin where vegetation and clays are present. Inceptisols are found primarily in the foothills or highlands. Younger Entisols are found along the river channels and likely associated with young alluvial deposits. Alfisols and Vertisols are found in small patches scattered throughout the Basin.

2.2.1.3 Regional Geology

The Basin is located mostly within the Mendocino Range in the northern part of the Coast Ranges Geomorphic Province (DWR, 2004; Farrar, 1986). The Mendocino Range is predominantly composed of the thick, late Mesozoic and Cenozoic sedimentary rocks of the Franciscan formation. The Coast Ranges Geomorphic Province exhibits low northwest-trending sub-parallel mountain ranges and valleys resulting from the compressional deformation between the Pacific and American plates (Fuller, Brown, Wills, & Short, 2015). Locally, the topography is controlled by tectonic activity associated with the right lateral Maacama Fault, a member of the San Andreas Fault System. As shown in **Figure 2.15**, this local faulting is expressed in numerous north-west trending lineaments throughout the Basin (Farrar, 1986). Sediments within the Basin are formed from erosion of the Franciscan formation and deposition via tectonic activity and uplift or as alluvial sediments from stream channel erosion (Farrar, 1986). The following sections detail the geologic history, significant geologic formations, geologic structures (faults and folds), and development of cross sections for the completion of this HCM.

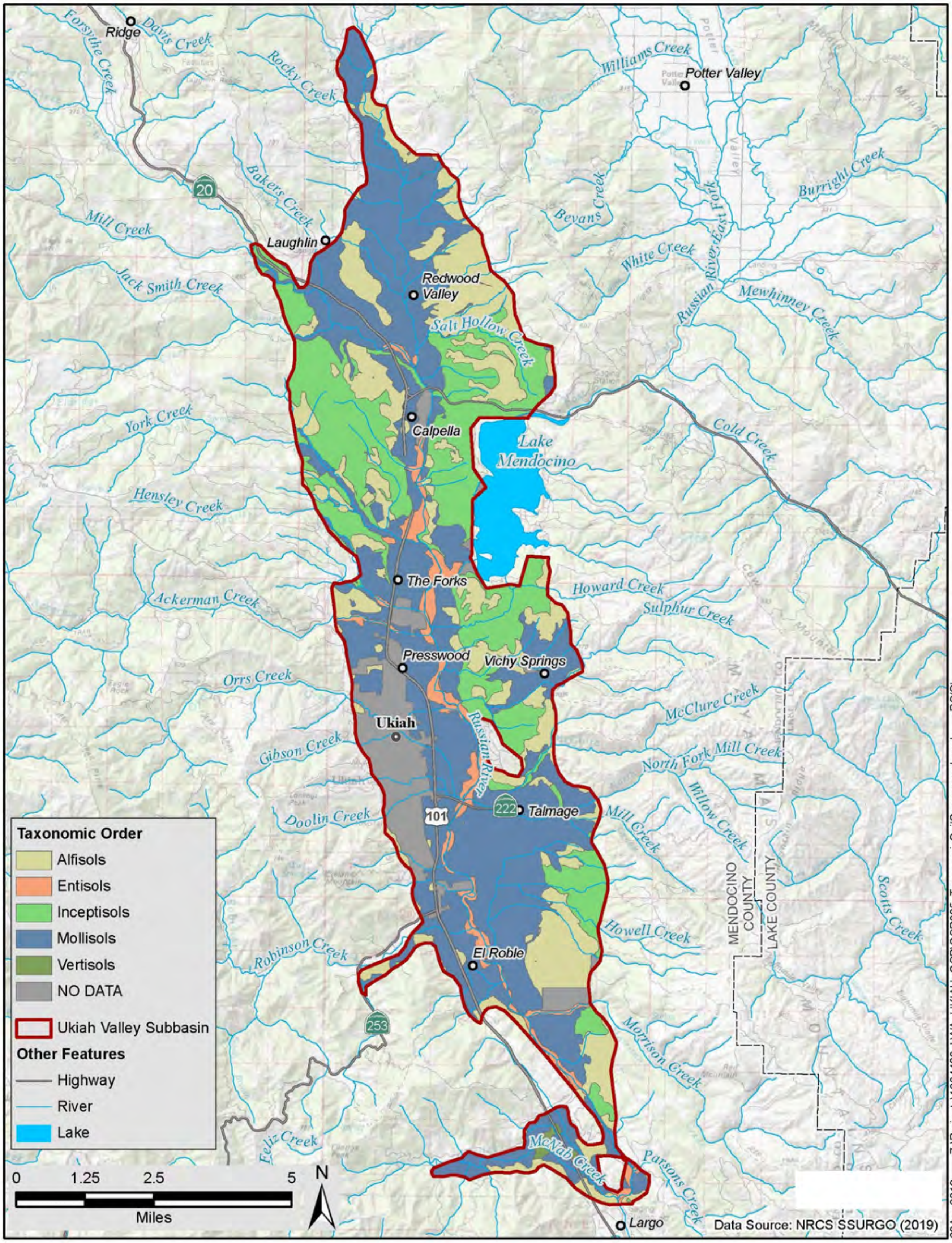


Figure 2.14: Taxonomic soil orders in the Basin

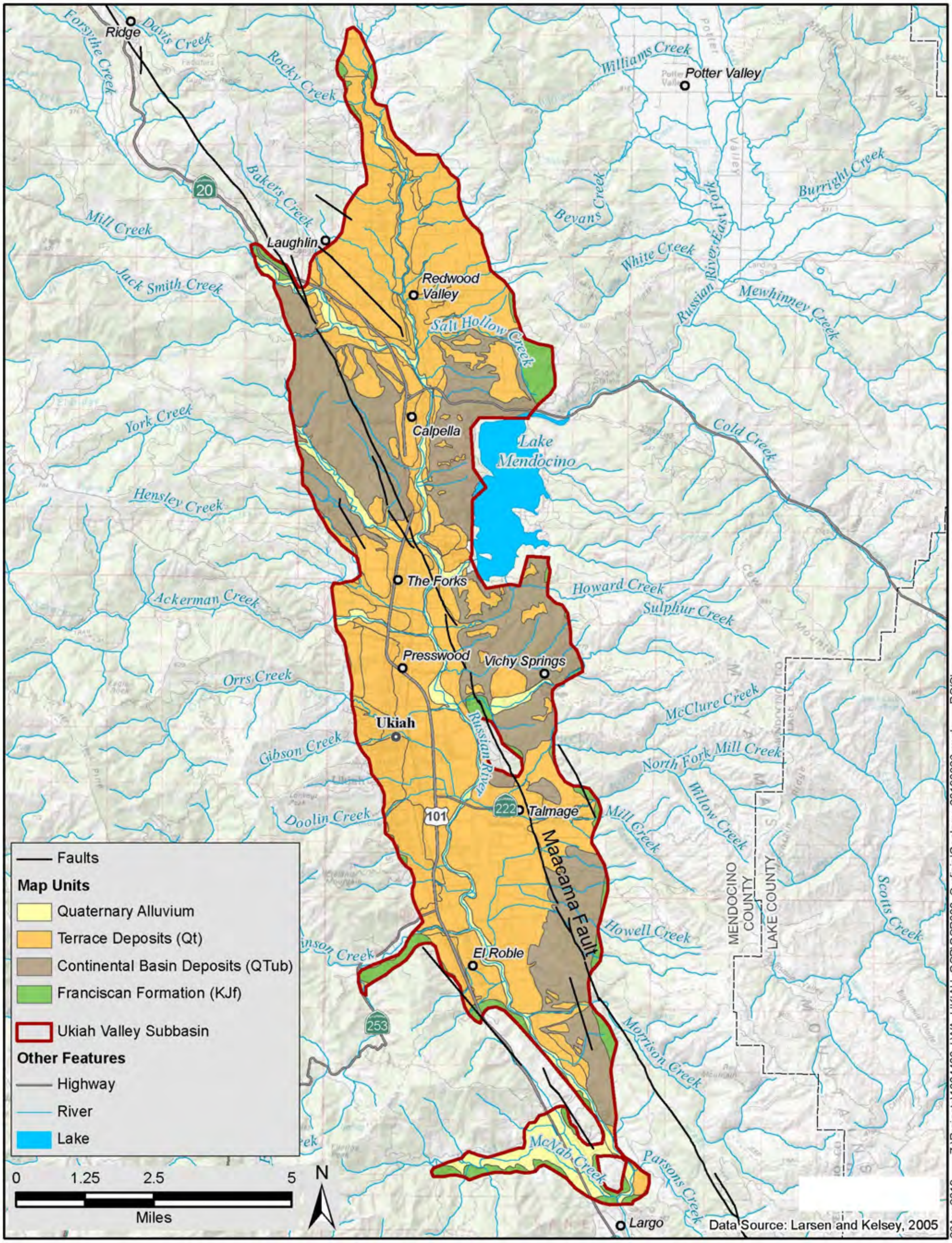


Figure 2.15: Surficial geology of the Basin.

Geologic History

The geomorphology, structural geology and geologic formations of the Coast Ranges occurred as a result of tectonic activity between the continental North American Plate and the oceanic Farallon Plate. During the Mesozoic Era subduction and under thrusting of the Juan De Fuca Plate (a remnant of the Farallon Plate) beneath the North American Plate formed an oceanic trench at the plate boundary. Tectonically mixed sediment accumulated as the trench uplifted and created the mountainous terrain of the Franciscan formation (Farrar, 1986).

The Maacama fault formed 3.2 million years ago as a splay of the Roger's Creek Fault Zone. Several strike slip basins were formed concurrently with the Maacama fault (McLaughlin et al., 2012). The development of such basins is believed to have begun less than 4 million years ago (Farrar, 1986). Formation of the Ukiah Valley was a result of oblique pull apart extension of an echelon and minor branching faults of the Maacama fault system (Farrar, 1986). Right lateral strike-slip motion along parallel faults caused wrenching apart and down dropping of the crustal block, forming a graben. Bounded by faults, the graben continued to drop a considerable amount of sediment which was deposited into the valley by streams, debris flows, and landslides (Farrar, 1986). This sediment makes up a good portion of the valley fill seen today. Changes in Basin geometry and fault geometry at this point are likely due to adjustments of fault zone reorganization caused by the migration of the Mendocino Triple Junction and the northward movement of a major releasing bend in the San Andreas Fault (McLaughlin et al., 2012).

Geologic Formations

Geologic formations described are based on a literature review including:

- Geology and Ground Water in Russian River Valley Areas and in Round, Laytonville and Little Lake Valleys, Sonoma and Mendocino Counties, California (Cardwell, 1965);
- Groundwater Resources in Mendocino County, California (Farrar, 1986);
- Water Supply Assessment for the Ukiah Valley Area Plan (MCWA, 2010);
- DWR's Bulletin 118 Basin descriptions (DWR, 2004);
- The 2005 surficial geology map by Larsen and Kelsey (Larsen & Kelsey, 2005); and,
- local well logs.

Four significant geologic formations were identified, and their surficial expressions are shown in **Figure 2.15**. Surficial geology shown in **Figure 2.15** is based on the 2005 Larsen and Kelsey map, which was developed for the Basin in conjunction with the USGS and DWR. Within the unconsolidated to loosely consolidated valley fill, which constitutes the Basin, three formations were identified: Quaternary (Recent) Alluvium, Pleistocene Terrace Deposits, and Pliocene/Pleistocene Continental Basin Deposits. Beneath the valley fill material is the Franciscan Formation. The Franciscan Formation is not considered to be part of the Basin from the perspective of SGMA. However, it is significant with regards to modeling the behavior of groundwater in the Basin and in identifying the Basin bottom. The following sections describe the geologic formations of the Basin in detail.

Franciscan Formation

The Franciscan Formation consists of rocks from the Jurassic to Cretaceous age and are considered the basement and bedrock for the Basin along with comprising the majority of the surrounding Mendocino Range. It is composed of consolidated marine rocks, sandstone, siltstone, shale, chert, serpentine, greenstone, and schist. Rocks are generally fractured and with numerous faults and zones of shearing (Cardwell, 1965). Fracturing in the Franciscan formation is due to faulting from active plate motion between the North American Plate and Oceanic Plate.

Continental Basin Deposits

Continental Basin Deposits are Pliocene and Pleistocene in age and underlie the Quaternary Alluvium and Terrace Deposits. They are comprised of poorly consolidated and poorly sorted clayey and sandy gravel, clayey sand, and sandy clay (Farrar, 1986). The vertical distribution of the Continental Basin Deposit materials includes thick clay layers that lie over and below confined aquifers consisting of sands and gravels (MCWA, 2010). Clays can occur both as beds, several tens of feet thick, to interstitial material between sand and gravel. The high clay content in the formation results in low permeability and low producing wells (MCWA, 2010). Depositional environment for the Continental Basin Deposits consists of weathered Franciscan Formation deposited as alluvial fans and as flood plain, stream channel, and lakebed sediments (Cardwell, 1965). According to Farrar, no wells have fully penetrated the Continental Basin Deposit formation in the Basin (Farrar, 1986). Continental Basin Deposits thickness ranges to a depth of up to 2,000 ft (~610 m) along the axis of the valley floor and overlie the basement rock of the Franciscan Formation.

Terrace Deposits

Terrace Deposits are Pleistocene in age and composed of partially to loosely cemented beds of gravel, sand, silt, and clay. They are similar in composition to Continental Basin Deposits but with less silt and clay. Terrace Deposits are discontinuous and long, narrow, elevated, gently inclined surfaces that are laterally interfingered with neighboring beds. Aggradation of eroded material, most likely from the surrounding Franciscan formation, formed the Terrace Deposits (Farrar, 1986). These deposits can be broken into two types, older Terrace Deposits, and younger Terrace Deposits. Older Terrace Deposits are thin and generally not water bearing. Located in the higher portions of the Basin, they consist of red, gravelly clay soil. Younger Terrace Deposits are located lower in the valley and consist of sandy or silty gravel with fragments of cobbles. Beds are compact and nearly flat-lying and may be up to 200 ft (~61 m) thick (Cardwell, 1965).

Quaternary Alluvium

Quaternary Alluvium is the primary water producing geologic unit in the Basin. It consists of unconsolidated gravel, sand, silt, and minor amounts of clay that were deposited in thin bands along river channels and wider flood plains of the Russian River and its tributaries, along with alluvial fans and as colluvium (Cardwell, 1965). These are the unconsolidated, youngest, and least weathered of the valley fill geologic units. The thin layers of unconsolidated sand and gravel found closest to the Russian River have shown a hydraulic connection with the river. Buried channels of Quaternary Alluvium show coarser material with boulders and gravel (Cardwell, 1965). Alluvium particle size tends larger and coarser along the axis of the stream and finer moving away to the flood plains. However, alluvium is generally heterogeneous with depth at all locations due to the ever-changing nature of river channels (Farrar, 1986). Thickness of the Quaternary Alluvium varies from 10 ft (~3 m) to greater than 100 ft (~30.5 m) in some places and overlies the Terrace and Continental Basin Deposits (Cardwell, 1965; Farrar, 1986).

Faults and Folds

Major geologic structures in the Basin have a regional northwest to north-northwest trend (including faults and folds) which can be observed in topographic features including the Russian River and the axis of the Basin. However, locally much of the geology shows a chaotic structure (Farrar, 1986). Little evidence of significant folds was observed in investigations of the Basin but does not exclude the existence of such folds. The Maacama fault is the major fault in the area and runs through the middle of the Basin trending in a northwest direction. The location of the Maacama fault in the Basin is shown on **Figure 2.15**.

Maacama Fault

The Maacama fault is a member of the San Andreas fault system and is the result of the interaction between the Pacific, Gorda-Juan de Fuca, and North America plate boundaries. The fault was formed 3.2 million years ago and originated as a northeast splay from the southern portion of the Roger's Creek Fault Zone (McLaughlin et al., 2012). It displays right lateral motion and from extension, volcanism, and strike-slip Basin development, has acquired several right steps and splays during its evolution (McLaughlin et al., 2012; Rexford, 1989). The Maacama fault is mapped as an active fault by the California Geologic survey and may have been active during the Holocene time period (California Geological Survey, 2017; Rexford, 1989). Evidence of the Maacama Fault's effects on groundwater levels and flow were not found during the development of this HCM. If new information regarding the Maacama Fault and its effects on groundwater flow are discovered, either through implementation of the GSP or through independent studies, this information will be incorporated during the GSP updates.

Geologic Cross Sections

Three cross sections were constructed for the development of the HCM to illustrate the subsurface and better understand the hydrogeology of the Basin. These cross sections were developed based on lithologic data and show a textural representation of the subsurface, such as gravels, sands, and clays. Textural cross sections illustrate the location of coarse, permeable material and improves the understanding of flow through aquifer material. The cross sections were also used in hydrologic modeling of the Basin. Lithologic data were roughly correlated to one of the two principal aquifers for the Basin. Without more detailed lithologic data, these aquifer delineations are estimates of the aquifer location and extent. Cross section locations are shown on **Figure 2.12**. Cross sections and the location of well completion reports (WCRs) used to develop the cross sections are shown on **Figure 2.16** through **Figure 2.18**. WCRs used to develop the cross sections can be found in **Appendix 2-C**.

Cross sections for this HCM were developed to supplement cross sections developed as part of the IHCM. For this reason, both HCM and IHCM cross sections were developed at the same locations. The IHCM cross sections present the depth and extent of geologic formations within the Basin down to the Basin bottom. For this reason, IHCM cross sections have a greater depth than those developed for this HCM. IHCM cross sections used lithology presented in WCRs to infer geologic formations, as presented in **Section [Geologic Formations]**, and geologic contacts. IHCM cross sections can be found in **Appendix 2-A**.

Due to the lack of detail in the lithologic data used to develop both the IHCM and HCM cross sections, there is greater uncertainty as to the extent of geologic formations and aquifers. As more lithologic data is collected through well construction, GSP implementation, and regional studies, these data will be used to further refine the cross sections and the HCM as necessary.

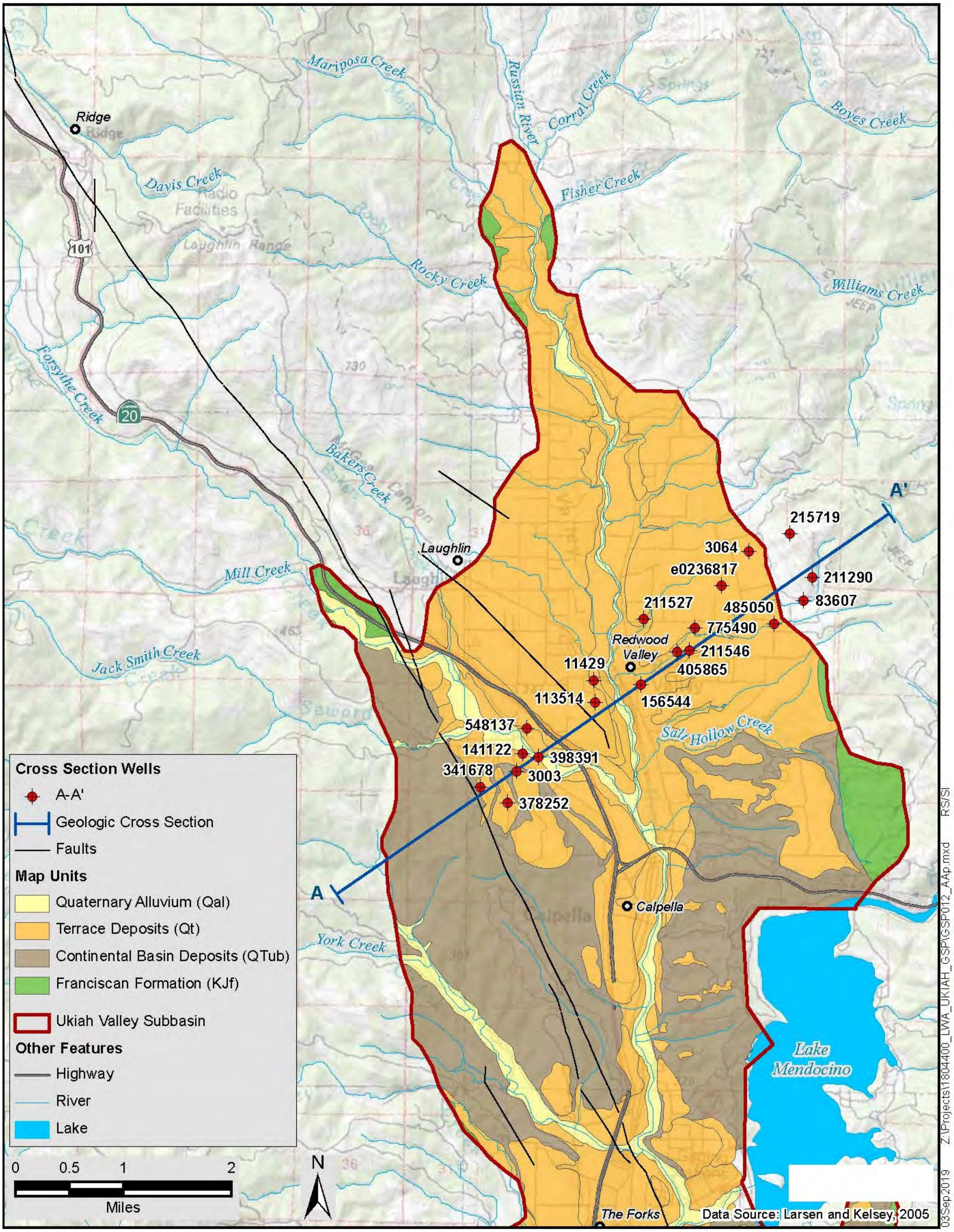


Figure 2.16: Cross section A-A' with well locations.

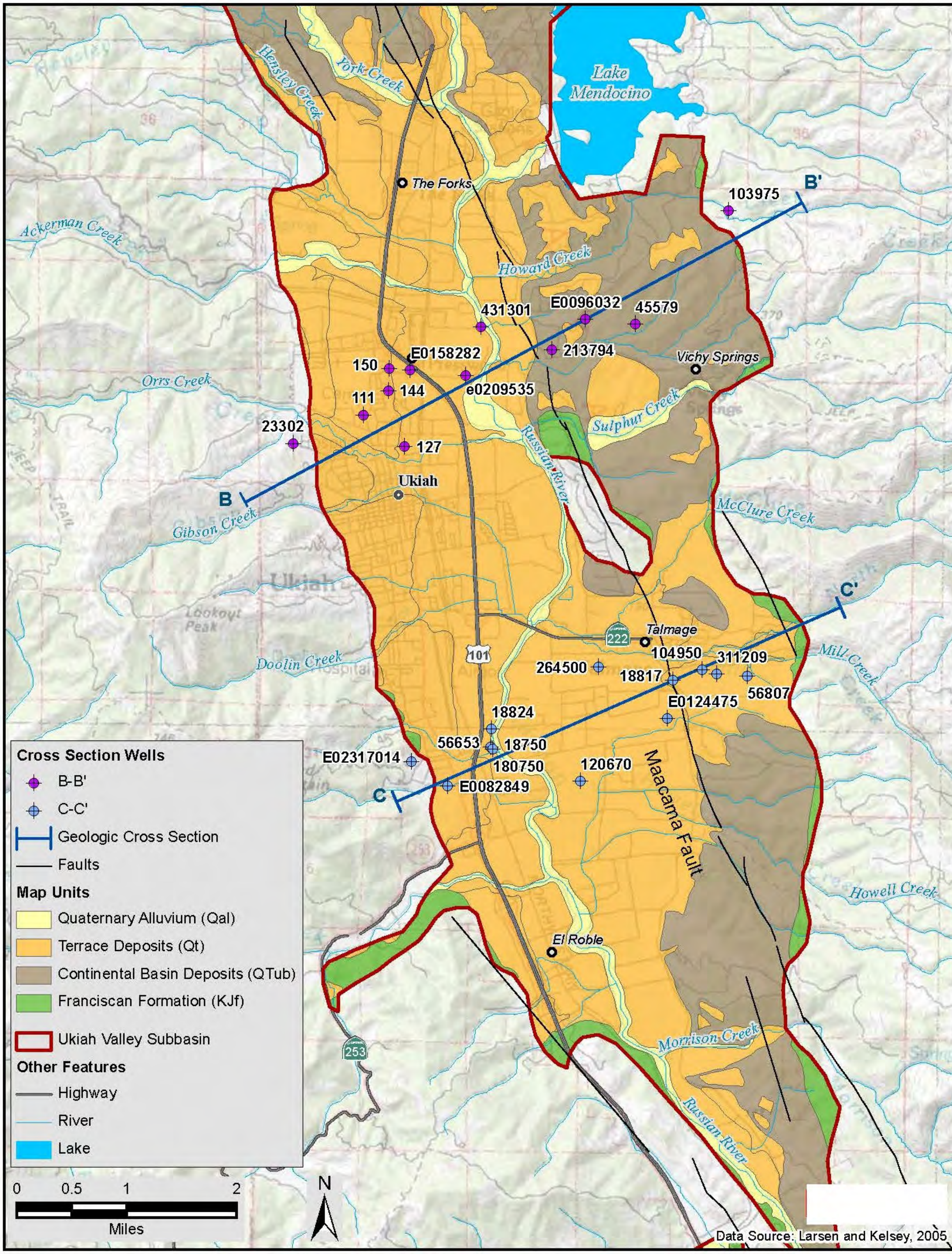


Figure 2.17: Cross section B-B' and C-C' with well locations.

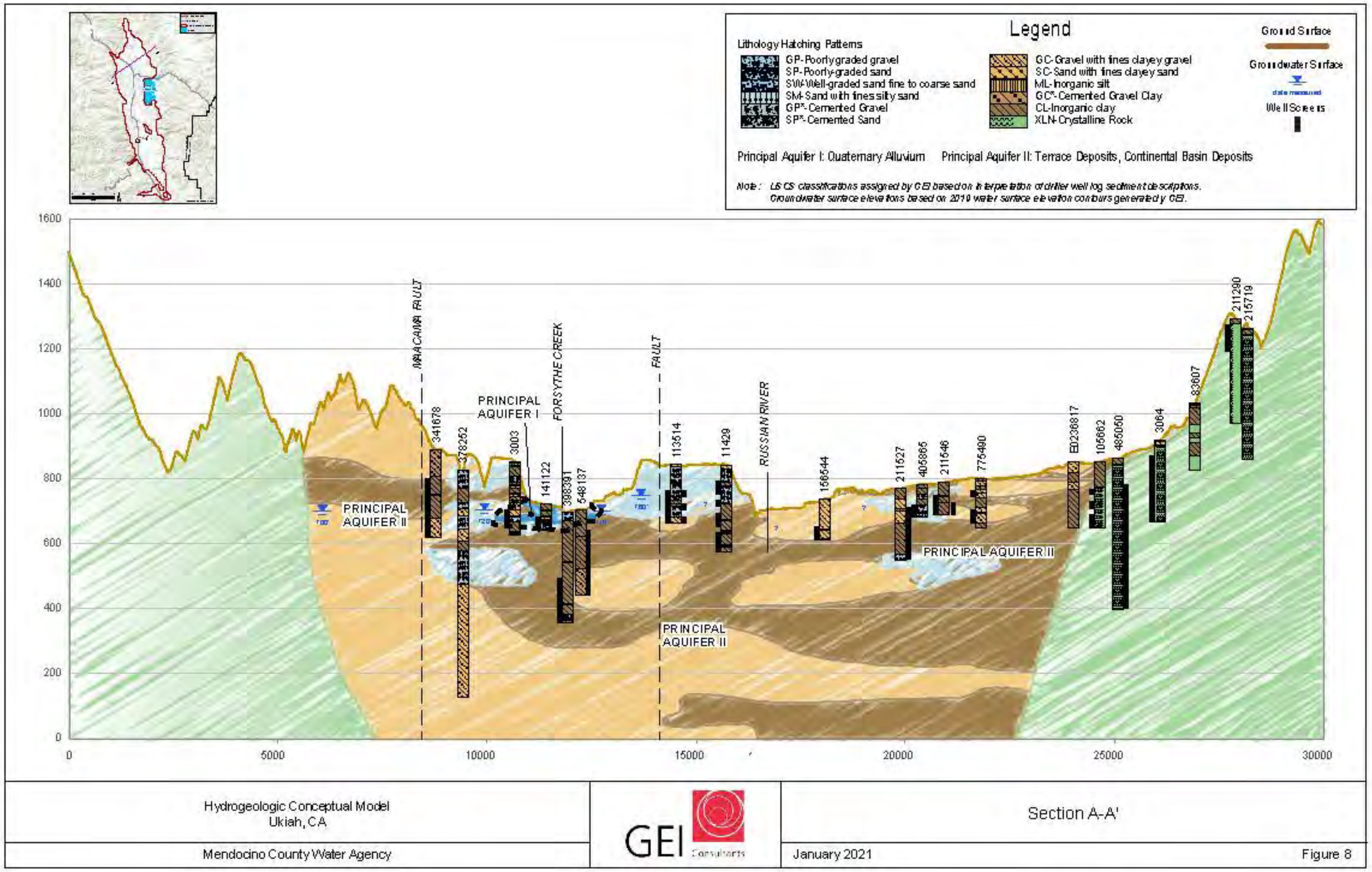


Figure 2.18: Cross section A-A'.

Cross Section Development

Cross sections were developed using lithologic information from both DWR WCRs and additional lithologic data provided by the USGS. WCRs from the IHCM cross sections were used where possible to maintain consistency. Any identified data gaps from the IHCM cross sections were addressed through the inclusion of wells and borings from the USGS. Well data were then plotted, and those wells located reasonably close to each cross section were selected. Selected wells are located no further than 2,500 ft (762 m) from any cross section with the most wells falling within 1,000 ft (304.8 m). Selected wells were projected at ground surface along the appropriate cross sections.

Once wells were selected, driller's logs and WCRs were reviewed with the logged soils descriptions assigned a lithologic code. These lithologic codes were based on the Unified Soil Classification System (USCS). The USCS classifies soils based on dominant texture classes of gravels, sands, silts, and clays. Modified lithologic codes in addition to those of the USCS were used, such as cemented sands and gravels, based on an understanding of the local geology and literature reviews in order to better characterize the subsurface geology. Wells and lithologies were then plotted along the cross sections with the subsurface interpreted by GEI geologists based on well log lithologies, literature reviews, and understanding of the depositional environment for the Basin. Lithologic codes used for generation of the cross sections, along with inferred geologic formation, hydrogeologic properties, and associated principal aquifers can be found in **Table 2.8**.

From the USCS classifications and the WCRs lithologic descriptions, geologic formations and principal aquifer designations were assigned. Sands and gravels that showed little weathering or cementation were indicative of the younger Quaternary Alluvium. These soils were indicative of Principal Aquifer I. Gravels and sands intermixed with fines such as silts and clays, or showing signs of weathering and cementation, were classified as the Terrace Deposits. These deposits are difficult to distinguish from those of the underlying Continental Basin Deposits but were identified where possible. Clays, sandy/gravely clays, and highly weathered and cemented sands and gravels were classified as Continental Basin Deposits. The major indicator for the Continental Basin deposits were the high clay content or cementation. The clay layers generally signified a transition from the Quaternary Alluvium to the Continental Basin Deposits. As both the Terrace Deposits and Continental Basin Deposits are similarly low producing formations, and distinct from the Alluvial Deposits hydraulically, they were considered Principal Aquifer II. Where these deposits were identified was considered the extent of Principal Aquifer III.

HCM cross sections were referenced against those generated as part of the IHCM. Boundaries between the Quaternary Alluvium and Continental Basin Deposits were compared as well as the general extent of each formation. Franciscan Formation extent was taken from the IHCM cross sections and verified by the inclusion of select USGS wells. Because of the highly interpretive nature of cross section development, and the lack of detailed lithologic data, there are some discrepancies between the extent of geologic formations and principal aquifer shown in the cross sections in comparison to the surficial geology shown on **Figure 2.15**. The cross sections serve to provide a conceptual model of subsurface geology and aquifer conditions rather than surface expression of geologic formations and are likely less accurate in terms of the surface geology. As more lithologic data are collected, greater clarity in the extent of geologic formation and aquifers will be provided.

Table 2.8: Lithologic codes for cross sections

Lithologic Code	Description	Assigned Geologic Formation	Assumed Hydrogeologic Properties	Principal Aquifer
GP	Poorly Graded Gravel	Quaternary Alluvium	High conductivity	I
GP*	Cemented Gravel	Terrace Deposits	Moderate to low conductivity	II
GC	Gravel with fines, clayey gravel	Continental Basin Deposits	Moderate to low conductivity	II
GC*	Cemented Gravel Clay	Continental Basin Deposits	Moderate to low conductivity	II
SP	Poorly graded sand	Quaternary Alluvium	High conductivity	I
SW	Well graded sand	Quaternary Alluvium	High conductivity	I
SM	Sand with fines, silty sand	Terrace Deposits	Moderate conductivity	II
SP*	Cemented sand	Terrace Deposits	Moderate conductivity	II
SC	Sand with fines, clayey sand	Terrace Deposits	Moderate to low conductivity	II
ML	Inorganic silt	Terrace Deposits	Moderate to low conductivity	II
Cl	Clay	Continental Basin Deposits	Low conductivity	II
XLN	Crystalline rock	Franciscan Formation	Low conductivity	NA

Note: NA - Not Applicable, not considered part of Ukiah Valley Groundwater Basin
* Denotes cemented material

Cross Section Interpretation

Textural cross sections graphically illustrate the extent of coarse-grained and fine-grained material throughout the Basin and are helpful in understanding Basin hydraulics and groundwater flow. Inferences of the extent and location of principal aquifers can be made by combining lithologic and local geography. Cross sections developed as part of this HCM were developed to assist in determining the general flow of groundwater through the Basin, regions with the most probability of significant groundwater supply, and location and extent of geologic formations/principal aquifers (refer to **Section 2.2.1.4)**). Geologic formations were identified based on lithologic descriptions, as shown in **Table 2.8**.

The IHCM was also reviewed to establish depth to bedrock and as a check against the textural cross sections in terms of the location and the extent of the Quaternary Alluvium (Principal Aquifer I). All other material was considered Principal Aquifer II. Both the IHCM and textural cross sections provide a small-scale snapshot of the Basin geology at each location, and while regional trends may be inferred, subsurface geology varies.

Cross Section A-A'

Cross Section A-A' (**Figure 2.18**) is the northernmost cross section in the Basin as shown in **Figure 2.12** and **Figure 2.16**. From the textural cross sections, it is shown that there is little high permeability material (gravels and sands) associated with the Quaternary Alluvium or Principal Aquifer I. This material is denoted by the blue and light blue hatching indicating gravels and sands. Unconsolidated gravels and sands begin to appear around the western portion of the Basin at ground surface near the Russian River. Alluvium material is present at the scale of tens of feet thick and occurs over 3,000 to 4,000 ft (914 to 1,219 m) wide. This material may be in connection with the Russian River due to its proximity. There is no evidence of Quaternary Alluvium outside of this small band of material.

Directly adjacent to the Quaternary Alluvium are cemented gravel and sand interlayered with sections of clay and gravel clays. This material is likely indicative of the Terrace Deposits or Continental Deposits. The deepest well logs, greater than 200 ft (~61 m) deep, show predominantly clay material intermixed with pockets of gravel and sands indicative of the Continental Basin Deposits. To the west, there is evidence for greater sandy clays and gravelly clays in contrast to the clay dominant material to the east. Based on the nature of the Terrace Deposits and Continental Basin Deposits, it is difficult to distinguish between the two material. However, extensive clays and fine grain material is assumed to be indicative of Continental Basin Deposits. Continental Basin Deposits and Terrace Deposits make up Principal Aquifer II, as shown on **Figure 2.18**, and are identified by the brown and gray hatching indicating the lithology is primarily clays and gravelly, sandy clays. The significant increase in clay content between Principal Aquifer I and the Terrace Deposits and Continental Basin Deposits of Principal Aquifer II likely acts to restrict groundwater flow between aquifers.

Based on the textural cross section for A-A', it is expected that the greatest amount of available groundwater and flow occurs in the narrow and shallow band of unconsolidated sand and gravel along the Russian River. The majority of the subsurface however is intermixed clay and sandy/gravely clays of the Continental Basin Deposits that have low conductivity, limited production capacity, and restrict the flow of groundwater.

The IHCM A-A' cross section (**Appendix 2-A**) shows greatest depth of the bedrock (Franciscan) contact at an elevation of approximately 1,200 feet below mean sea level (ft-bmsl;365.8 m-bmsl).

Vertical offset of approximately 100 ft (30.5 m) in the bedrock (Franciscan) caused by the Maacama Fault was documented in the Erikson thesis (Erickson, 2008). This has not been observed in lithologic data for the shallow lithologic material and impacts of such offsetting on aquifer hydraulics is not evident in the available data. IHCM cross sections for A-A' consists primarily of low permeability Continental Basin Deposits and Terrace Deposits of Aquifer II with small bands of Quaternary Alluvium (Principal Aquifer I) around Forsythe Creek and the Russian River. Extent of the Quaternary Alluvium was consistent between the IHCM and textural cross sections.

Cross Section B-B'

Cross Section B-B', **Figure 2.19**, runs horizontally across the middle of the Basin just north of the city of Ukiah in the west to just south of Lake Mendocino in the east, as shown in **Figure 2.12** and **Figure 2.17**. The unconsolidated sand and gravel of the Quaternary Alluvium is much more present in this region and found on the west side of the cross section near the Russian River. The alluvium was observed across a zone of approximately 10,000 ft (3048 m) wide and varying in thickness from approximately 100 ft (~30.5 m) to tens of feet thick. The Quaternary Alluvium of Principal Aquifer I is denoted by the blue and light blue hatching indicating gravels and sands. This material may be connected hydraulically to the Russian River due to its proximity. The Maacama fault is located on the eastern edge of the loose alluvium.

Directly adjacent to the Quaternary Alluvium are clay and gravel clay layers typically indicative of the Continental Basin Deposits and Principal Aquifer II. Continental Basin Deposits are denoted by the brown and gray hatched areas on **Figure 2.19**, indicating clays gravelly/sandy clays. The clay layers likely separate the coarse alluvium and surface water from the underlying aquifer material and constrain groundwater flow out of Principal Aquifer I. The lightly to moderately cemented gravels and sand indicative of Terrace Deposits are found in the highlands at the eastern portion of the cross section and above the local water table. Most of the cross section is dominated by clays and gravelly and sandy clays of the Continental Basin Deposits. There is some evidence of buried stream channels at depth with moderately cemented sands and gravels.

Due to the larger portion of Quaternary Alluvium found in B-B', it is expected that this region has a greater amount of available groundwater and higher yield than the northern portion of the Basin illustrated in **Figure 2.18**. However, Quaternary Alluvium in B-B' is still constrained to a relatively shallow and narrow portion of the Basin, with lithologic material at depth being the low yield Continental Basin Deposits and Terrace Deposits of Principal Aquifer II. Groundwater gradient and flow likely decreases moving away from the Russian River and towards finer geologic material. Some recharge from the overlying Terrace Deposits may occur.

The IHCM cross section B-B' (**Appendix 2-A**) shows the deepest bedrock (Franciscan) contact at an elevation of approximately -700 ft-amsl (-213.4 m-amsl) at the center of the cross section. Vertical offset, caused by the Maacama fault, of the basement rock of approximately 100 ft (~30.5 m) was observed. The Maacama fault runs through both the Quaternary Alluvium of Principal Aquifer I and the Continental Deposits and Terrace Deposits of Principal Aquifer II in the region of the Basin. Vertical offset of aquifer material is not observed in the lithologic dataset and hydrologic effects of faulting is not present in the current dataset. Similar to the textural cross section, the IHCM B-B' shows predominantly Continental Basin Deposits with Quaternary Alluvium found west of the Maacama fault around the Russian River. Extent of the Quaternary Alluvium was consistent between the two cross sections.

Cross Section C-C'

Cross section C-C' (**Figure 2.20**) is the southernmost cross section in the Basin, as shown in

Figure 2.12 and **Figure** 2.17. Unconsolidated sand and gravel of the Quaternary Alluvium of Principal Aquifer I is greatest in section C-C' compared to others. It is found at the westernmost end of the cross section and encompasses a nearly 10,000-ft (3048 m) width, similar to that of B-B', but substantially thicker at approximately 200 ft (~61 m) thick. Alluvium is denoted by the blue and light blue hatching indicating sands and gravels. The Russian River lies in the middle of this western section of alluvium. A smaller portion of loose alluvium is observed on the easternmost boundary of the cross section, just east of the Maacama fault. It is significantly thinner and occupies a width of approximately 3,000 ft (~914.4 m) and is observed at a maximum depth of approximately 200 ft (~61 m) thick. These materials may be hydraulically connected with overlying surface water.

Surrounding the loose alluvium is the clays and gravely and sandy clays indicative of the Continental Basin Deposits and Principal Aquifer II. These extend from below the loose alluvium down to the bedrock contact. There was no evidence of Terrace Deposits in this section. Quaternary Alluvium occupies the largest area in C-C', with the greatest yield and groundwater production anticipated in this portion of the Basin. Looser material and greater groundwater flow are expected to the west with limited flow and recharge to the east. At depth, groundwater gradient and flow are reduced due to the high clay content of Principal Aquifer II.

The IHCM cross section C-C' (**Appendix 2-A**) shows the deepest bedrock (Franciscan) contact at 400 ft-bmsl (121.9 m-bmsl). A vertical offset in the bedrock caused by the Maacama fault of approximately 100 ft (~30.5 m) was observed. The Maacama fault in this portion of the Basin runs through the Terrace Deposits and Continental Deposits of Principal Aquifer II. Vertical offset from the Maacama fault is not observed in the lithologic dataset nor is evidence of hydrologic effects of fault activity observed in existing data. The IHCM cross section shows a deep and wide section of loose alluvium to the west and a narrower section of alluvium just east of the Maacama fault. The majority of the IHCM cross section shows Continental Basin Deposits material. The extent of the Quaternary Alluvium was consistent between the IHCM and textural cross sections.

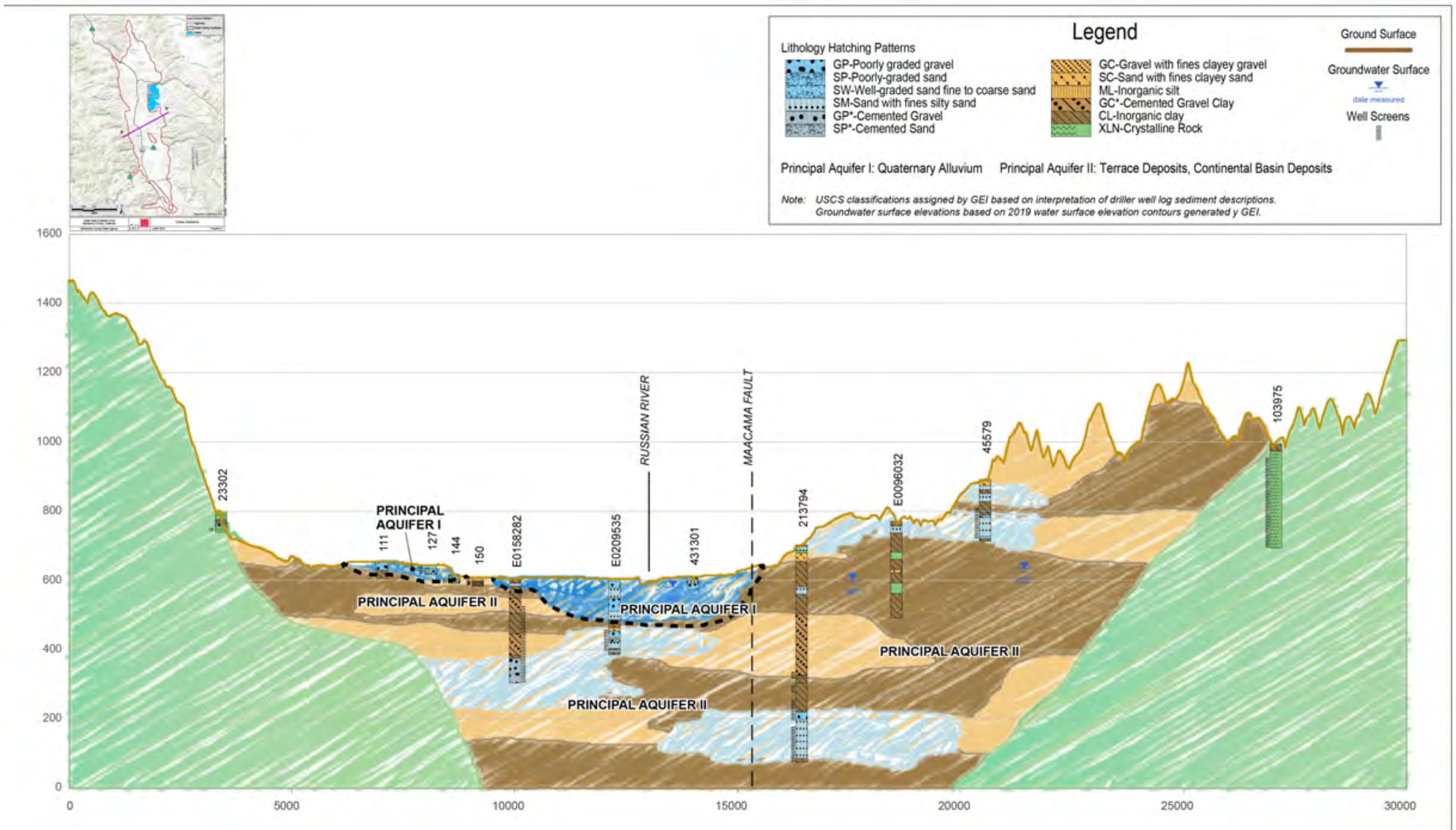


Figure 2.19: Cross section B-B'.

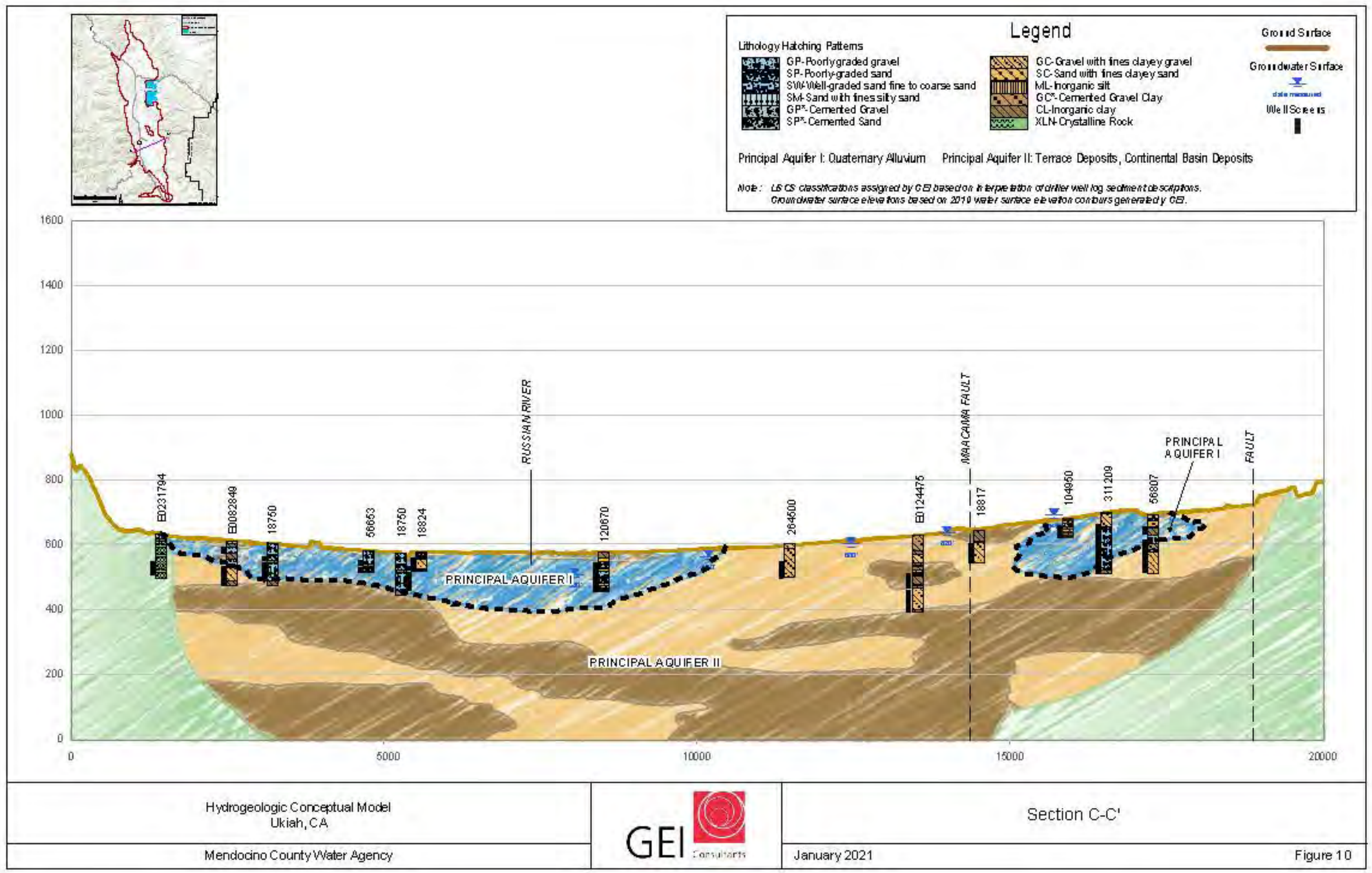


Figure 2.20: Cross section C-C'.

Table 2.9: Regional cross section characteristics

Cross Section	Quaternary Alluvium Max Depth (ft)	Quaternary Alluvium Max Thickness (ft)	Franciscan Formation Max Depth (ft-bmsl)
A-A’	~20	~3,000-4,000	1300
B-B’	~100	~10,000	700
C-C’	~200	~10,000	400

Regional Trends

The following regional trends are observed moving north to south from A-A’ to C-C’.

1. Depth to bedrock (Franciscan Formation) decreases from north to south.
2. Extent of the loose alluvium (Quaternary Alluvium) increases from north to south.

Table 2.9 shows the characteristics of the Quaternary Alluvium and Franciscan Formation for each cross section. Moving south, the The Basin becomes shallower with the deepest elevation of bedrock contact decreasing from 1,200 ft-bmsl (365.8 m-bmsl) in A-A’ to 400 ft-bmsl (121.9 m-bmsl) in C-C’. The slope of the Basin floor and walls decreases from A-A’ to C-C’. There is also a general increase in extent and depth of the Quaternary Alluvium in the south. It occupies a narrow extent of 3,000 to 4,000 ft (914.4 to 1219.2 m) and depths of approximately 20 ft (~6.1 m) in the north at A-A’. Moving south, there is a significant increase in depth and area of Quaternary Alluvium in B-B’. There is a less significant change between B-B’ and C-C’ with the Quaternary Alluvium occupying the same extent, but at C-C’ occupies greater depths of approximately 200 ft (~61 m). Regionally, a shallowing of the Basin and an increase in Quaternary Alluvium from north to south is observed. This trend more prominent between A-A’ and B-B’.

2.2.1.4 Principal Aquifers and Aquitards

There are two principal aquifers which make up the Basin. These aquifers, and their general properties, are as follows:

- Principal Aquifer I – Quaternary Alluvium: The primary production aquifer for the Basin. It is constrained to small, narrow bands along the Russian River and its tributaries. Its extent and depth increase moving south in the Basin.
- Principal Aquifer II – Terrace Deposits and Continental Basin Deposits: Principal Aquifer II comprises the largest portion of the Basin and is a low yield aquifer containing both the thin and discontinuous Terrace deposits and the gravelly/sandy clays and thick clays of the Continental Basin deposits.

Both geologic formations have low hydraulic conductivities and the large clay content can act to locally confine the aquifer. At depth, Principal Aquifer II may act like a confined aquifer.

The lack of an observed barrier to flow between Principal Aquifer I and Principal Aquifer II, and a review of literature for the Basin, point to hydraulic connection between the aquifers. However, the discontinuity within the Basin and the relatively low transmissivity of Principal Aquifer II, due the high percentage of clays in this aquifer, may restrict flow between aquifers. While the Franciscan formation does contain water available in fractures, and small domestic wells are drilled into the formation, they are low yield and the Franciscan is not a significant water bearing formation. For this reason, it is not considered a principal aquifer. **Table 2.10** shows a summary of each geologic formation, and by association the principal aquifer's, extent and conductivities based on both a literature review and pumping tests/textural analysis done as part of the IHCM and HCM. Pumping test data and textural analysis are discussed in more detail below.

Pumping test data presented in this HCM were analyzed in the IHCM generated by LACO. These values served as a starting point for determining hydrogeologic properties for each principal aquifer. Pumping test data were sourced from WCRs from DWRs database, representing initial tests to establish well production capacity and typically present a flow rate and a well specific capacity (feet of drawdown/pumping rate). From these datapoints, the IHCM estimated transmissivity and hydraulic conductivity. These results are not ideal due to the lack of monitoring wells during testing and uncertainty about the test method. Data from the IHCM were paired down to only the WCRs that could be confirmed within the Basin. WCRs with pumping test data used in the HCM are included in **Attachment C**. Pumping test data were not reevaluated in this HCM but rather further verified using a textural analysis of lithologic data in the Basin as additional data points in setting the initial hydrologic properties of each aquifer. Hydrogeologic properties presented in this section are coarse estimates based on the pumping test data and textural analysis and serve as a starting point for which to model flow in the Basin. As additional data becomes available, the HCM and groundwater models shall be updated to improve accuracy.

Regional water surface elevations are shown on the cross sections(**Figures 2.18** through **2.20**) and were generated based on spring 2019 CASGEM water level data. These groundwater surface elevations and associated contours are discussed in more detail in **Section 2.2.2.1**. Water surface elevations are near ground surface across the Basin for all cross sections with greatest depths to water at the edges of the Basin and around 60 feet below ground surface (ft-bgs). General water levels in the Basin range from a few feet to 20 ft-bgs (~6.1 m-bgs) in the plains and 60 ft-bgs

(~18.3 m-bgs) or more in the uplands (Cardwell, 1965). Recharge from precipitation and loss from streams fully replenish the groundwater Basin each year (Cardwell, 1965).

The following sections provide a more detailed description of the two principal aquifers in the Basin including their hydrogeologic characteristics, water quality, and beneficial uses.

Table 2.10: Aquifer characteristics

Source	Principal Aquifer I		Principal Aquifer II			
	Recent Alluvium Hydraulic Properties	Recent Alluvium Thickness	Terrace Deposits Hydraulic Properties	Terrace Deposits Thickness	Continental Deposits Hydraulic Properties	Continental Deposits Thickness
Cardwell	Specific Capacity: 5-400 gpm/ft Yield: > 100 gpm	50-80 ft.	Specific Capacity: < 1gpm/ft Yield: App. 60 gpm	Up to 200 ft.	Specific Capacity: < 1gpm/ft Yield: 50 gpm	1500
DWR 118	Specific Yield: 20%	50-80 ft.	Unconfined/confined conditions	Up to 200 ft.	-	Up to 2000 ft.
Farrar	Connection to River Yield: up to 1,000 gpm	< 100 ft.	Specific Capacity: 0.02 - 7.1 gpm/ft Yield: 1-100 gpm	-	Specific Capacity: 0.004 - 1.33 gpm/ft Yield: 0.75-50 gpm	Up to 2000 ft.
HCM	Specific Capacity: 9-34 gpm/ft Transmissivity: 2000-20250 sq.ft/day Conductivity: 18-153 ft/day	20-200 ft.	Specific Capacity:0.02-8.0 gpm/ft Transmissivity: 4-2160 ft2/day Conductivity: 0.01 - 9.6 ft/day	> 2,000 ft.	Specific Capacity:0.02-8.0 gpm/ft Transmissivity: 4-2160 ft2/day Conductivity: 0.01 - 9.6 ft/day	> 2,000 ft.

Notes: ft = feet
gpm = gallons per minute

Aquifer I – Quaternary Alluvium

Principal Aquifer I – Quaternary Alluvium is composed of highly permeable unconsolidated sands and gravels. It is the primary production aquifer of the Basin. The extent of Aquifer I is shown on both the surficial geology map, **Figure 2.12**, and on the cross sections, **Figure 2.18** through **Figure 2.20**. While it is the primary production aquifer, the Quaternary Alluvium occupies a proportionally small area of the Basin and is constrained to small bands along the river channels. As discussed in **Cross Section Interpretation**, depth and thickness of Aquifer I increases moving north to south in the Basin.

Aquifer I is unconfined with high conductivities that decrease moving away from the stream channels into older deposits (Farrar, 1986). It overlies or is adjacent to both the Terrace Deposits and Continental Basin Deposits of Aquifer II and Aquifer III, respectively. The Quaternary Alluvium is distinguished from the Terrace Deposits by a lack of cementation and clay. Estimated storage capacity of Aquifer I varies between 60,000 to 120,000 acre feet (74 to 148 million cubic meters) using specific yields between 6 to 20 percent (DWR, 2016a; Farrar, 1986). Due to its proximity to the river systems and high permeability, the Quaternary Alluvium is considered hydraulically connected with adjacent rivers (Cardwell, 1965). Groundwater elevations fluctuate seasonally, and the aquifer generally recharges each year, with the exception of drought conditions (Mendocino, 2009). Water surface elevations generated for spring 2019 appear near ground surface where Aquifer I was observed (**Figures 2.18** to **2.20**).

Hydrogeologic properties for Aquifer I were estimated in the original IHCM generated by LACO using available pumping test data from the well completion report, shown in **Table 2.11**. Data were limited to six wells with pumping test data, accurate locational data, and evidence of being screened in Principal Aquifer I. Only five of these tests provided data with which the IHCM estimated hydrogeologic parameters. Specific capacity varied between 8 to 75 gpm per foot (1.65 to 15.5 liters per meter). Transmissivity ranged from 2,000 to 20,250 ft^2/day (~186 to 1,905 m^2/day). Only two wells had hydraulic conductivity estimates of 18 and 153 ft/day (5.5 to 46.6 m/day).

Due to the limited pumping test data set, conductivity values were also estimated based on dominant soil texture of the aquifer and average textural conductivity values. In addition to the values listed in **Table 2.11** conductivity values were estimated from Basic Ground-Water Hydrology (Heath, 1983), shown in **Figure 2.21**, based on the WCR data and additional lithologic data provided by the USGS. For the primarily gravels and coarse sands observed, expected conductivity values range from the middle to high tens to low hundreds of feet per day. With thicknesses between 20-200 ft (~6-61 m), this correlates roughly to transmissivities between 1,000 and 30,000 ft^2/day (~93 and 278.7 m^2/day). The observed pumping test results likely represent the high and low conductivity and transmissivity values found in this aquifer. Based on existing literature (Farrar, 1986), one would expect to find the lower conductivity values (18 ft/day or 5.5 m/day) further away from the river channel where increased weathering has occurred, and the higher conductivities (150 ft/day or 45.7 m/day) near the river channel. As further data become available in the future, hydrogeologic properties for Principal Aquifer I will be refined. These theoretical estimates agree with the values listed in **Table 2.11**.

Table 2.11: Principal aquifer I - pump test data log

Log Number	Township Range Section	Yield (gpm)	Drawdown (ft)	Specific Capacity (gpm/ft)	Transmissivity (ft2/day)	Hydraulic Conductivity (ft/day)	Screened Interval
215713	15N/12W-NN	20	2	10	2000	133	9-14
156501	-	1080	32	33.75	9112.5	-	-
61330	15N/12W-28	650	0	-	-	-	-
18824	15N/12W-33	75	1	75	20250	153.41	18-58
34433	15N/12W-28	70	8	8.75	2363	17.5	24-76
E0151151	14N/12W-25	300	10	30	8100	-	20-80
Range	-	-	-	9 - 34	2000 - 20250	18 - 153	-

Notes:
Pumping Test data and analysis from LACO IHCM

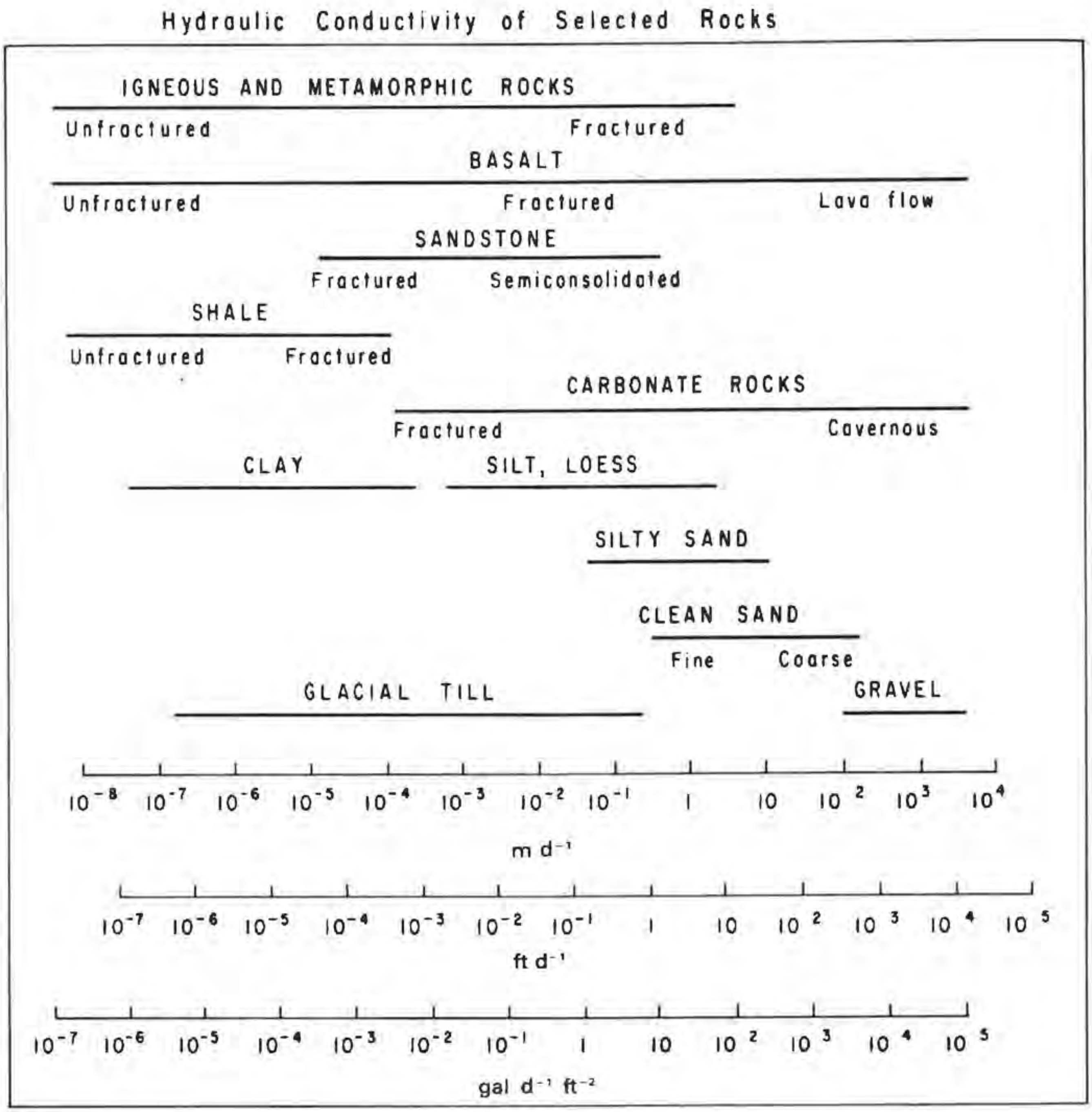


Figure 2.21: Basic groundwater hydrology paper 2220 - conductivity values.

Aquifer II – Terrace Deposits

Aquifer II – Terrace Deposits and Continental Basin Deposits are composed primarily of moderately cemented sands and gravels and thick clay layers with intermittent gravely clay zones. In the highlands of the Basin, the Terrace Deposits occur in thin lenses and are not considered water bearing formations. However, in the valley they can yield moderate amounts of water. Extent of the Terrace Deposits are shown on the surficial geology map, **Figure 2.12**, and on the cross sections, **Figure 2.18** through **Figure 2.20**. The Terrace Deposits are discontinuous and difficult to discern from the Continental Basin Deposits. In some areas, the Terrace Deposits occur above the water table and are likely non-water bearing. Continental Basin Deposits are composed primarily of thick clay layers interbedded with gravelly/ sandy clay mixtures. Continental Basin Deposits occupy most of the Basin are likely in contact with the Franciscan Formation at the Basin bottom. Surficial expression of the Terrace Deposits and Continental Basin Deposits are shown on **Figure 2.12**, and subsurface extent is shown on the cross sections **Figure 2.18** through **Figure 2.20**.

The Terrace Deposits and Continental Basin Deposits of Aquifer II are low yielding material. Terrace deposits tend to have slightly higher yields than those of the Continental Basin Deposits, but not by much. Principal Aquifer II has low conductivity and generally low well yields from pockets of buried gravels, sands, or gravelly clays that are separated by thick clay layers (MCWA, 2010). Recharge to Principal Aquifer II comes from precipitation where surface outcroppings are present, the Basin margins, and fractured Franciscan Formation bedrock (Fisher et al., 1965). Principal Aquifer II varies from unconfined to locally confined, as a result of the aquifer being primarily fine-grained material with pockets of coarser production zones. While not geologically separated from Aquifer I, Aquifer II has significantly lower conductivities and yields than Aquifer I. Storage capacity for Principal Aquifer II is estimated at 324,000 acre-feet (275.6 million cubic meters) but difficult to develop due to low permeability (Farrar, 1986).

Hydrogeologic properties for Aquifer II were estimated in the original IHCM generated by LACO using available pumping test data from the well completion reports, shown in **Table 2.12**. A total of 35 wells were identified with pumping test data, accurate location data, and evidence of being screened in Aquifer II. Some of these wells were originally identified as Principal Aquifer I in the IHCM, but very low production capacity and further investigation of the lithologic data classified them as Aquifer II. For this HCM, where applicable, further lithologic data were used to calculate hydraulic conductivity when applicable. Specific capacity values ranged from 0.02 to 8.0 gpm per foot (0.004 to 1.65 liters per meter). Transmissivity values ranged 4 to 2,160 ft^2/day (0.37 to 200.7 m^2/day). Hydraulic conductivity values ranged from approximately 0.01 to 10 ft/day (0.003 to 3.05 m/day). **Table 2.12** shows the WCR pumping test data.

Due to the limited pumping test data set, conductivity values were also estimated based on dominant soil texture of the aquifer and average textural conductivity values. In addition to the values listed in **Table 2.12**¸conductivity values were estimated from Basic Ground-Water Hydrology (Heath, 1983), shown in **Figure 2.21**, based on the WCR data and additional lithologic data provided by the USGS. Aquifer II is composed of lightly to moderately cemented sands and gravels of the Terrace Deposits and clays and gravely, sandy clays of the Continental Deposits. Conductivity values for fine sands to silty sands, comparable to the lightly to moderately cemented sands and gravels found in the Terrace Deposits, are estimated between 0.1 and 10 ft/day (0.03 to 3.05 m/day) based on the level of weathering and cementation. For Continental Basin Deposits type of material, expected conductivity values range from the high end of clay material to the low end of silt material with values from 0.001 to 0.1 ft/day (0.0003 to 0.03 m/day). A total conductivity range for this aquifer would be 0.001 to 10 ft/day (0.0003 to 3.05 m/day). Pumping test results skew to the high end of this range which is likely due to the wells being screened in the more permeable material of the Continental Basin Deposits or lightly cemented sands of the Terrace Deposits.

Table 2.12: Principal aquifer II - pump test data log

Log Number	Township Range Section	Yield (gpm)	Drawdown (ft)	Specific Capacity (gpm/ft)	Transmissivity (sq.ft/day)	Hydraulic Conductivity (ft/day)	Screened Interval
211109	14N/12W-10	20.0	75	0.27	72.0		-
E0097559	15N/12W-21	20.0	50	0.40	108.0	2.84	22-60
451246	14N/12W-5	30.0	167	0.18	48.5	0.80	-
118658	14N/12W-14	56.0	330	0.17	45.8	0.46	50-150
141377	16N/12W-4	7.5	72	0.10	28.1	0.23	22-42, 62-82
211546	16N/12W-4	51.0	50	1.02	275.0	2.57	60-100
125320	16N/12W-3	5.0	4	1.25	337.5	3.59	58-78
769737	15N/12W-7	4.0	45	0.09	24.0	0.10	24-44, 99-159
141431	15N/12W-8	30.0	38	0.79	213.2	0.82	37-57
18817	15N/12W-26	4.5	60	0.08	20.3	0.17	41-101
211028	15N/12W-26	40.0	7	5.71	1542.9	9.60	20-40
509528	15N/12W-21	50.0	80	0.63	168.0	1.10	29-89
264526	15N/12W-34	40.0	5	8.00	2160.0	3.06	45-105
775095	16N/12W-28	12.0	280	0.04	12.0	0.03	260-280, 340-360, 400-440
705654	16N/12W-22	15.0	20	0.75	203.0	0.39	335-415
E0160418	16N/12W-17	7.0	230	0.03	8.0	0.01	199-239
705663	15N/12W-NN	2.0	130	0.02	4.0	0.01	100-160
E070302	16N/12W-16	15.0	340	0.04	12.0	0.01	200-355
705657	15N/12W-35	8.0	120	0.07	18.0	0.01	80-100, 220-260
775102	16N/12W-16	8.0	170	0.05	13.0	0.01	137-217, 239-257
931929	17N/12W29	15.0	160	0.09	25.0	0.05	140-180
18729	17N/12W-32	8.0	9	0.89	240.0	0.51	80-150
210815	16N/12W-20	2.0	90	0.02	6.0	0.01	186-286
e0255737	17N/12W-29	15.0	210	0.07	19.0	0.13	60-220
210813	16N/12W-20	8.0	220	0.04	10.0	0.01	278-338

Table 2.12: Principal aquifer II - pump test data log *(continued)*

Log Number	Township Range Section	Yield (gpm)	Drawdown (ft)	Specific Capacity (gpm/ft)	Transmissivity (sq.ft/day)	Hydraulic Conductivity (ft/day)	Screened Interval
156544	16N/12W-4	6.0	120	0.05			83-123
713846	16N/12W-20	13.0	320	0.04	11.0	0.01	260-280, 300-360, 380-400
141122	16N/12W-7	30.0	62	0.48			40-80
18702	16N/12W-16	215.0	110	1.95	527.0	0.42	148-400
E0108596	16N/12W-28	7.0	200	0.04	10.0	0.01	120-220
18819	14N/12W-3	40.0	27	1.48	395.0		44-104
E0124475	15N/12W-34	20.0	200	0.10	27.0	0.05	120-240
e0209535	15N/12W-9	90.0	200	0.45	122.0	0.11	150-210
3003	16N/12W-7	7.0	135	0.05	14.0	0.03	146-206
398391	16N/12W-8	20.0	200	0.10	27.0	0.05	200-340
Range	-						-

Notes:
Pumping Test data and analysis from LACO IHCM

Aquifer Water Quality

In the HCM, water quality as it pertains to the principal aquifers is based on the findings of the literature review. Historical and current water quality for the Basin and each principal aquifer is further analyzed and discussed in **Section 2.2.2.4**. It will be expanded upon as additional data is available through future monitoring. This section primarily focuses on existing literature and those findings generally align with the analyses of data provided in **Section 2.2.2.4**.

Aquifer I, the primary production aquifer for the Basin, is generally of moderately hard to hard bicarbonate type water (Cardwell, 1965). Dominant groundwater quality constituents are estimated at 40 percent calcium, 40 percent magnesium, and 20 percent sodium (Cardwell, 1965). Locally, water type tends to calcium-bicarbonate in the southern portion of the Basin and magnesium-bicarbonate in the east and central portions (Mendocino, 2009). Chemical signatures for Aquifer I are similar to that of the Russian River, but with higher dissolved solids and chloride levels (DWR, 2004).

Due to the possible connection between Principal Aquifer I and the Russian River, water quality varies seasonally and is likely affected by surface water conditions (Mendocino, 2009). During the baseflow season in late spring and early fall, releases from Lake Mendocino may influence the water quality of Aquifer I with respect to specific conductance, total nitrate, and turbidity. In the winter, stormwater flows entering the Russian River may increase turbidity and surface runoff pollutants and in turn Principal Aquifer I (Mendocino, 2009). Total dissolved solids for Aquifer I range from 87 to 301 milligrams per liter with an average of 166 milligrams per liter (DWR, 2004). **Table 2.13** shows general water quality for Aquifer I. General water quality for both the Russian River and Aquifer I are limited and a potential data gap.

Table 2.13: Principal aquifer I - water quality

Constituent Parameter	Reported range (units as shown)	Reference
Total Dissolved Solids	· Range: 87-301 mg/L · Average: 166 mg/L · 190.0 mg/L (KP-MW 1, 1 July 2005) · 190.0 mg/L (Well P6, 2 October 2002)	DWR, 2004; Kunzler Terrace Mine, 2009
Total Hardness	· Moderately Hard to Hard Bicarbonate	DWR, 2004; Kunzler Terrace Mine, 2009
Chloride	· 7.3 mg/L (KP-MW 1, 1 July 2005) · 6.1 mg/L (Well P6, 2 October 2002) · 6.5 mg/L (015N012W08F001M3, October 1981)	ESA, 2010
Electrical Conductivity	· 250.0 (July 2005) · 293.0 (015N012W08F001M3)	ESA, 2010

Sourced from LACO IHCM

Principal Aquifer II has a much more limited water quality data set. As these aquifers are lower producers, wells drilled are mostly private which limits the availability of public water quality data. However, there is water quality data from previous studies within the Basin that help characterize these aquifers. The water quality type in Principal Aquifer II is similar to Principal Aquifer I (calcium bicarbonate type); however, Principal Aquifer II has a higher concentration of sodium than Principal Aquifer I. Lack of hydraulic connection to surface water reduces seasonal fluctuations. Total dissolved solids concentrations are greater in Principal Aquifer II than Principal Aquifer I. Elevated levels of total dissolved solids have been observed as well as elevated gasses (Cardwell, 1965; Fisher et al., 1965). Wells on the west side of Redwood Valley have been observed with explosive levels of flammable gas and pressurized carbon dioxide gas has been encountered during drilling near Coyote Valley, southwest Ukiah, and Talmage (Cardwell, 1965). Water quality for Principal Aquifer II is considered a data gap for the Basin.

General water quality is good throughout the Basin and suitable for beneficial uses; however, further monitoring as a result of GSP implementation, regulatory programs, or future studies within the Basin will serve to further refine water quality for both principal aquifers. As discussed previously, groundwater type tends toward calcium bicarbonate water in the southern portion and magnesium bicarbonate in the east-central portion. Water quality conditions in the Basin were assessed using available data through the California Groundwater Ambient Monitoring and Assessment (also known as GAMA) Program. Based on this analysis, groundwater elements of interest for the Basin include boron, iron, manganese, and nitrate for both principal aquifers.

On a regional scale, water quality data from the GeoTracker program were used to analyze regions of potential water quality concerns in the Basin and inform future water quality monitoring networks. GeoTracker is a database system maintained by the SWRCB to monitor wells with water quality concerns related to unauthorized releases, LUST sites, and other cleanup and non-cleanup sites. Known open GeoTracker sites were plotted and categorized by site type. GeoTracker sites are shown in **Figure 2.22**.

There are a total of 31 open GeoTracker sites in the Basin. These sites were characterized as either a cleanup program, LUST site, or a land disposal site. Most of the sites are located near the City of Ukiah. Almost all sites are in the City or along Highway 101 with the exception of three land disposal sites on the fringes of the Basin.

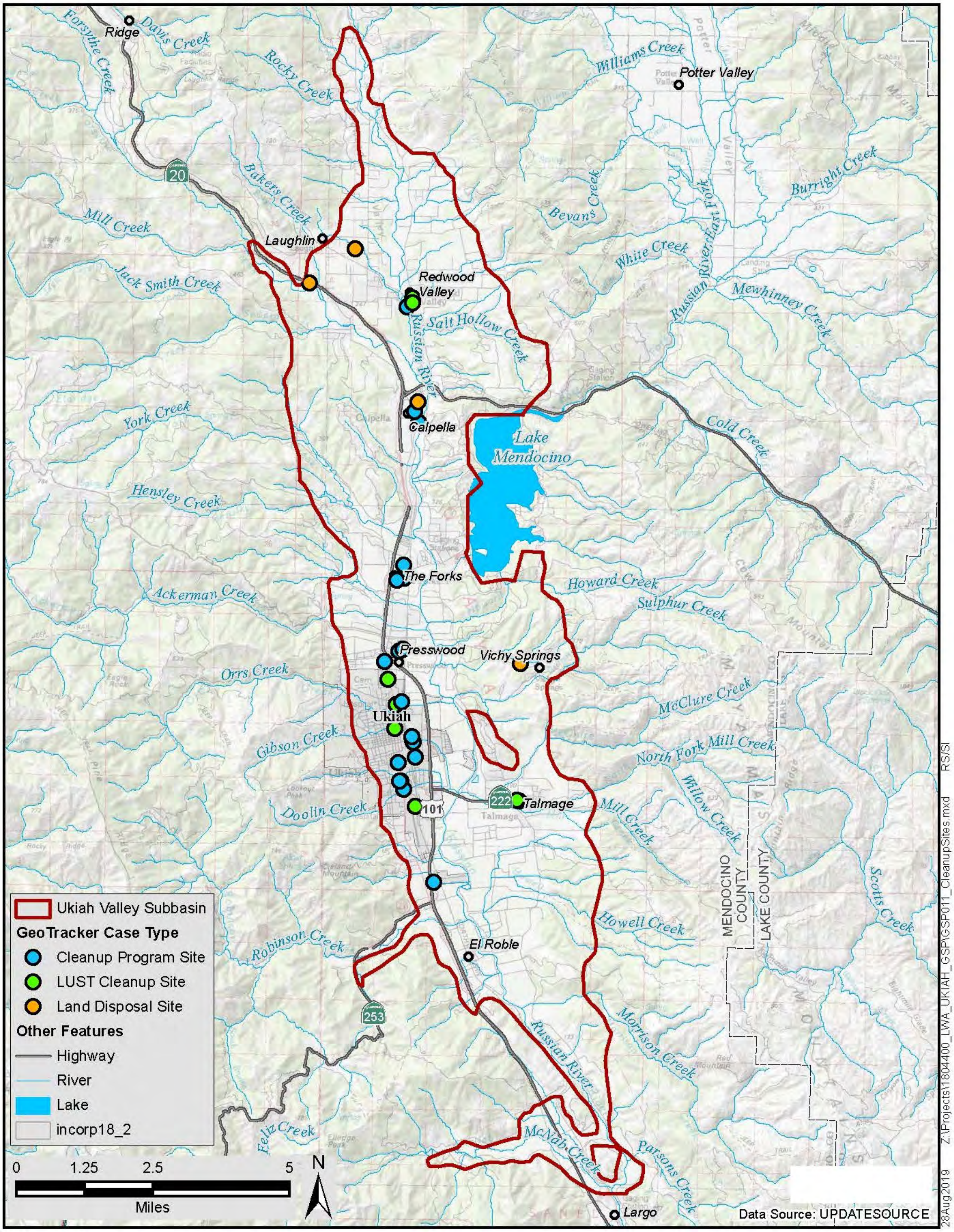


Figure 2.22: Open GeoTracker sites.

Aquitards

No evidence of significant aquitards within the Basin was found. However, the significant clay composition of the Continental Basin Deposits of Principal Aquifer II influences the flow of groundwater through the system. Groundwater in this aquifer may act as partially to locally confined. This local confinement has been verified by observed rises in water levels for wells drilled into the Continental Basin Deposits (Cardwell, 1965). Where Continental Basin Deposits are found above the water table, perched water may be observed. These clay and silt layers are not extensive enough to truly act as an aquitard and restrict movement between principal aquifers.

Beneficial Users

According to the DWR pursuant to Water Code Sections 10723.8(a)(4) and 10723.2, beneficial uses and users of groundwater in the Basin include:

- Agricultural;
- Domestic well owners;
- Municipal well operators;
- Public water systems;
- Land use planning;
- Resource management;
- Ecological Users;
- State agencies and other government agencies;
- California Native American tribes;
- Private water companies; and,
- Disadvantaged communities.

The primary uses of water are irrigation, domestic, and municipal use. Principal Aquifer I is the main source of groundwater and is used for all these purposes. Principal Aquifer II is primarily used for domestic water supply due to limited yield of the aquifer.

Agricultural commodities in the Basin include fruits and nuts, livestock production, poultry products, nursery production, and field crops with the major crops being wine grapes, timber, pears, apples, and pasture and range land. Cannabis is another major user of water in the Basin but is a relatively new crop and data regarding cannabis water consumption were not available during the development of this HCM.

Groundwater is also used for industrial purposes along with public and domestic supply. In the past, industrial use of groundwater is primarily for sawmills and wood product manufacturing plants. However, facilities such as the Masonite plant, are no longer in operation. Most of the groundwater used for industry is returned to the Russian River (Cardwell, 1965). Historical studies indicate that public and domestic water supply is primarily sourced from groundwater (Cardwell, 1965), with the city of Ukiah as the primary municipal well operator according to DWR pursuant to Water Code Sections 10723.8(a)(4) and 10723.2. There are seven public water systems within the Basin: Redwood Valley CWD, Millview CWD, Willow CWD, Calpella CWD, Sonoma County Water Agency, RRFC, and Upper Russian River Water Agency. Private water system operators include City of 10,000 Buddhas, Rogina Water Company, and Yokayo Water Systems.

2.2.1.5 Groundwater Recharge and Flow

Understanding where potential flow and recharge opportunities are throughout the entire Basin, is important to sustainable management under SGMA. Identified recharge areas may be where active groundwater recharge is occurring or may represent where future recharge projects may take place. To further understand the mechanics of the Basin groundwater system, general groundwater flow was analyzed along with potential areas of additional recharge and groundwater discharge by:

- Spatially plotting areas where soils with potential for infiltration are present; and,
- Generating groundwater contours to evaluate groundwater flow throughout the Basin.

Soils with potentially high infiltration were identified based on the hydrologic soil groups presented in **Figure 2.13** and discussed in **Section 2.2.1.2**. Soils that fell into Hydrologic Group A were considered high infiltration soils and regions of potential recharge. Groundwater contours were used to assess general groundwater flow direction and identify regions of potential groundwater discharge. Groundwater contours were developed using water surface elevations from CASGEM wells within the Basin. Spring 2019 measurements were used to provide insight on the most recent conditions. **Figure 2.23** shows identified recharge areas along with the spring 2019 water surface elevation contours and the CASGEM wells used to generate them. CASGEM program's monitoring network information and wells' construction information are shown in **Table 2.14**. As further discussed in *Section 2.2.2*, groundwater levels fluctuate seasonally but show stable levels throughout the period of monitoring.

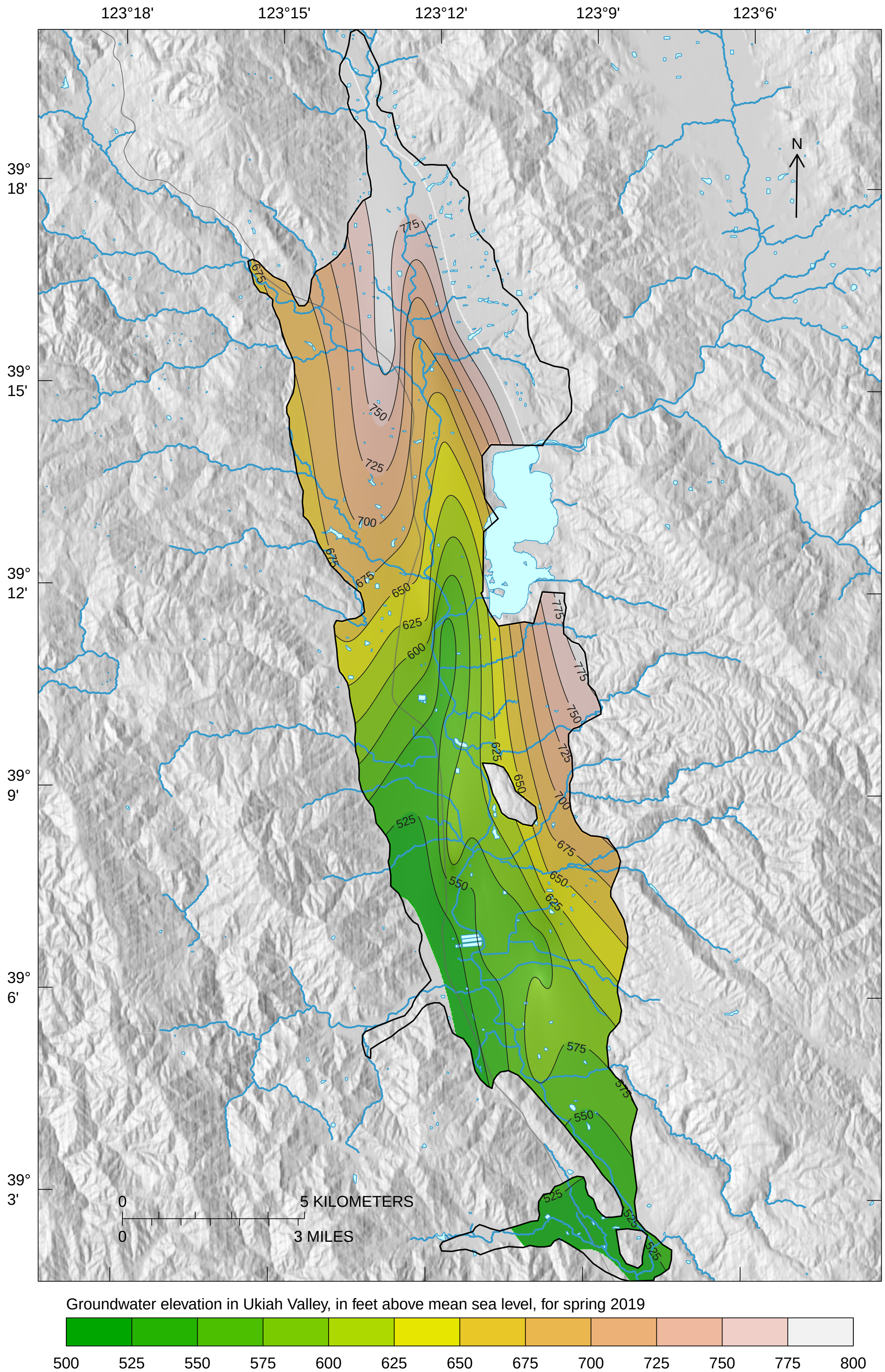


Figure 2.23: Groundwater elevation contours in the Ukiah Valley Groundwater Basin, in feet amsl, for spring of 2019

Table 2.14: CASGEM monitoring network well specification and construction information.

CASGEM Well Site Code	Well Name	Latitude	Longitude	Well Depth (ft)	Perforation Top (ft)	Perforation Bottom (ft)	Assigned Principal Aquifer
390466N1231507W001	-	39.04660	-123.1507	40	20	40	Aquifer II
390664N1231491W001	Ukiah Valley-32	39.06639	-123.1491	60	36	56	Aquifer I
391031N1231649W001	Ukiah Valley-12a	39.10311	-123.1649	105	30	105	Aquifer II
391046N1231647W001	Ukiah Valley-12b	39.10462	-123.1647	100	30	100	Aquifer II
391086N1231710W001	Ukiah Valley-27	39.10860	-123.1710	107	30	107	Aquifer II
391096N1231677W001	-	39.10960	-123.1677	112	20	111	Aquifer II
391156N1231788W001	Ukiah Valley-29c	39.11560	-123.1788	100	25	95	Aquifer II
391159N1231770W001	Ukiah Valley -29b	39.11586	-123.1770	91	25	85	Aquifer II
391174N1231836W001	Ukiah Valley-28	39.11744	-123.1836	75	26	70	Aquifer II
391185N1231747W001	Ukiah Valley-29a	39.11847	-123.1747	170	80	170	Aquifer II
391225N1231852W001	Ukiah Valley-26	39.12245	-123.1852	60	30	60	Aquifer I
391236N1231869W001	Ukiah Valley-22	39.12361	-123.1869	100	30	100	Aquifer I
391246N1231827W001	Ukiah Valley-25	39.12464	-123.1827	80	30	80	Aquifer I
391248N1231848W001	Ukiah Valley-38	39.12484	-123.1848	180	150	180	Aquifer II
391252N1231822W001	Ukiah Valley-11	39.12524	-123.1822	105	30	105	Aquifer I
391281N1231621W001	Ukiah Valley-33	39.12806	-123.1621	41	13	41	Aquifer I
391285N1231607W001	Ukiah Valley-34	39.12853	-123.1607	160	80	160	Aquifer II
391304N1231929W001	Ukiah Valley-10b	39.13039	-123.1929	200	30	200	Aquifer II
391322N1231929W001	Ukiah Valley-10a	39.13220	-123.1929	60	20	60	Aquifer I
391334N1231885W001	Ukiah Valley-24	39.13344	-123.1885	120	40	120	Aquifer II
391409N1231982W001	Ukiah Valley-14	39.14093	-123.1982	222	35	213	Aquifer II
391411N1231983W001	Ukiah Valley-37	39.14111	-123.1983	215	60	210	Aquifer II
391411N1231983W002	Ukiah Valley-37	39.14111	-123.1983	215	60	210	Aquifer II
391482N1231810W001	Ukiah Valley-31	39.14815	-123.1810	283	60	283	Aquifer I&II
391586N1232003W002	Ukiah Valley-36	39.15861	-123.2003	260	80	260	Aquifer II
391730N1232108W001	15N12W08L001M	39.17300	-123.2108	62	-	-	Aquifer II
391860N1232039W001	Ukiah Valley-15	39.18599	-123.2039	45	20	45	Aquifer II

Table 2.14: CASGEM monitoring network well specification and construction information. *(continued)*

CASGEM Well Site Code	Well Name	Latitude	Longitude	Well Depth (ft)	Perforation Top (ft)	Perforation Bottom (ft)	Assigned Principal Aquifer
391917N1232000W001	Ukiah Valley-23	39.19175	-123.2000	420	120	220	Aquifer I&II
391918N1232003W001	Ukiah Valley-1	39.19177	-123.2003	160	130	150	Aquifer I
391918N1232003W002	Ukiah Valley-2	39.19177	-123.2003	230	200	220	Aquifer II
391918N1232003W003	Ukiah Valley-3	39.19177	-123.2003	380	350	370	Aquifer II
391918N1232003W004	Ukiah Valley-4	39.19177	-123.2003	500	470	490	Aquifer II
391920N1232273W001	Ukiah Valley-21	39.19199	-123.2273	140	20	140	Aquifer II
391932N1232124W001	Ukiah Valley-35	39.19315	-123.2124	-	-	-	Aquifer I&II
392358N1232020W001	-	39.23580	-123.2020	274	94	274	Aquifer II
392455N1231977W001	Ukiah Valley-16	39.24551	-123.1977	95	80	90	Aquifer II
392455N1231977W002	Ukiah Valley-17	39.24551	-123.1977	235	190	230	Aquifer II
392455N1231977W003	Ukiah Valley-18	39.24551	-123.1977	345	280	340	Aquifer II
392516N1231610W001	Ukiah Valley-20	39.25161	-123.1610	200	80	200	Aquifer I&II
392556N1232312W001	Ukiah Valley-8	39.25555	-123.2312	200	-	-	Aquifer II
392572N1231906W001	Ukiah Valley-9	39.25718	-123.1906	138	38	138	Aquifer II
392594N1232129W001	Ukiah Valley-19	39.25939	-123.2129	190	-	-	Aquifer II
392606N1232098W001	Ukiah Valley-6	39.26057	-123.2098	347	-	-	Aquifer II
392645N1231955W001	Ukiah Valley-5	39.26446	-123.1955	100	-	-	Aquifer II
392647N1232245W001	Ukiah Valley-30	39.26470	-123.2245	80	20	80	Aquifer II
392648N1232318W001	Ukiah Valley-7	39.26482	-123.2318	60	-	-	Aquifer I
392730N1231770W001	Ukiah Valley-13	39.27300	-123.1770	400	186	400	Aquifer II
392882N1231962W002	Ukiah Valley-39	39.28816	-123.1962	81	21	81	Aquifer II
392883N1231962W002	Ukiah Valley-40	39.28825	-123.1962	-	-	-	Aquifer II
392962N1232047W001	-	39.29620	-123.2047	32	-	-	Aquifer II
Ukiah WWTP-MW1	CIWQS-UWWTP MW1	39.11045	-123.1903	35	13	33	Aquifer I
UVBGSA-01a	UVBGSA-01a	39.11880	-123.1926	40	25	35	Aquifer I
UVBGSA-01b	UVBGSA-01b	39.11880	-123.1926	110	70	100	Aquifer II
UVBGSA-01c	UVBGSA-01c	39.11880	-123.1926	170	145	165	Aquifer II

Table 2.14: CASGEM monitoring network well specification and construction information. *(continued)*

CASGEM Well Site Code	Well Name	Latitude	Longitude	Well Depth (ft)	Perforation Top (ft)	Perforation Bottom (ft)	Assigned Principal Aquifer
UVBGSA-06a	UVBGSA-06a	39.26593	-123.2098	27	25	27	Aquifer I
UVBGSA-06b	UVBGSA-06b	39.26593	-123.2098	80	55	75	Aquifer I
UVBGSA-06c	UVBGSA-06c	39.26593	-123.2098	160	135	155	Aquifer II
UVBGSA-06d	UVBGSA-06d	39.26593	-123.2098	230	215	225	Aquifer II
UVBGSA-05	UVBGSA-05	39.23240	-123.2026	70	20	70	Aquifer I
UVBGSA-07	UVBGSA-07	39.27610	-123.2067	74	20	70	Aquifer I
UVBGSA-02	UVBGSA-02	39.12569	-123.1995	45	20	40	Aquifer I

Groundwater Flow Direction and Gradient

Water surface elevation contours (**Figure 2.23**) show a general flow direction in the Basin of north to south with larger flow gradients found in the north and along the edges of the Basin. A maximum water surface elevation of 789 ft-amsl (240.5 m-amsl) was observed in the northernmost portion of the Basin and a minimum elevation of 541 ft-amsl (165 m-amsl) was observed in the southernmost portion of the Basin.

Groundwater surface elevations, following topographic trends, are lowest in the southern portion of the Basin, indicating general flow of groundwater to the south. Results of the water surface elevation contours agree with those of previous studies which indicate a general flow direction down valley (north to south) and towards the Russian River, with gradients lowest in the alluvium of the Basin and highest in the less permeable material of the uplands (Cardwell, 1965). Vertical flow within the aquifer system is not well understood. Further understanding of vertical groundwater gradients may be addressed through implementation.

There are no known barriers to groundwater flow within the Basin. While the Maacama fault may be acting as a barrier to flow, there is yet to be hydrologic evidence to support this. Further understanding of groundwater flow within the basin and any barriers to flow will be further characterized as a result of expanded and continued monitoring under SGMA.

Recharge Areas

As discussed earlier, historical studies indicate that much of the Basin is recharged through precipitation with shallow alluvial aquifers receiving recharge from surface water (Cardwell, 1965). While historical studies identify recharge to Principal Aquifer I as being through stream losses (Cardwell, 1965) there is little data confirming this assertion and recharge in this aquifer is identified as a data gap. Planned projects identified in this GSP should help to characterize recharge to Principal Aquifer I. The deeper aquifers receive recharge through deep percolation on the edges of the Basin and through fractures in the Franciscan bedrock (Cardwell, 1965). Recharge along the edges of the Basin contributes to the Continental Basin Deposits and is likely slow percolation of precipitation or stormwater (Cardwell, 1965).

The main elements of recharge to both aquifers can be categorized into:

- Deep percolation of precipitation in outcrop areas;
- Infiltration of surface water from streambeds of the Russian River and its tributaries; and,
- Recharge from applied irrigation, unlined storage ponds, and percolation ponds of the small water agencies and UWWTP.

Further clarity on recharge to principal aquifers will be achieved through continuous GSP monitoring and implementation, along with future studies in the Basin. By analyzing where regions of Hydrologic Soil Group A are found within the Basin, it can be determined where the greatest potential for recharge in the Basin is located. These may not be areas of ongoing recharge but show soils with the greatest recharge capacity. Understanding these locations is important for potential future recharge projects to help manage the Basin sustainably.

Soils falling in Group A were chosen due to their high saturated infiltration potential. These soil zones, shown in **Figure 2.23**, are located primarily in small bands around the Russian River and its tributaries. Small pockets of high infiltration soils are observed away from the river channels. These may be evidence of historical river channels or alluvial material that is less weathered.

The extent of the potential recharge areas identified in **Figure 2.23** coincide with findings from the literature and are illustrated in the developed textural cross sections. Most areas with high recharge potential within the Basin occur where coarse to slightly weathered alluvium of Principal Aquifer I is found either at current river channels or historic channels. Moving away from the river there are pockets of lightly weathered material may contribute to recharge but where the Terrace Deposits and Continental Basin Deposits of Principal Aquifer II outcrop, recharge potential drops significantly. The likely reason for stabilization of water levels in Principal Aquifer II may be due to the lack of significant extraction.

Discharge Areas

Discharge areas within the Basin include discharge to surface water bodies, root uptake and evapotranspiration by vegetation and crops, groundwater withdrawal through municipal, domestic, and agricultural pumping, and discharges from the boundaries of the Basin. Recharge and discharge from the aquifers are discussed in more detail in the water budget section and will be improved upon a better understanding of Basin conditions using additional data and studies. **Section 2.2.3** further discusses and quantifies groundwater recharge and outflows in the Basin. This section also discusses the mechanics for groundwater recharge and flow as modeled for management of the Basin.

2.2.1.6 Surface Water

The two major surface water features controlling surface water hydrology within the Basin include Lake Mendocino along with the Russian River and its tributaries. Lake Mendocino is located on the eastern edge of the Basin, just southeast of Calpella. While technically outside of the Basin, releases from Lake Mendocino are significant because the lake is a federal water supply and flood control reservoir managed by Sonoma Water and the United States Army Corps of Engineers (USACE). Flows into Lake Mendocino through East Fork Russian River are controlled by the Pacific Gas and Electric's (also known as PG&E) Potter Valley Project. Sonoma Water is a wholesale water supplier and manages water supply storage. Reservoir releases are managed to maintain minimum instream flows in the Russian River and to meet water supply demands for both Sonoma Water and Russian River water users (SCWA, 2016). The Lake was constructed in 1958 for flood control(operations controlled by USACE), water supply, recreation, and streamflow regulation.

The Russian River runs north to south through the center of the Basin. The West Fork of the Russian River runs through the center of the Basin while the East Fork runs into Lake Mendocino. The East Fork and West Fork meet south of Lake Mendocino forming the mainstem the Russian River. The Russian River exits at the southernmost end of the Basin, just north of Hopland. Releases from Lake Mendocino significantly impact surface water flows in the Russian River. The headwaters of the Russian River are located 15 miles north of Ukiah, are habitat to endangered salmonid species, and are therefore, subject to minimum flow requirements established under the Federal Endangered species Act (SCWA, 2016).

Surface Water Characterization

The Russian River is the main flowing water body within the Basin. It extends for the entire length of the Basin from north to south for approximately 33 miles with several tributaries contributing to its flow (LACO Associates, 2017). Most of the contributing tributaries are seasonal or intermittent, as shown in **Table 2.15**. However, many of the intermittent streams have been shown to be flow at any array of locations upstream and within the Basin area while remaining disconnected from the Russian River. A recent local study by the Ukiah farming community during the 2018 water year has provided observational insights into the flowing patterns of the major tributaries to the Russian River within the Basin (Robinson, 2019). It is worth noting that the available information provided through this study (**Table 2.15**) corresponds to a relatively dry year and cannot necessarily be representative of all climatic conditions.

Streamflow of the Russian River and the contribution of its tributaries is measured at four USGS streamflow gages, shown in **Figure 2.24**. **Table 2.16** presents the location of the USGS stations along with average flow data. Station 11462000 is no longer monitored by the USGS and has been reassigned to the DWR and monitored through the California Data Exchange Center under Site ID "CDM."

Table 2.15: Russian River tributaries within the Basin and their flowing periods

Tributary Name	Description	Approximate Drainage Area (sq. mi)	Flowing period during 2018 Water Year
Sulphur Creek (Vichy Creek)	An eastern tributary with only a small portion located within the UVGB.	7.5	Flows into the basin and the Russian River from November through June
McClure and Mill Creek	Both eastern tributaries. Drain from Cow Mountain and join to discharge into the Russian River just north of the Talmage bridge.	18.0	Perennial flow, but December to April discharge to the Russian River
Howel Creek	An eastern tributary, it enters the basin under multiple branches. It has noncontiguous pools when it is dry.	10.0	Wet season flow only. Drains to the Russian River only during and after strong rainfall.
Morrison Creek	An eastern tributary, flows perennially in the upstream and mountainous streambed. Can become subsurface passing the alluvial streambeds.	10.0	Flows into the basin and the Russian River from December through March
Forsyth Creek	A western tributary, it drains the largest area to the basin.	28.0	Almost year round flow, disconnects from the Russian River in June (late Spring)
York Creek	A western tributary, it drains into the Russian River north of the East and West Fork confluence. It has one NMFS streamflow gauge.	14.0	Perennial flow. Disconnected from the Russian River in June.
Hensley Creek	A western tributary with a relatively small watershed.	7.5	Flows into the basin and the Russian River from the start of the wet season through June

Table 2.15: Russian River tributaries within the Basin and their flowing periods *(continued)*

Tributary Name	Description	Approximate Drainage Area (sq. mi)	Flowing period during 2018 Water Year
Ackerman Creek	A western tributary that shows occasional significant flows. In the spring wet stretches of creek bed can be seen downstream of dry stretches, showing significant interactions of stream with subsurface flow.	20.0	Disconnects from the Russian River in June
Orrs Creek	A western tributary that flows through the urban (City of Ukiah) and agricultural landscapes.	20.0	Flows through late Summer but disconnects from the Russian River in May.
Gibson and Doolan Creeks	A western tributary, it enters the basin in three separate branches. It includes segments of artificial channels and culverts and drains into the Russian River immediately north of the Talmage Bridge.	8.0	Flows through late Summer but disconnects from the Russian River in May.
Robinson Creek	A western tributary with a sizeable watershed that can show significant flows in winter. It becomes subsurface flow in late spring and summer, while flowing on the long stretch of alluvial downstream bed.	26.0	Perennial flow, but disconnects from the Russian River in June
McNab Creek	A western tributary that is gauged at three locations by the CLSI and one location by NMFS.	13.0	No available information.

Table 2.16: USGS stations within the Ukiah Valley Groundwater Basin

Station ID	Location	Long-term Average (cfs)	Percent Dry Years	Dry Years Average (cfs)	Wet Years Average (cfs)
11461000	Russian River North of Ukiah	153	59	126	232
11462000	East Fork Russian River	273	59	168	351
11462080	Russian River near Talmage	399	50	192	518
11462500	Russian River North of Hopland	605	53	353	759

The following three streamflow gauging stations can provide an overall characterization of the flow within the Basin:

- Station 11462000: Representative of the East Fork Russian River and releases from the Lake Mendocino.
- Station 11461000: Representative of the West Fork Russian River up to north of the city of Ukiah and before the confluence of the East Fork and West Fork.
- Station 11462500: Representative of the total flow draining from the Basin located downstream of the Basin.

Table 2.17 presents monthly average streamflow at each of these stations along with their minimum and maximum historical streamflow. As presented in this table, January through March are the months with the highest flows at all three stations and June through September are the driest months with the lowest flows. However, the West Fork Russian River experiences its dry conditions as early as May and remains relatively dry through November. The East Fork Russian River is the main contributor to the Russian River's mainstem during this dry period.

Figure 2.25 illustrates the mean annual streamflow at these three USGS stations. **Figure 2.26** through **Figure 2.28** show mean daily streamflow at each individual station. As demonstrated in this group of figures, 1998 was the wettest year on record. The most recent wet year was 2017. The driest year on record at these stations was 2013. Overall, the last decade has been considerably drier than what was observed in preceding decades, and shows the effect of the most recent drought.

Table 2.17: Monthly and long-term average, minimum, and maximum historical streamflow

Month	Station 11462500 Russian River North of Hopland (cfs)	Station 11462000 East Fork Russian River (cfs)	Station 11461000 Russian River North of Ukiah (cfs)
January	1563	519	406.0
February	1517	478	442.0
March	1118	308	356.0
April	592	278	168.0
May	297	229	59.0
June	176	195	16.2
July	174	222	3.3
August	181	229	0.8
September	179	229	0.6
October	197	224	6.8
November	220	170	40.5
December	920	208	335.0
Maximum historical flow	27403	5329	10083.0
Minimum historical flow	21	5	0.0

Water Systems Operations

The surface water system of the Basin is controlled by releases from Lake Mendocino into the East Fork Russian River along with precipitation and stormwater runoff. Inflow into Lake Mendocino is approximately 235,000 acre-feet (289.9 million cubic meters) per year, with a peak annual inflow of 443,000-acre feet (546.4 million cubic meters) in 1983 and a minimum annual inflow of 60,000 acre-feet (74.0 million cubic meters) in 1977 (SCWA, 2016). Storage capacity of the Lake is 116,500 acre-feet (143.7 million cubic meters) with a water supply pool between 68,400 acre-feet (84.4 million cubic meters) and 111,000 acre-feet (136.9 million cubic meters) (SCWA, 2016). Lake Mendocino receives water from the Eel River through the PG&E Potter Valley Project. A more detailed discussion of the water systems operations is included in **Appendix 2-D**.

During the winter months, flow in the Russian River is mainly unimpaired stream flow derived from precipitation and subsequent runoff. In the summer months, flow is primarily supplied by storage releases from Lake Mendocino (SCWA, 2016). Under State Water Board Decision 1610, the Russian River is subject to minimum instream flow requirements. To guide these requirements, hydrologic conditions of Normal, Dry, and Critical were established and based on inflow into Lake Pillsbury of the Potter Valley Project. Hydrologic conditions are based on the criteria shown in **Table 2.18** described in acre-feet of storage in Lake Pillsbury (SCWA, 2016):

Normal hydrologic conditions exist whenever dry or critical conditions aren't present (SCWA, 2016). These conditions guide the minimum flow requirements for the upper reach of the Russian River, which constitutes the stretch of the river starting at Lake Mendocino down to a river segment south of the Basin border.

Under normal conditions, 185 cfs is required within the river from April 1 through August 1 and 150 cfs from September 1 to March 31. During dry conditions, 75 cfs is required in the river

Table 2.18: Dry and critical hydrologic conditions definition for the Russian River Watershed

Dry	Critical
8,000 acre-feet as of January 1	4,000 acre-feet as of January 1
39,200 acre-feet as of February 1	20,000 acre-feet as of February 1
65,700 acre-feet as of March 1	45,000 acre-feet as of March 1
114,500 acre-feet as of April 1	50,000 acre-feet as of April 1
145,600 acre-feet as of May 1	70,000 acre-feet as of May 1
160,000 acre-feet as of June 1	75,000 acre-feet as of June 1

and under critical conditions 25 cfs (SCWA, 2016). However, under the recommendation of the National Marine Fisheries (NMFS) *Russian River Biological Opinion* (NMFS, 2008), instream flow requirements were reduced. A permanent reduction to 125 cfs between June 1 and August 31 and from September 1 and October 31 was applied to the Upper Russian River. Summer releases from Lake Mendocino are controlled based on these criteria to maintain minimum flow thresholds.

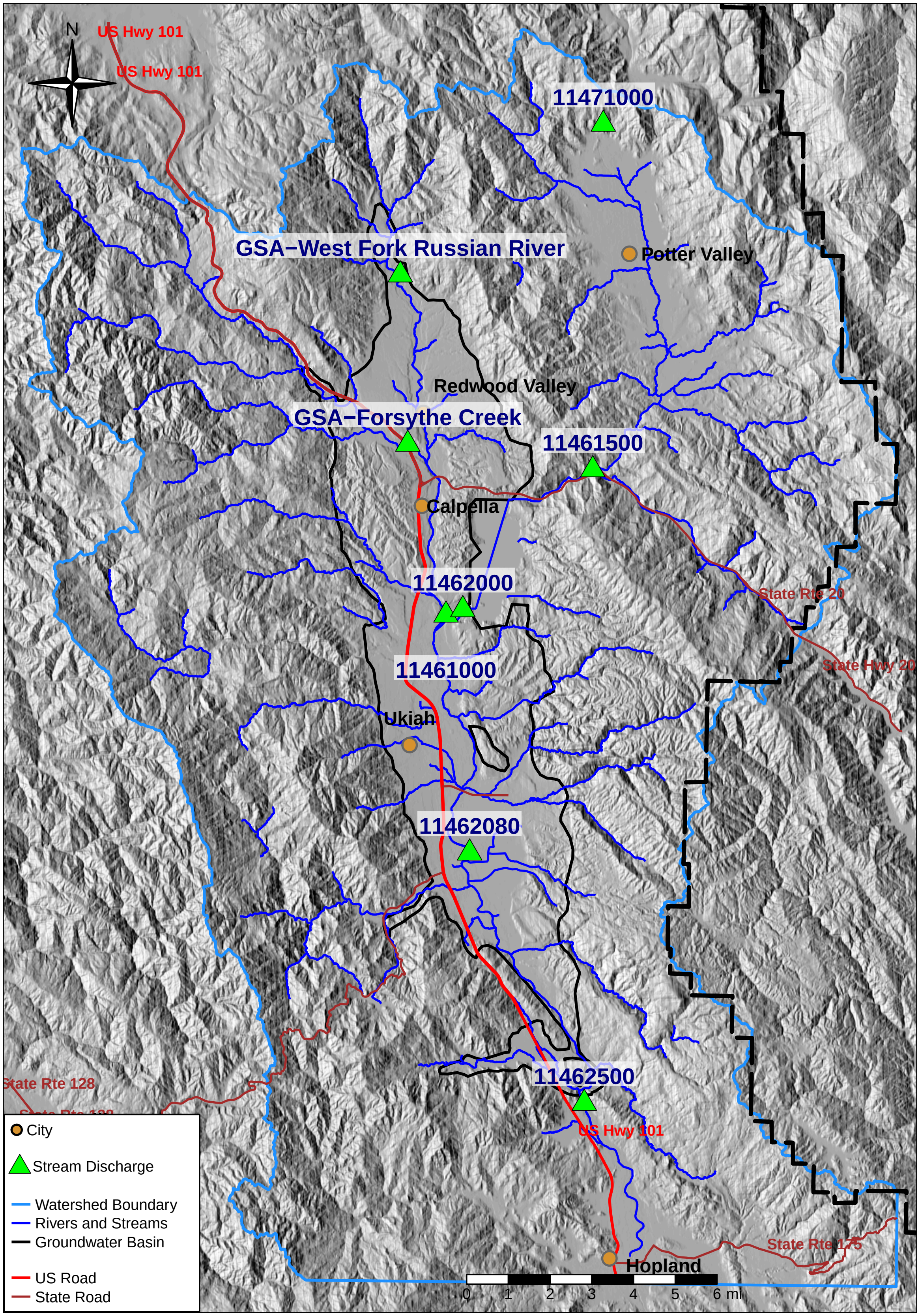


Figure 2.24: Available streamflow measurement gages within the UVGB.

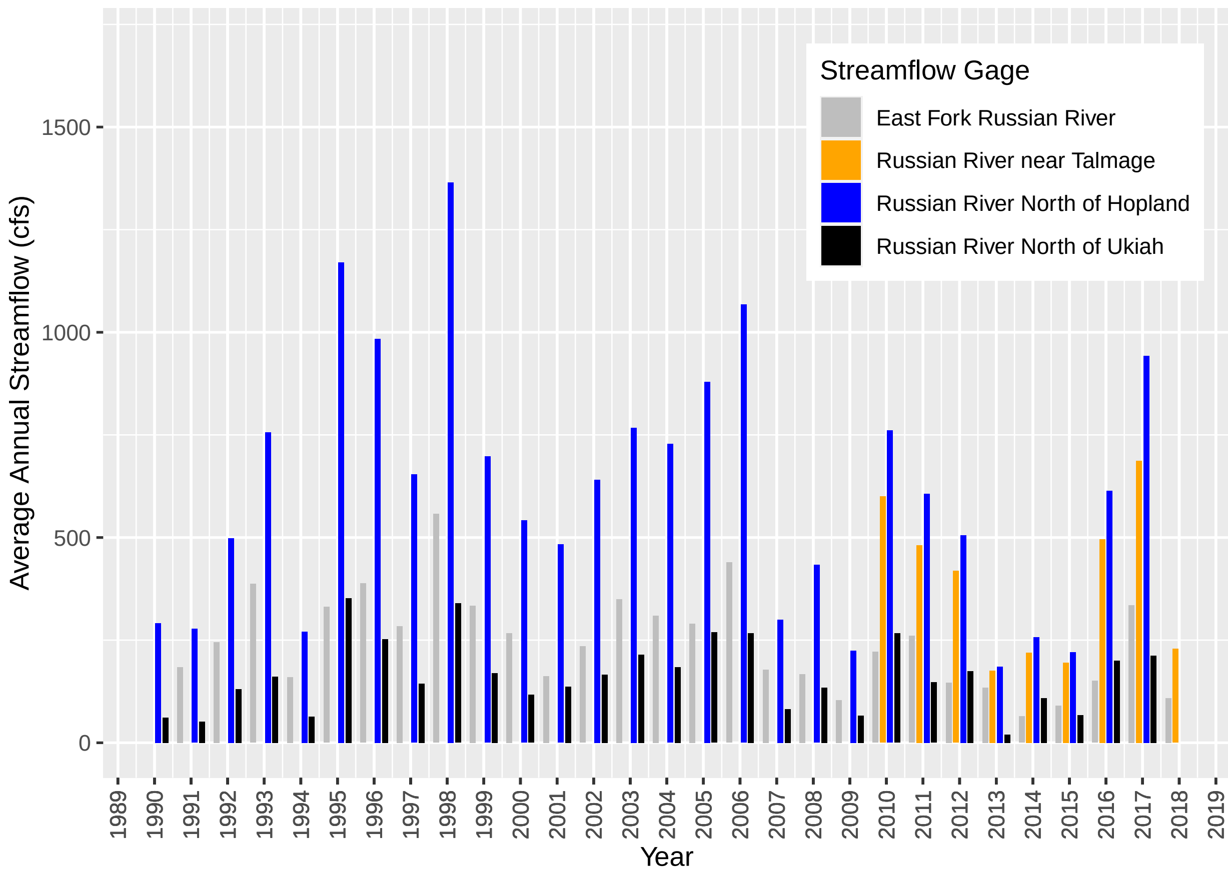


Figure 2.25: Mean annual streamflow at select stations.

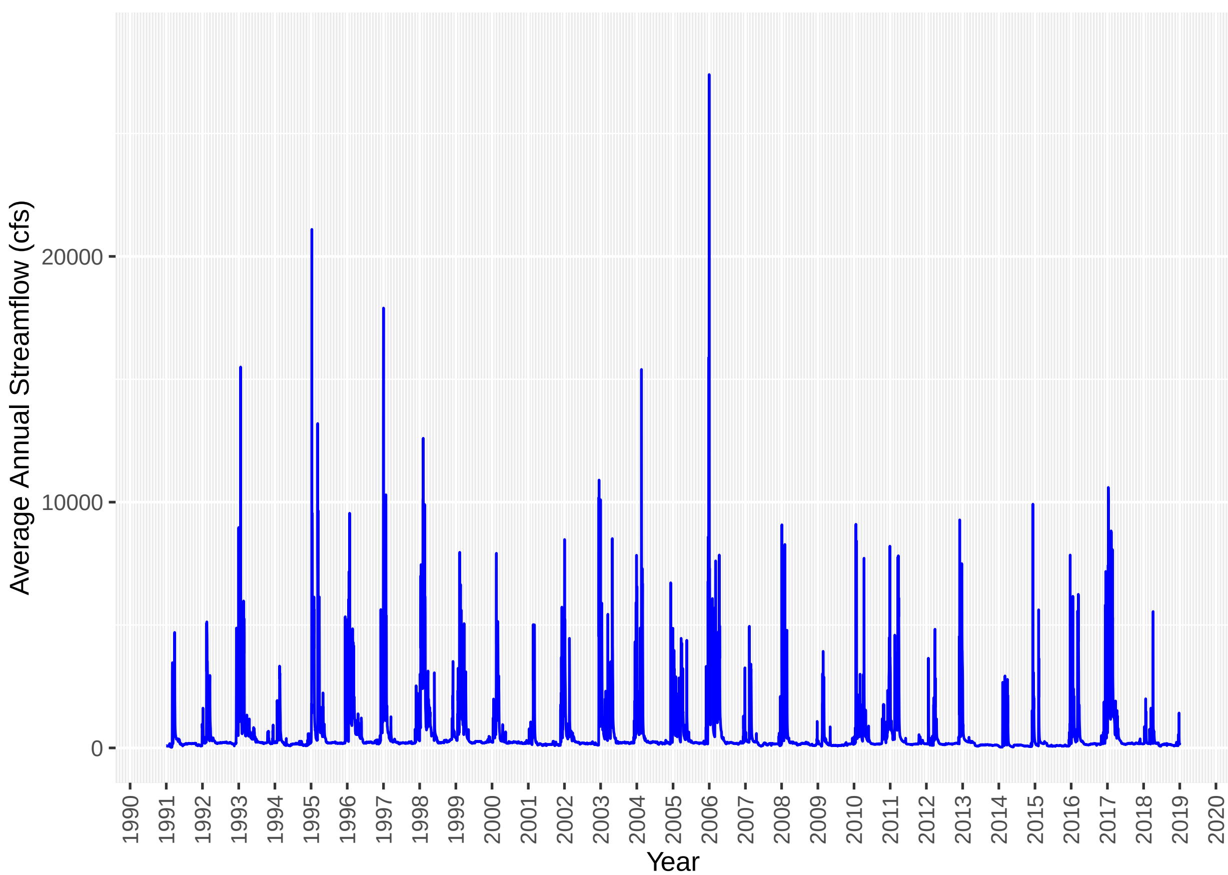


Figure 2.26: Mean daily streamflow; station 11462500 Russian River North of Hopland.

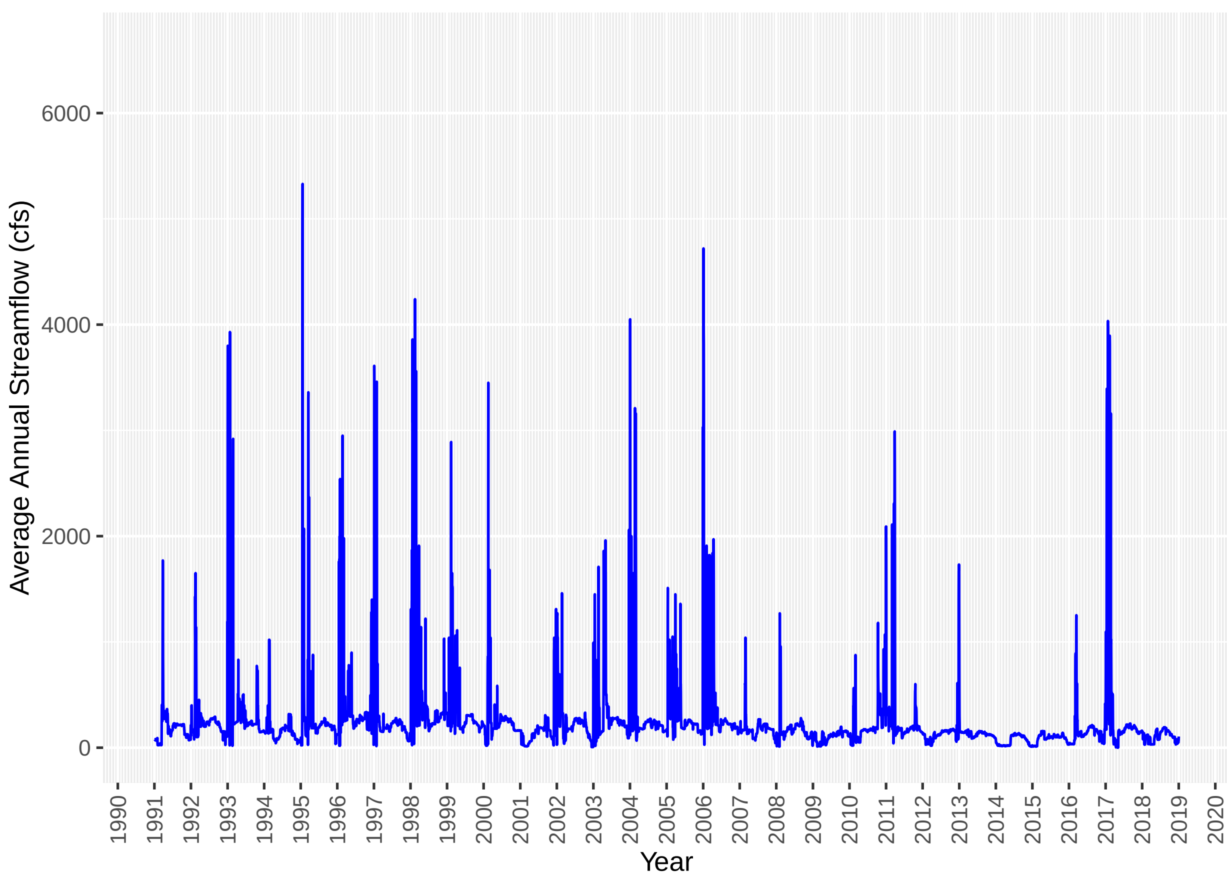


Figure 2.27: Mean daily streamflow; station 11462000 East Fork Russian River.

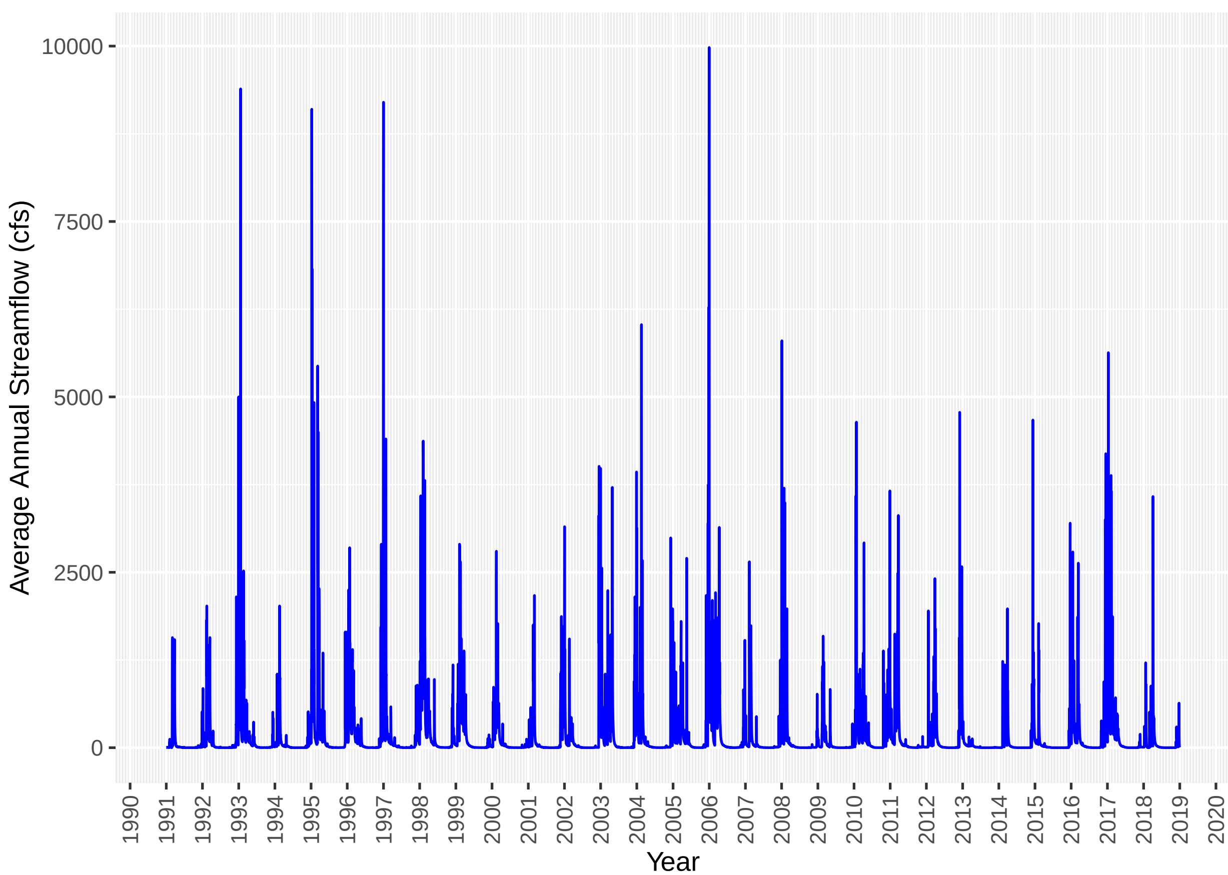


Figure 2.28: Mean daily streamflow; station 11461000 Russian River North of Ukiah.

2.2.1.7 Data Gaps

As defined by SGMA, a data gap is defined as uncertainty that, “could affect the ability of the Plan [GSP] to achieve the sustainability goal for the Basin.” For the HCM, data gaps identified may need to be addressed if they are found they significantly imped efforts to achieve sustainability. These data gaps include:

- Limited understanding of the hydrogeologic properties of the Basin. This will be addressed through pumping tests, to further refine modeling of the Basin.

- Limited water quality data. This will be addressed through data collection to further refine the water chemistry of the Basin and identify where additional monitoring may be needed.
  - General chemistry analysis from water quality sample results to characterize Principal Aquifer I and the Russian River for potential connection between the two.
  - Water quality characterization for Principal Aquifer II.
  - Identify potential areas of water quality concerns for future monitoring.

- Understanding of the mechanisms for recharge to Principal Aquifer I.
- Analysis of groundwater level and streamflow data to understand the relationship between Principal Aquifer I and the Russian River.
- Further analysis of Maacama fault and its hydrogeological properties.

A detailed discussion of data gaps is presented in **Appendix 2-E**.

2.2.2 Current and Historical Groundwater Conditions

The Basin was categorized as a medium priority groundwater basin in the 2016 and 2019 SGMA prioritizations due to the assignment of non-zero scores related to its population, projected growth, irrigated acreage, number of supply wells, and reliance on groundwater. The Basin received no priority points for any documented impacts on groundwater within the Basin that may include overdraft, subsidence, saline intrusion, water quality degradation, and any other factors relevant to DWR's evaluation such as adverse impacts on local habitat and local streamflows. This evaluation has been consistent in the literature and the past studies of the Basin. However, several studies, management decisions, and regulatory actions have been carried out in the Upper Russian River Watershed overlying the Basin area to manage streamflow in the mainstem of the Russian River and tributaries. Therefore, the main sustainability indicators assessed for the Basin include preserving groundwater elevations and preventing an undesired reduction in storage, maintaining the interconnection of surface water and groundwater, and preserving water quality.

As outlined in **Section 2.1.1**, agricultural and urban demands are the predominant water uses within the Basin. Surface water and groundwater are used conjunctively in most of the Basin to satisfy existing demands. For water purveyors and agricultural users located closer to the Russian River and its tributaries, the primary source of supply is surface water that is diverted from Coyote Dam releases and through direct diversions from the Russian River. Groundwater supply is the secondary source of supply for the majority of the Basin and largely augments the surface water supply. However, further from the Russian River and closer to the eastern and western boundaries of the Basin, especially in the central and southern areas of the Basin, reliance on groundwater increases for domestic and agricultural uses due to the lack of access to surface water supplies.

This section of Chapter 2 describes historical and current groundwater conditions in the Basin and satisfies the requirements of Section 354.16 of the SGMA Emergency Regulations by presenting:

- *Groundwater elevation data demonstrating flow directions, lateral and vertical gradients, and regional pumping patterns, including:*
  - *Groundwater elevation contour maps depicting the groundwater table or potentiometric surface associated with the current seasonal high and seasonal low for each principal aquifer within the Basin.*
  - *Hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients between principal aquifers.*
- *A graph depicting estimates of the change in groundwater in storage, based on data, demonstrating the annual and cumulative change in the volume of groundwater in storage between seasonal high groundwater conditions, including the annual groundwater use and water year type.*
- *Seawater intrusion conditions in the Basin, including maps and cross-sections of the seawater intrusion front for each principal aquifer.*
- *Groundwater quality issues that may affect the supply and beneficial uses of groundwater, including a description and map of the location of known groundwater contamination sites and plumes.*
- *The extent, cumulative total, and annual rate of land subsidence, including maps depicting total subsidence, utilizing data available from the Department, as specified in Section 353.2, or the best available information.*

- *Identification of interconnected surface water systems within the Basin and an estimate of the quantity and timing of depletions of those systems, utilizing data available from the Department, as specified in Section 353.2, or the best available information.*
- *Identification of groundwater-dependent ecosystems within the Basin, utilizing data available from the Department, as specified in Section 353.2, or the best available information.*

2.2.2.1 Groundwater Elevation

Groundwater well information and groundwater level monitoring data were compiled from the following public sources:

- DWR CASGEM Program database[6]
- SWRCB GeoTracker database[7]

Data obtained through these sources included information such as well location, well use, casing material and elevation, ground surface elevation, and groundwater elevation data with related information including measurement date, depth to water, groundwater surface elevation, QA/QC information, and other comments. A complete list of the data fields available from these sources can be found on their respective websites. It is worth noting that not all of these data fields were available for all the wells within the Basin.

Groundwater elevation data available through the end of December 2020 were used in the development of the GSP. However, data availability in the Basin is not consistent throughout the years. Groundwater elevation data are very scarce prior to 2014 and are limited to three DWR wells[8] (site codes: 391096N1231677W001, 391730N1232108W001, 392358N1232020W001). Records for all three wells include relatively consistent biannual data (fall and spring samples) that continue to date **(Figure 2.29)**. Measurements at Site “391730N1232108W001” began in 1966 while the other two wells were first measured in 1973. These three wells are monitored by DWR and are incorporated in the CASGEM Program for Mendocino County and administered by the MCRCD. The MCRCD began integrating local wells into the program in 2014 through a contract with the MCWA. As of 2020, the CASGEM database contains biannual data for 45[9] wells within the Basin **(Figure 2.30)**.

The GSA has instrumented existing wells with continuous measurement devices and is using DWR TSS funds to drill new wells to monitor groundwater elevations. Although this high-frequency data was not available during the GSP development period, it will be available during GSP implementation as part of the GSP monitoring network (**Section 3.3**).

[6] https://www.casgem.water.ca.gov

[7] https://Geotracker.waterboards.ca.gov

[8] DWR has four wells within the Basin. However, only three of these wells have measured data prior to 2000.

[9] The number of wells monitored for CASGEM program has been variable. The maximum number of wells monitored through 2019 for any year has been 45 wells.

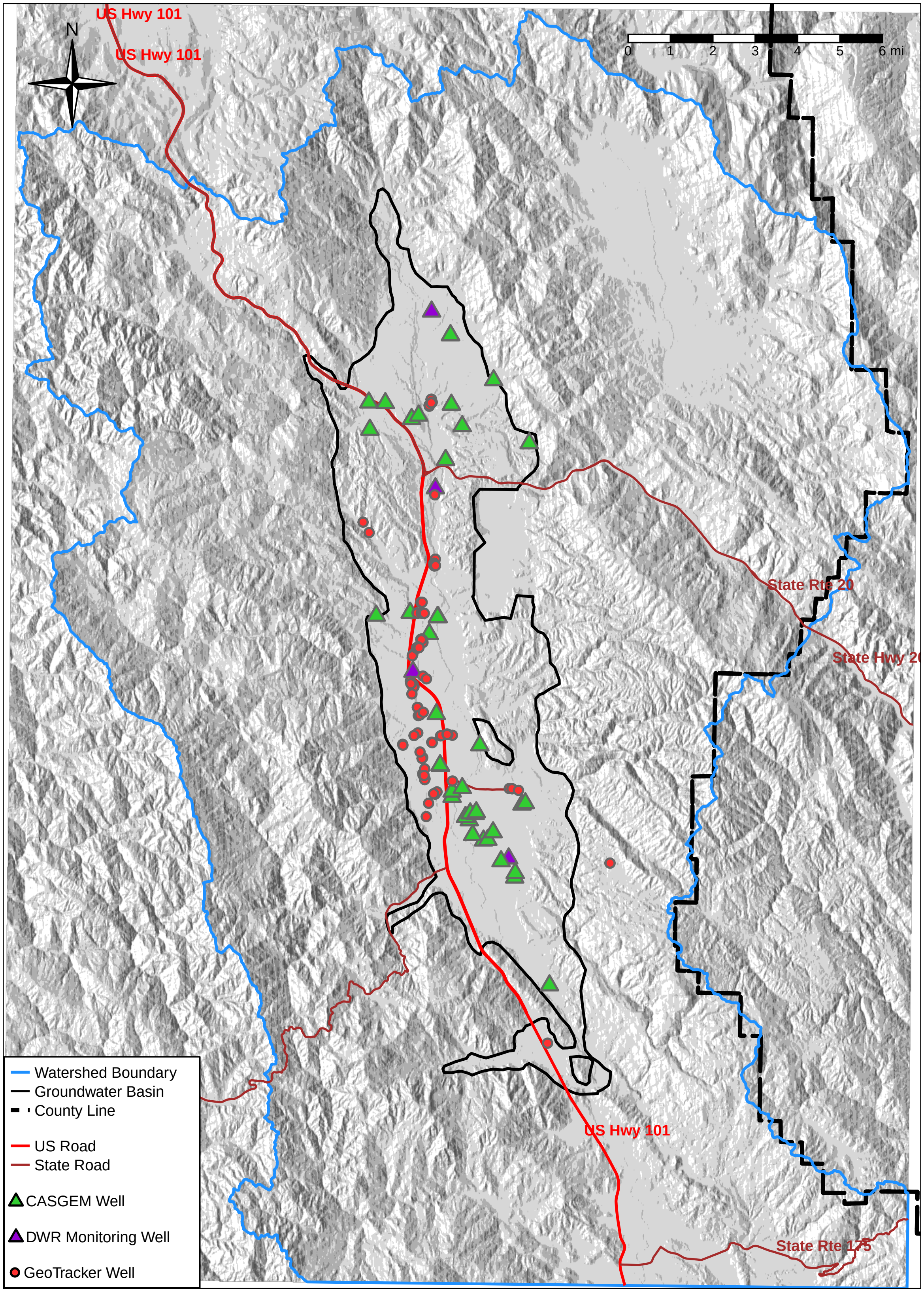


Figure 2.29: Groundwater elevation monitoring wells in the Ukiah Valley Groundwater Basin from 1967 to 2019.

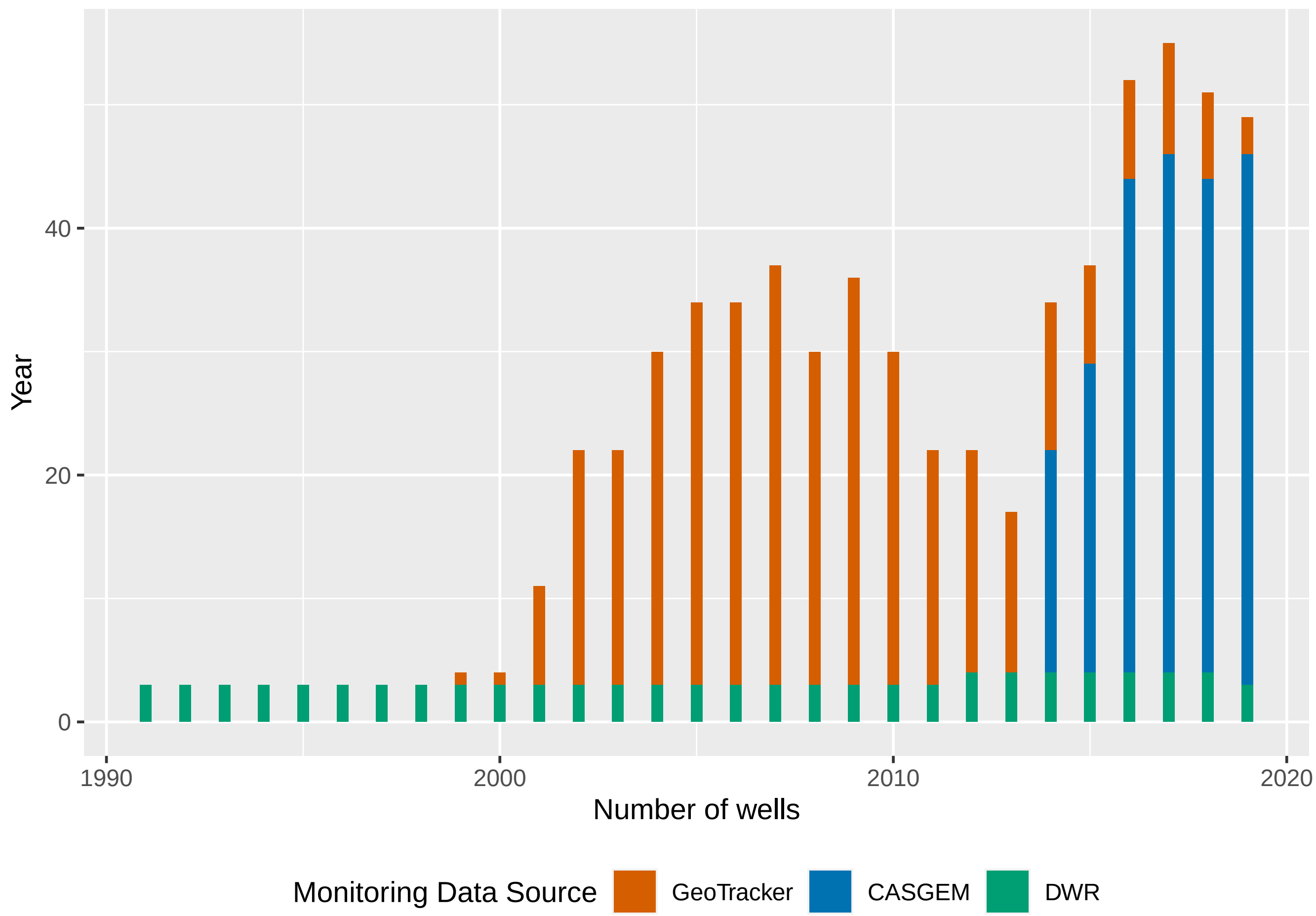


Figure 2.30: Total number of monitoring wells measured historically in the Ukiah Valley Groundwater Basin by the DWR, CASGEM, and GeoTracker monitoring programs

Before 2014, groundwater elevation data are limited to the three DWR wells mentioned above and periodic measurements of wells with data in the GeoTracker database. GeoTracker is the State Water Board's data management system for sites that impact, or have the potential to impact, groundwater quality in California. These include cleanup sites, Department of Defense Sites , and LUST sites. The GeoTracker database contains some periodic groundwater elevation data for the Basin. For the period of 1999 to 2019, data from a total of 464 monitoring wells within the Basin were downloaded from the GeoTracker database and utilized for the groundwater condition characterization effort. However, these data were not uniformly collected across the entire 20-year period. The number of wells represented in GeoTracker grew from 6 wells in 1999 to over 200 wells in the period between 2004 and 2012 though the number has decreased consistently since then. Data were uploaded to Geotracker for 26 wells within the Basin in 2019. While GeoTracker data provide valuable insight into groundwater elevations within the Basin, the high quantity of wells does not necessarily translate to better spatial coverage. Cleanup sites can have multiple wells drilled in close proximity to one another, but typically do not cover a large spatial area. In addition, a great majority of these wells are shallow wells within the alluvial aquifer and do not provide information regarding conditions in the deeper aquifers within the Basin.

As a result of the data scarcity outlined above, historical groundwater evaluations rely heavily on the three wells monitored by DWR with a longer and more reliable period of record. Well elevation data contained in GeoTracker were incorporated where they provided additional information from 1999 to 2015. For the recent and current groundwater elevation evaluation, CASGEM wells were exclusively used due to their spatial and depth coverage and their overall data quality.

Historical Groundwater Elevations and Trends

Groundwater elevations in the Basin have been relatively stable over the past 30 years while showing small seasonal fluctuations (DWR, 2019d). Due to the limited historical data outlined above, it is difficult to produce reliable groundwater elevation contours for the historical period. However, the three DWR wells **(Figure 2.31)** associated with a long-term time-series of groundwater elevations show the stability of the groundwater elevations and the relative magnitude of seasonal fluctuations. The lowest elevations can be expected around October of each year before the start of the wet season and the highest elevations are normally observed in spring, during March or April (MCWA, 2010). The magnitude of seasonal fluctuations varies depending on the location of the wells, from the north of the Basin to the south. The majority of the wells show a range between 5 ft (1.5 m) to 15 ft (4.6 m) for their seasonal changes in groundwater elevation, but changes as low as 1 ft (0.3 m) and as high as 28 ft (8.5 m) are also recorded in the historical data. The magnitude of fluctuations is slightly higher during droughts but the Basin is shown to maintain its stable levels despite this change and rebounds to approximately the same levels as pre-drought conditions once drought conditions subside.[10]

Current Groundwater Elevations and Trends

Groundwater in the Basin flows southerly and towards the Russian River. Recent groundwater level measurements continue to show the stable conditions in the Basin for all aquifers.

Aquifer I - Quaternary Alluvium

There are a limited number of wells monitored for this aquifer historically. These wells do not provide sufficient spatial coverage to produce meaningful groundwater elevation contours for Aquifer I. However, well hydrographs can be investigated to understand the direction of groundwater flow and general trends in groundwater elevations.

Under current conditions, groundwater elevations in this aquifer generally follow ground surface elevations. Groundwater elevations are the highest in the north of the Basin in the Redwood Valley and decrease towards the southern boundary and the river. Groundwater elevations range from 736 ft-amsl (224.3 m-amsl) to 517 ft-amsl (157.6 m-amsl). The groundwater flow direction within the Basin is generally from north to south and towards the river.

In the Redwood Valley region, groundwater elevations range from 734 ft-amsl (223.7 m-amsl) to 729 ft-amsl (222.2 m-amsl) with seasonal fluctuations of approximately 3 to 4 ft (1 m; **Figures 2.32**). It is worth mentioning that these estimates are based on very limited data. There is only one well in the CASGEM program that could be attributed to Aquifer I. The groundwater surface at this well is between 4 and 11 ft-bgs (1.2 to 3.4 m-bgs).

In the central Ukiah Valley region, from the north of the Town of Calpella to the center of the City of Ukiah, only one well in the CASGEM program is attributed to Aquifer I (**Figure 2.33**). Groundwater elevations in this region were observed to be between 606 ft-amsl (184.7 m-amsl) and 595 ft-amsl (181.4 m-amsl). Seasonal fluctuation in this region of the Basin is between 5 ft (1.5 m) and 8 ft (2.4 m). The groundwater surface at the monitoring well has been between 39 and 42 ft-bgs (11.9 to 12.8 m-bgs) in fall and from 28 to 33 ft-bgs (8.5 to 10 m-bgs) in the spring.

In the southern region of the Ukiah Valley, from the City of Ukiah to the drainage of the Basin near the Town of Hopland, more monitoring wells are available from the CASGEM program. Groundwater elevations range from 517 ft-amsl (157.6 m-amsl) to 645 ft-amsl (196.6 m-amsl), as shown

[10] A few of the low groundwater level measurements at Well 392358N1232020W001 may have been collected in error since they do not conform to the groundwater level trend in that well or nearby wells in the Basin

in **Figure 2.34**. Agricultural use and vineyards are the dominant land uses in this area, especially east of the River. Groundwater elevations in this region may differ considerably in wells relatively close to each other due to the impacts of local production wells nearby. However, the general trend of decreasing elevations towards the south and the Russian River is still clear. The average seasonal fluctuation in this region is approximately 6 ft (1.8 m) and typically falls within the range of less than 1 ft (0.3 m) to 12 ft (3.7 m).

Aquifer II - Terrace Deposits

A similar groundwater flow direction is observed in the Terrace Deposits as in the Quaternary Alluvium. Groundwater elevations decrease from north to south in the Basin and follow the general ground surface elevations. Similarly, groundwater flow direction is evaluated to be generally from north to south within the Basin and towards the River. Groundwater elevations for spring and fall of water year 2017 are shown in **Figures 2.35** and **2.36**, respectively. Average seasonal changes in groundwater elevations are larger than in the Quaternary Alluvium aquifer.

In Redwood Valley, the majority of monitoring wells show groundwater elevations from 683 ft-amsl (208.178 m amsl) in the northwest portion of the Basin to 890.8 ft-amsl (211.8 m-amsl) in the northeast portion of the Redwood Valley **(Figure 2.37)**. Overall, groundwater is encountered between 7 ft-bgs (2.1 m-bgs) to 140 ft-bgs (42.7 m-bgs) depending on the location of the well. The average seasonal change in groundwater elevations is approximately 8 ft (2.4 m).

In the central Ukiah Valley region, from north of the Town of Calpella to the center of the City of Ukiah, groundwater elevations vary from 503 ft-amsl (153.3 m-amsl) to 629 ft-amsl (191.7 m-amsl), as shown in **Figure 2.38**. Groundwater can be reached at 5.4 ft-bgs (1.5 m-bgs) to 180 ft-bgs (54.9 m-bgs) depending on the location of the well. The average seasonal change in groundwater elevations in this region is approximately 8.6 ft (2.6 m).

In the southern region of the Ukiah Valley, from the City of Ukiah to the drainage of the Basin near the Town of Hopland, groundwater elevations range from 545.6 ft-amsl (166.3 m-amsl) to 649.7 ft-amsl (198 m-amsl), shown in **Figure 2.39**. As mentioned above, groundwater elevations in this region may differ considerably in wells relatively close to each other due to the impacts of local production wells nearby. Nevertheless, groundwater elevations maintain the general trend of decreasing elevations towards the south and the Russian River. According to historical measurements, beneficial users have accessed groundwater at depths between 4.8 ft-bgs (1.5 m-bgs) and 42.1 ft-bgs (12.8 m-bgs). The average seasonal fluctuation in this region is approximately 10.5 ft (3.2 m) and typically falls within the range of less than 1 foot (0.3 m) to 28 ft (8.5 m).

Vertical Gradients

In addition to the horizontal gradients in groundwater elevation described above, there are vertical gradients within the Basin. Two sets of multi-completion wells (nested wells) exist within the CASGEM database for the Basin. Both sets are located in the central Ukiah Valley region. One set is formed from CASGEM monitoring wells Ukiah Valley-1 to Ukiah Valley-4 that are located closer to the City of Ukiah and to the south of Lake Mendocino. The other set includes CASGEM monitoring wells Ukiah Valley-16 to Ukiah Valley-18 that are located north of the town of Calpella. Both sets of nested wells are screened at depths that can be attributed to the two principal aquifer systems within the Basin. Measured groundwater elevations at both sets of nested wells show a downward gradient from Aquifer I to Aquifer II (**Table 2.19**). The vertical gradient appears to be small in the nested wells closer to the City of Ukiah.

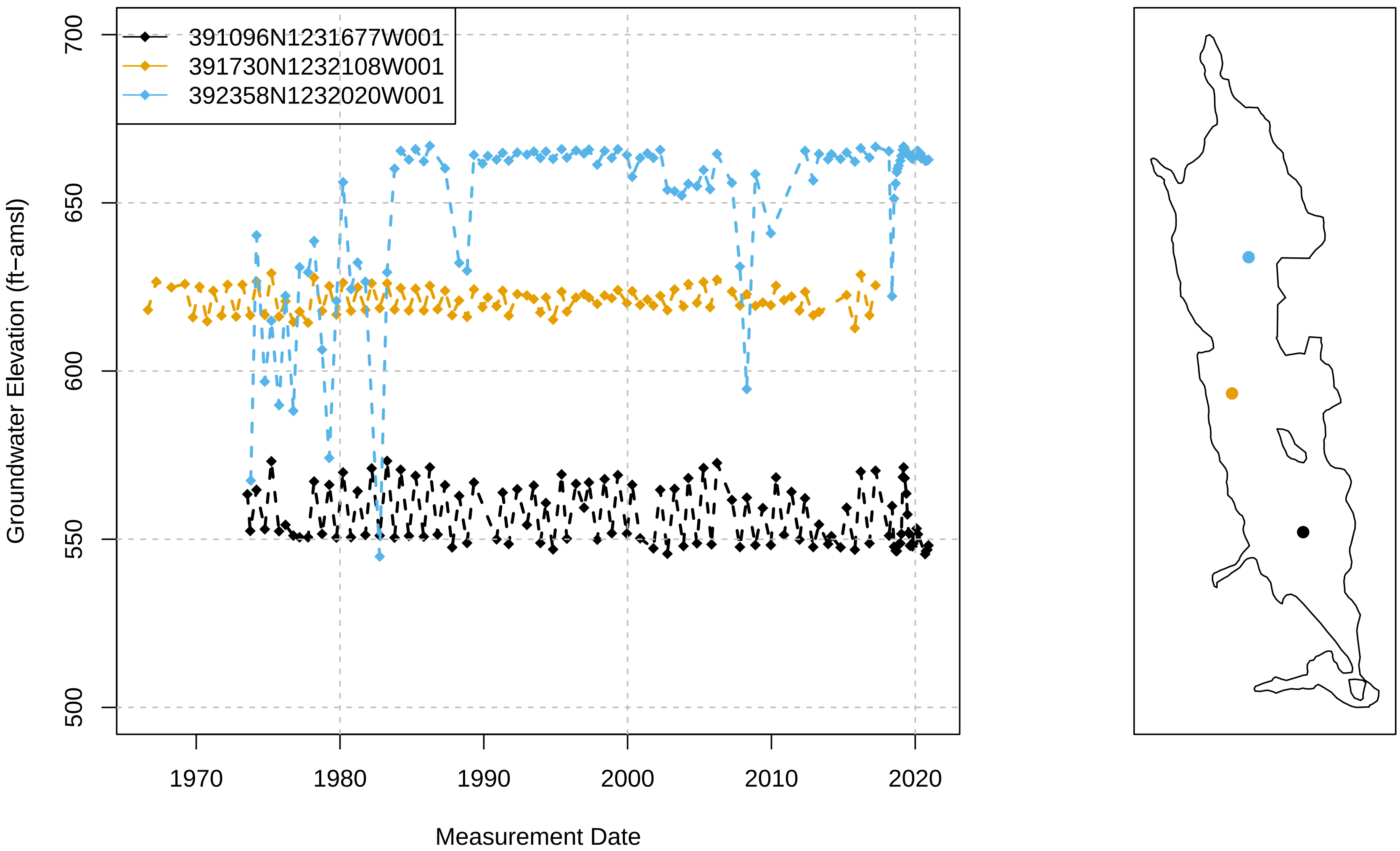


Figure 2.31: Historical groundwater elevations for the three DWR monitoring wells.

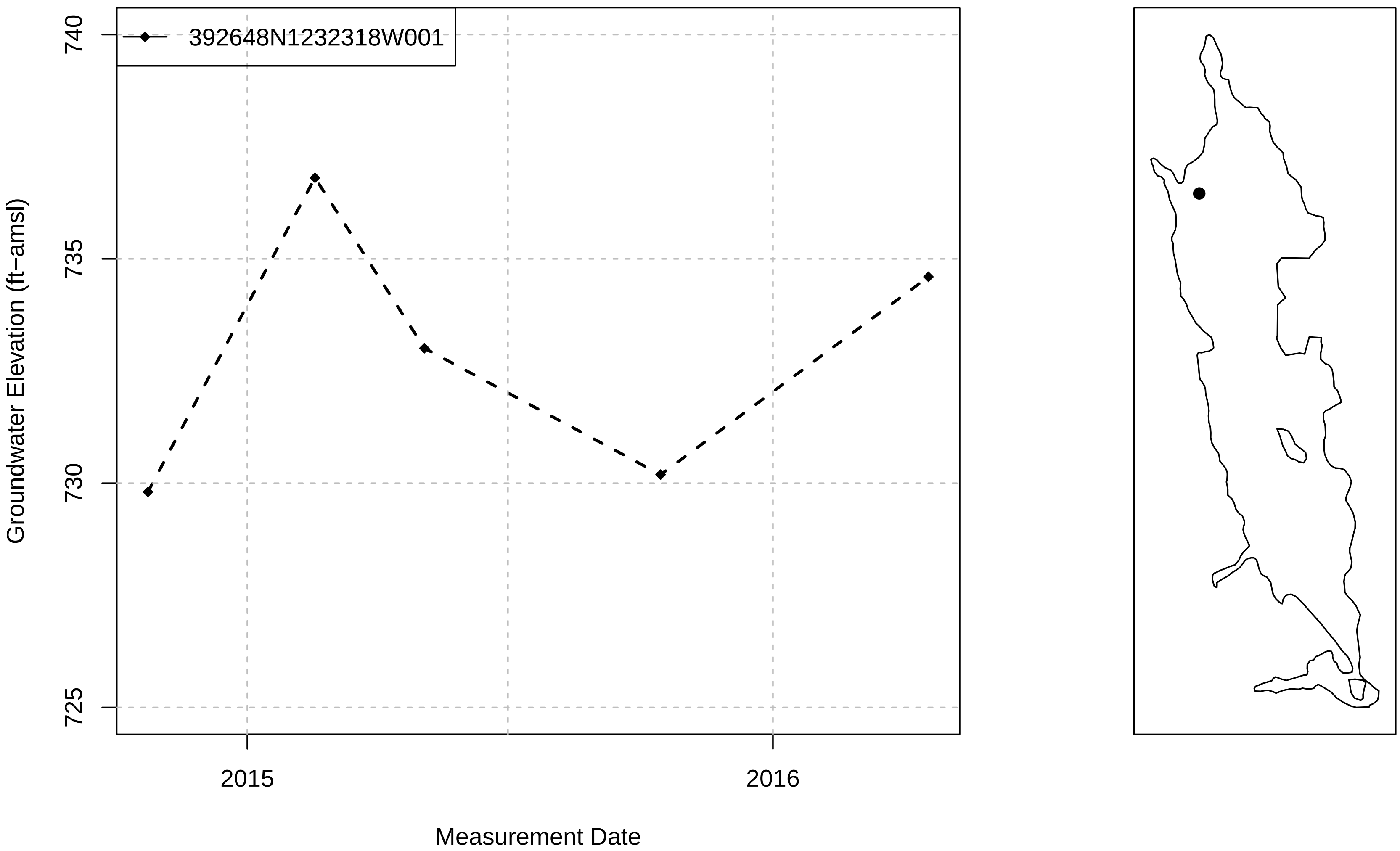


Figure 2.32: Groundwater elevations in the Redwood Valley, in feet amsl, for selected CASGEM wells screened in Aquifer I - Quaternary Alluvium.

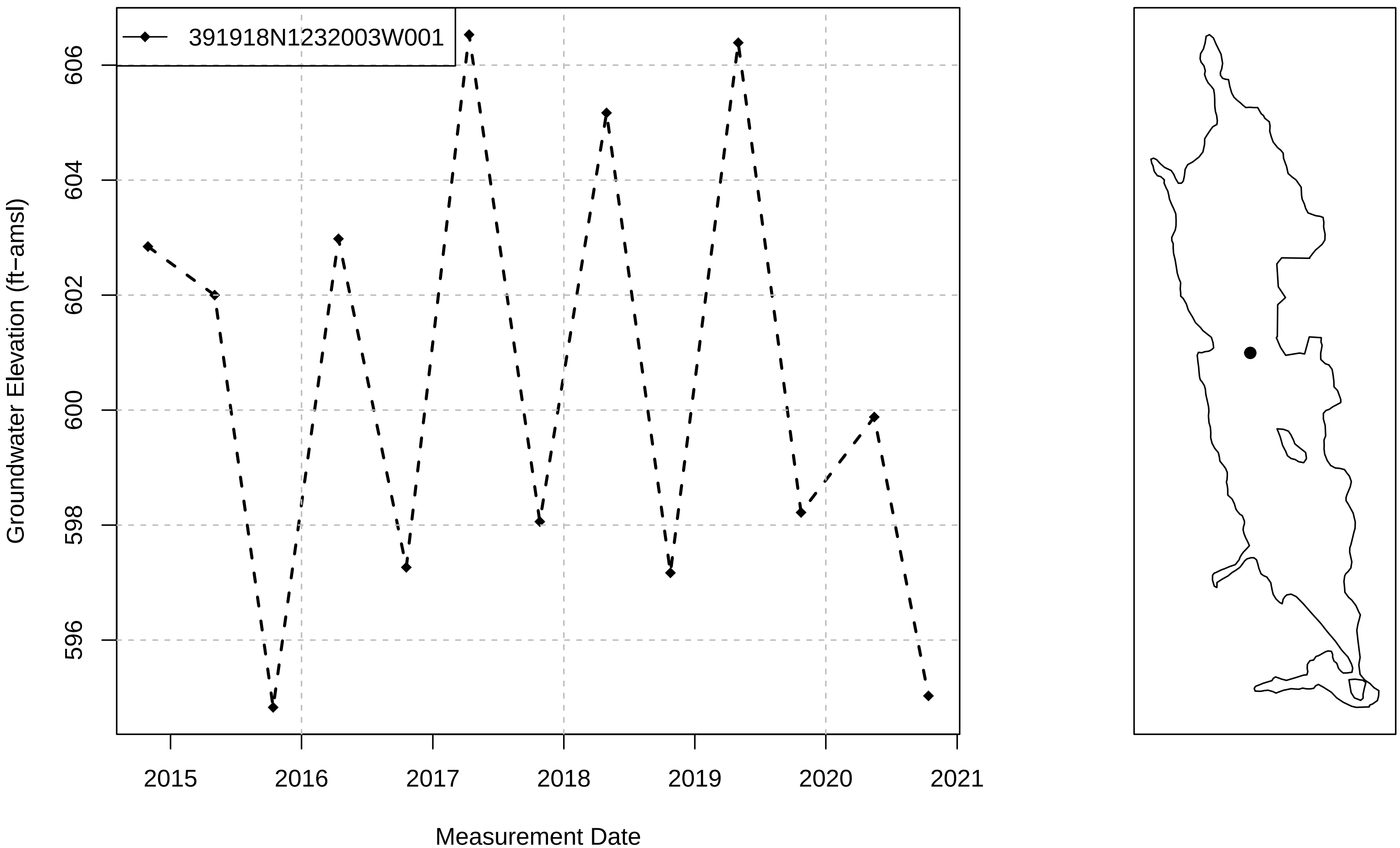


Figure 2.33: Groundwater elevations in the central Ukiah Valley region, in feet amsl, for selected CASGEM wells screened in Aquifer I - Quaternary Alluvium.

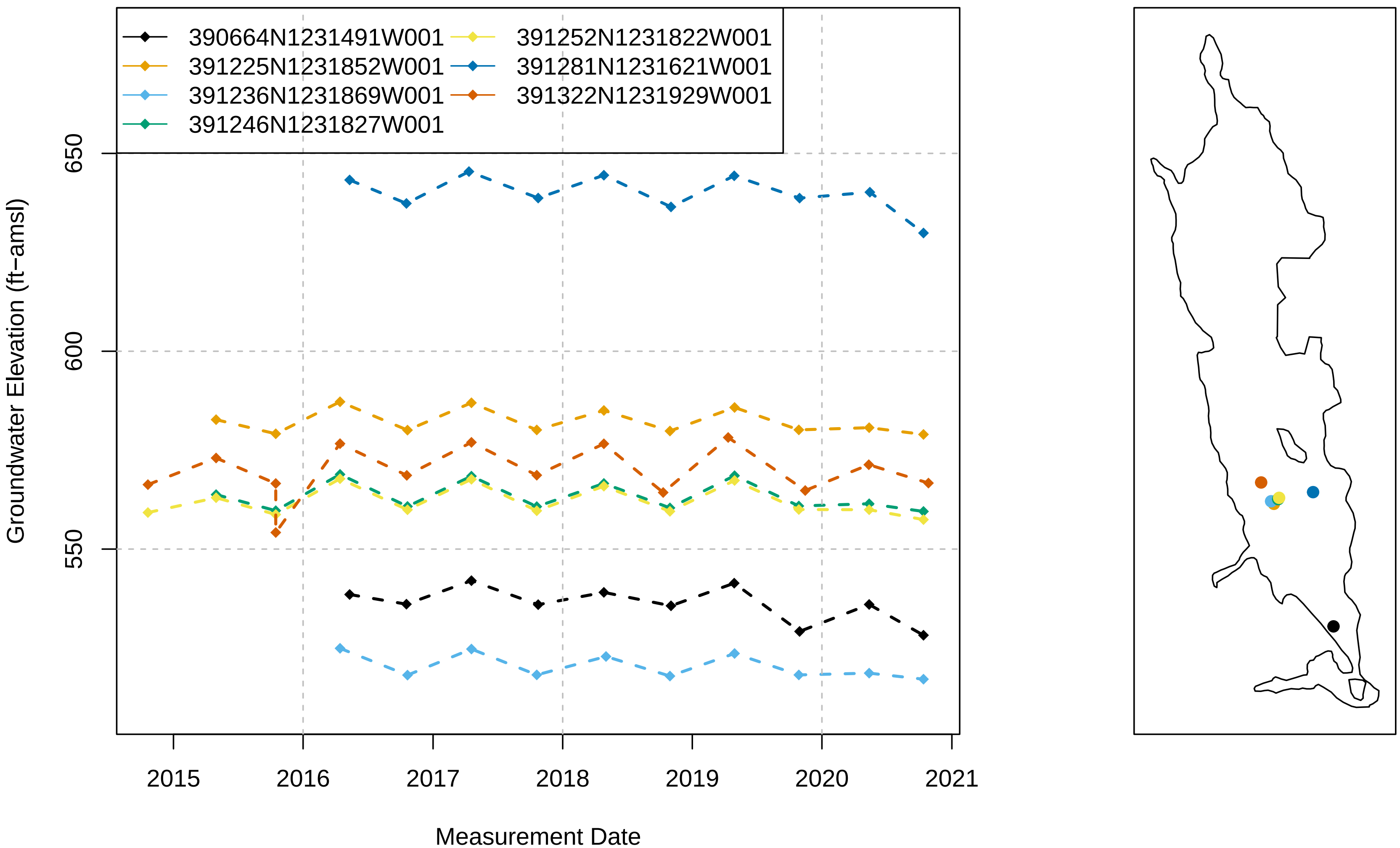


Figure 2.34: Groundwater elevations in the southern Ukiah Valley region, in feet amsl, for selected CASGEM wells screened in Aquifer I - Quaternary Alluvium.

```
## Warning:
## Grid searches over lambda (nugget and sill variances) with  minima at the endpoints:
##   (GCV) Generalized Cross-Validation
##    minimum at  right endpoint  lambda  =  0.00002656631 (eff. df= 11.4 )
```

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## Warning:
## Grid searches over lambda (nugget and sill variances) with  minima at the endpoints:
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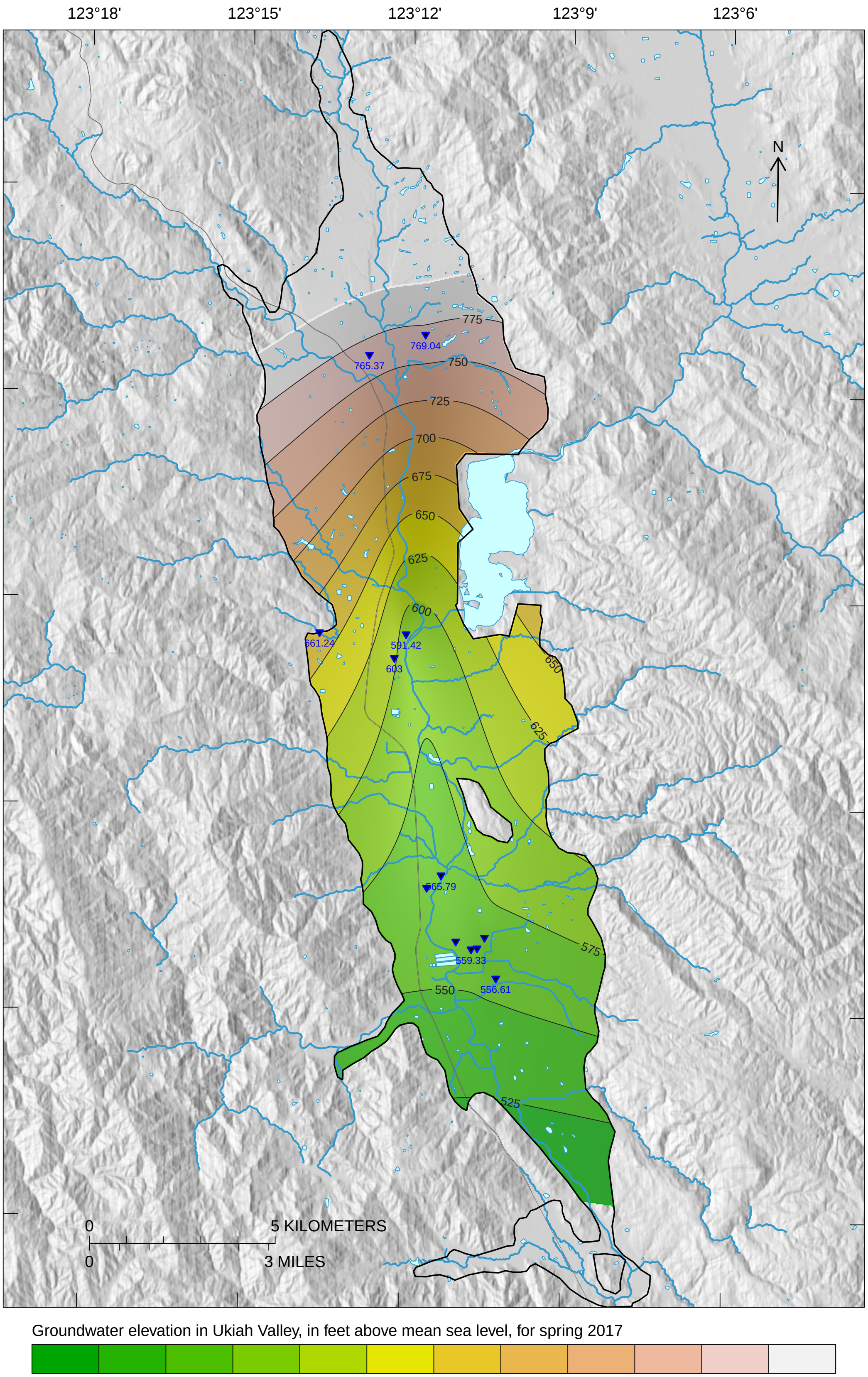

Figure 2.35: Groundwater elevation contours in the Ukiah Valley Groundwater Basin, in feet amsl, for spring of 2017.

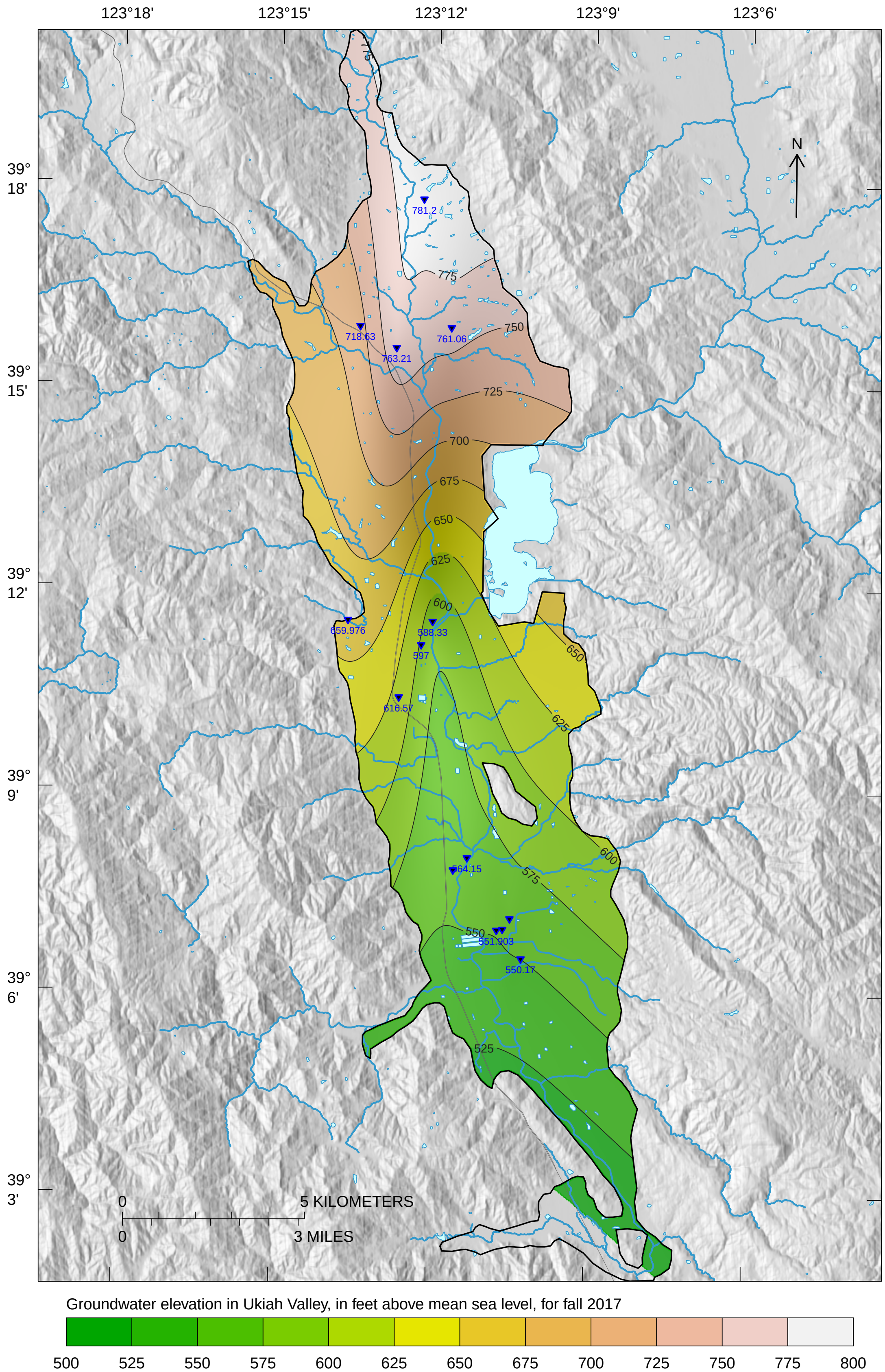

Figure 2.36: Groundwater elevation contours in the Ukiah Valley Groundwater Basin, in feet amsl, for fall of 2017.

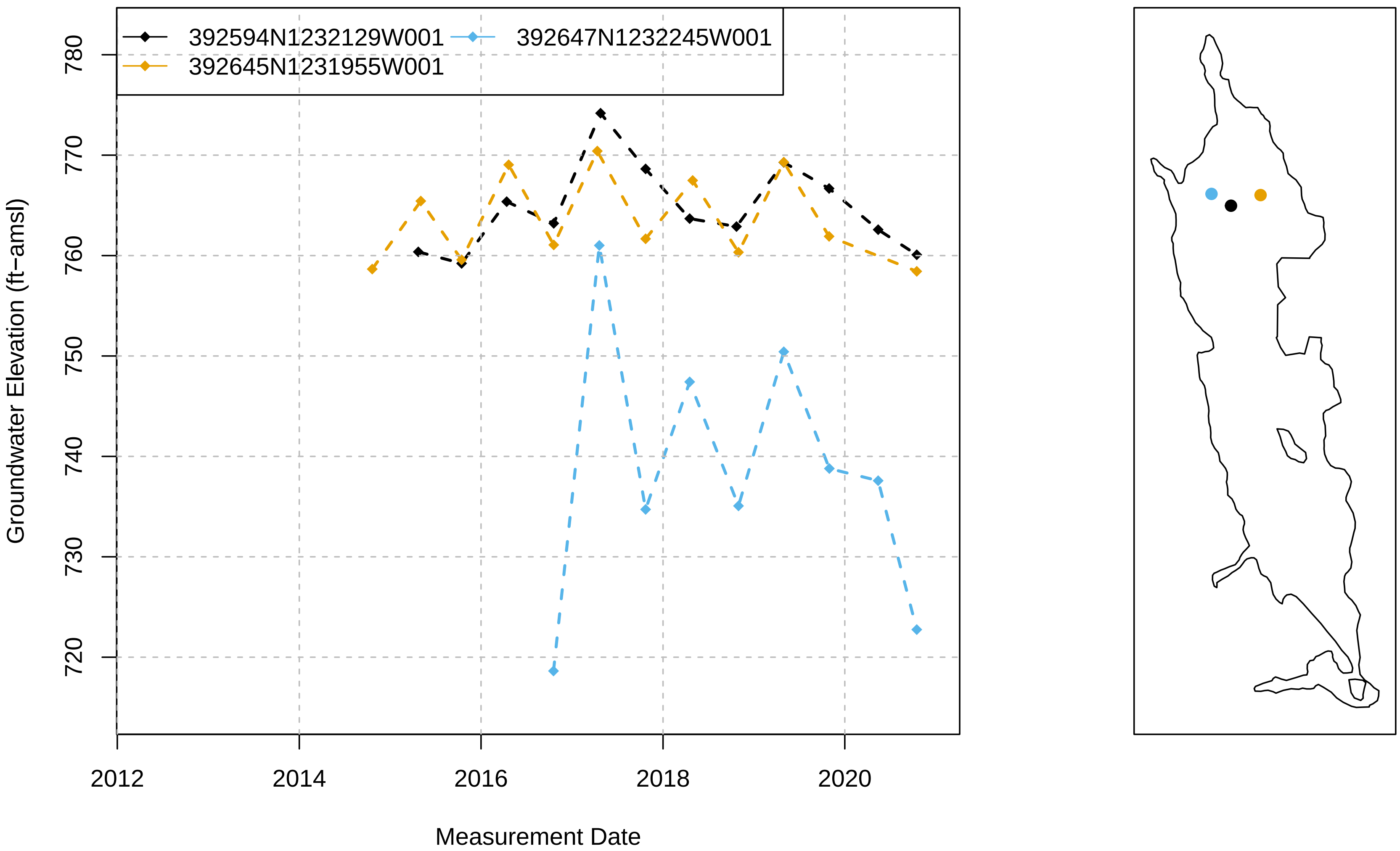

Figure 2.37: Groundwater elevations in the Redwood Valley region, in feet amsl, for selected CASGEM wells screened in Aquifer II - Terrace Deposits.

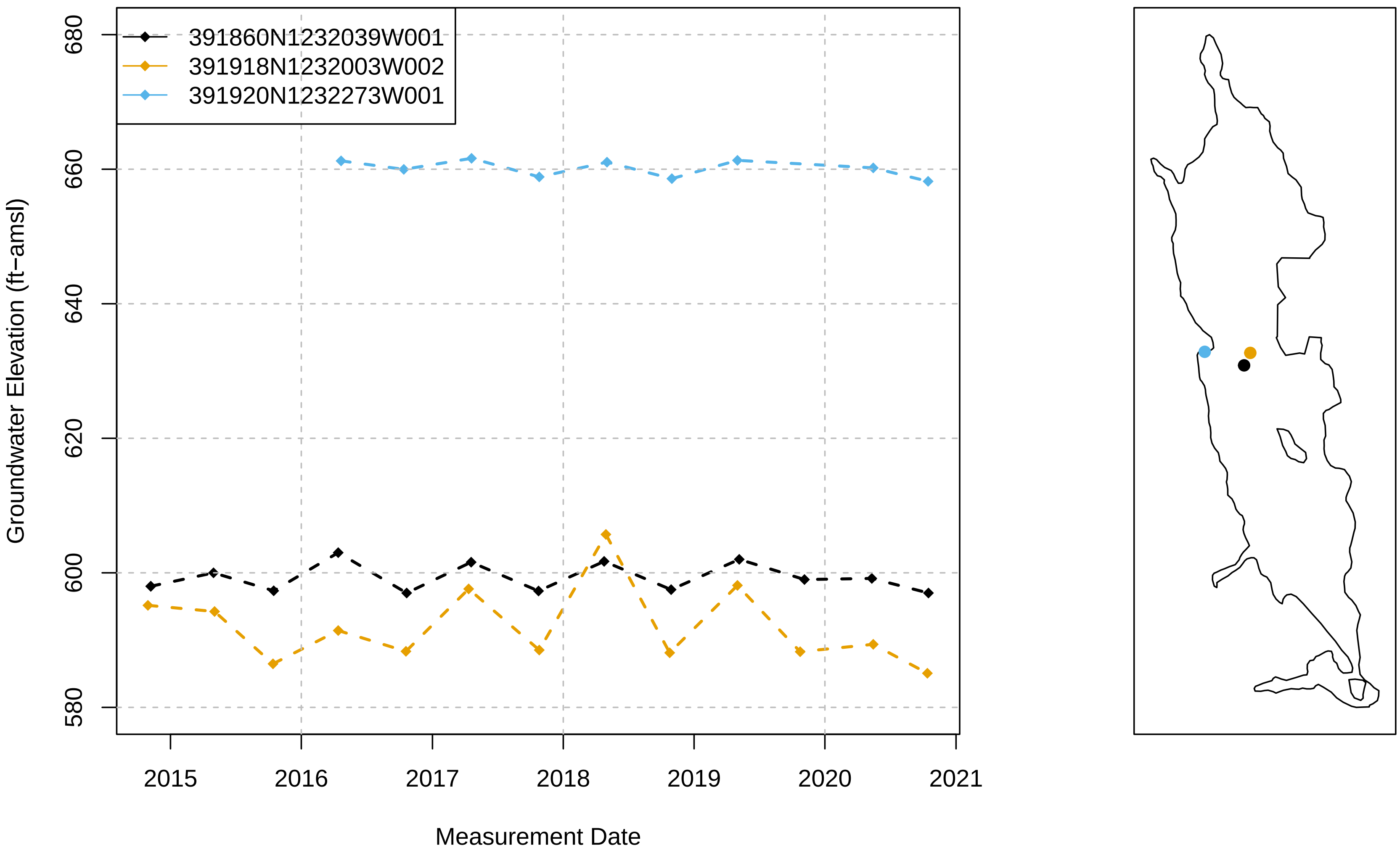

Figure 2.38: Groundwater elevations in the central Ukiah Valley region, in feet amsl, for selected CASGEM wells screened in Aquifer II - Terrace Deposits.

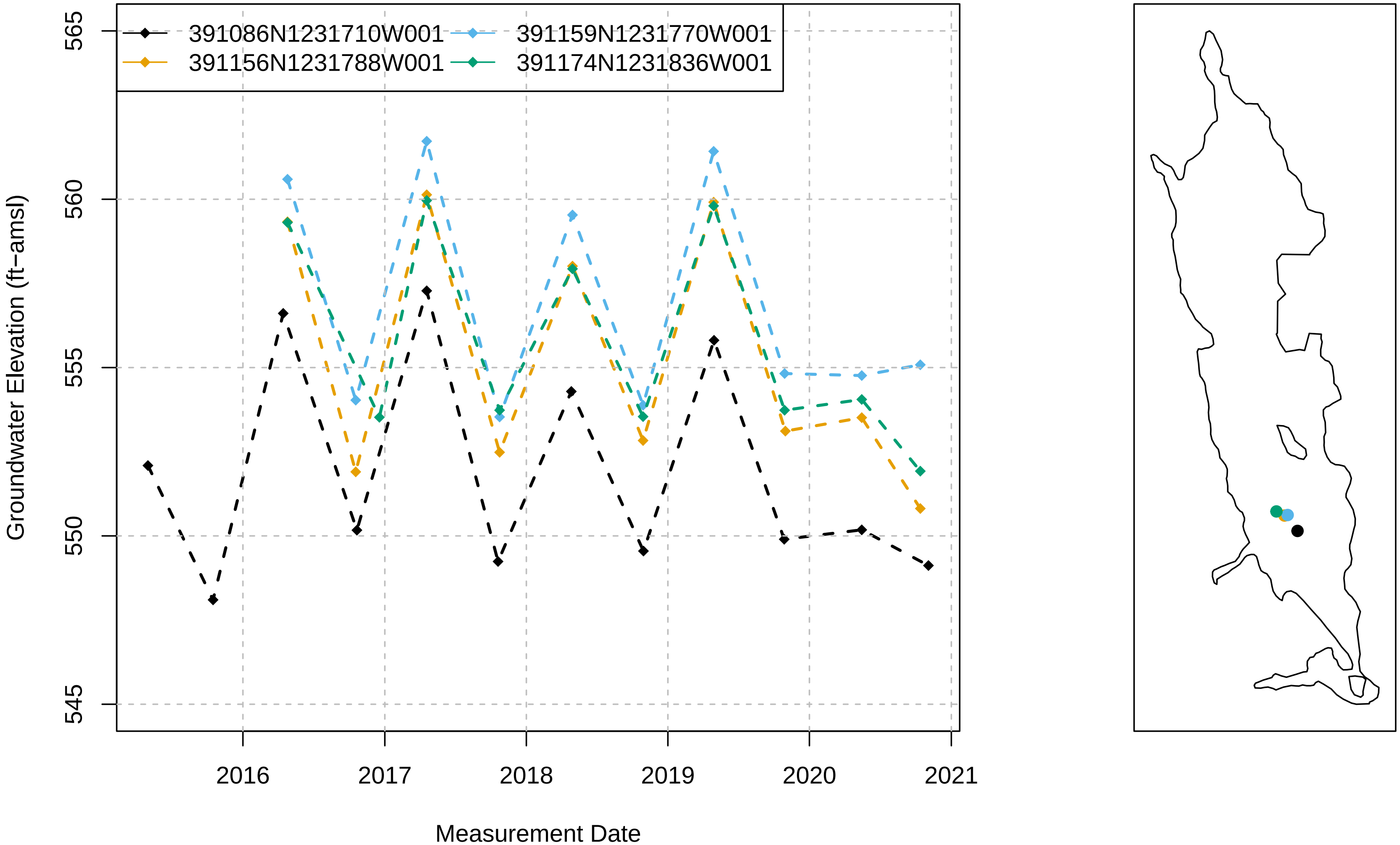

Figure 2.39: Groundwater elevations in the southern Ukiah Valley region, in feet amsl, for selected CASGEM wells screened in Aquifer II - Terrace Deposits.

Table 2.19: Groundwater elevation in feet amsl for the nested wells in the Ukiah Valley Groundwater Basin

	South of Lake Mendocino		North of the town of Calpella	
	UV-1	Average of UV-2, UV-3, and UV-4	Ukiah Valley-16	Average of UV-17 and UV-18
Monitoring Season	Aquifer I	Aquifer II-Average of Wells	Aquifer I	Aquifer II-Average of Wells
Fall - 2014	602.8	593.3	681.9	650.3
Fall - 2015	594.8	588.4	682.9	652.5
Spring - 2015	602.0	591.1	685.6	653.3
Fall - 2016	597.3	587.9	684.0	657.3
Spring - 2016	603.0	592.1	688.9	655.7
Fall - 2017	598.1	587.5	684.1	653.8
Spring - 2017	606.5	593.5	690.4	681.2
Fall - 2018	597.2	589.3	683.2	654.7
Spring - 2018	605.2	594.8	686.5	656.6
Fall - 2019	598.2	590.5	685.3	660.6
Spring - 2019	606.4	593.7	688.5	657.5

2.2.2.2 Change in Groundwater Storage

As discussed in **Section 2.2.1.4**, available storage in principal aquifers was estimated in the existing literature to be between 60,000 to 120,000 acre-feet per year (74 to 148 million cubic meters per year) for Aquifer I and 324,000 acre-feet (275.6 million cubic meters per year) for Aquifer II (DWR, 2016a; Farrar, 1986).

The Ukiah Valley Integrated Hydrological Model (UVIHM) was used to estimate the historical change in storage of the Basin for water years 1992-2018.[11] During this period, as shown in **Figure 2.40**, storage in the Basin has changed following water year types and precipitation patterns, decreasing during dry periods and increasing during above normal to wet periods. These changes to storage are not significant as the estimated cumulative storage change in the Basin does not reach or exceed 1,500 acre-feet during this period.

It is important to highlight how the cumulative change in storage resembles the pattern of the annual precipitation, suggesting the possibility that the precipitation term has an important role in controlling results for the change in storage (see **Figure 2.72**). It is also important to consider model uncertainties and data gaps, as outlined in **Appendix 2-E**, when analyzing storage estimates. However, previous literature and available groundwater elevation data discussed in **Section 2.2.2.1** support the assertion that the Basin has not experienced a significant reduction in storage historically and decreases in available water in storage due to prolonged dry periods were counterbalanced during wet periods.

[11]The UVIHM historical period was defined as 1991-2018, but the first few years are skipped as they fall into the model warmup period and are not illustrated in the historical results of this chapter. For more information on UVIHM and historical simulation, refer to **Appendix 2-D**.

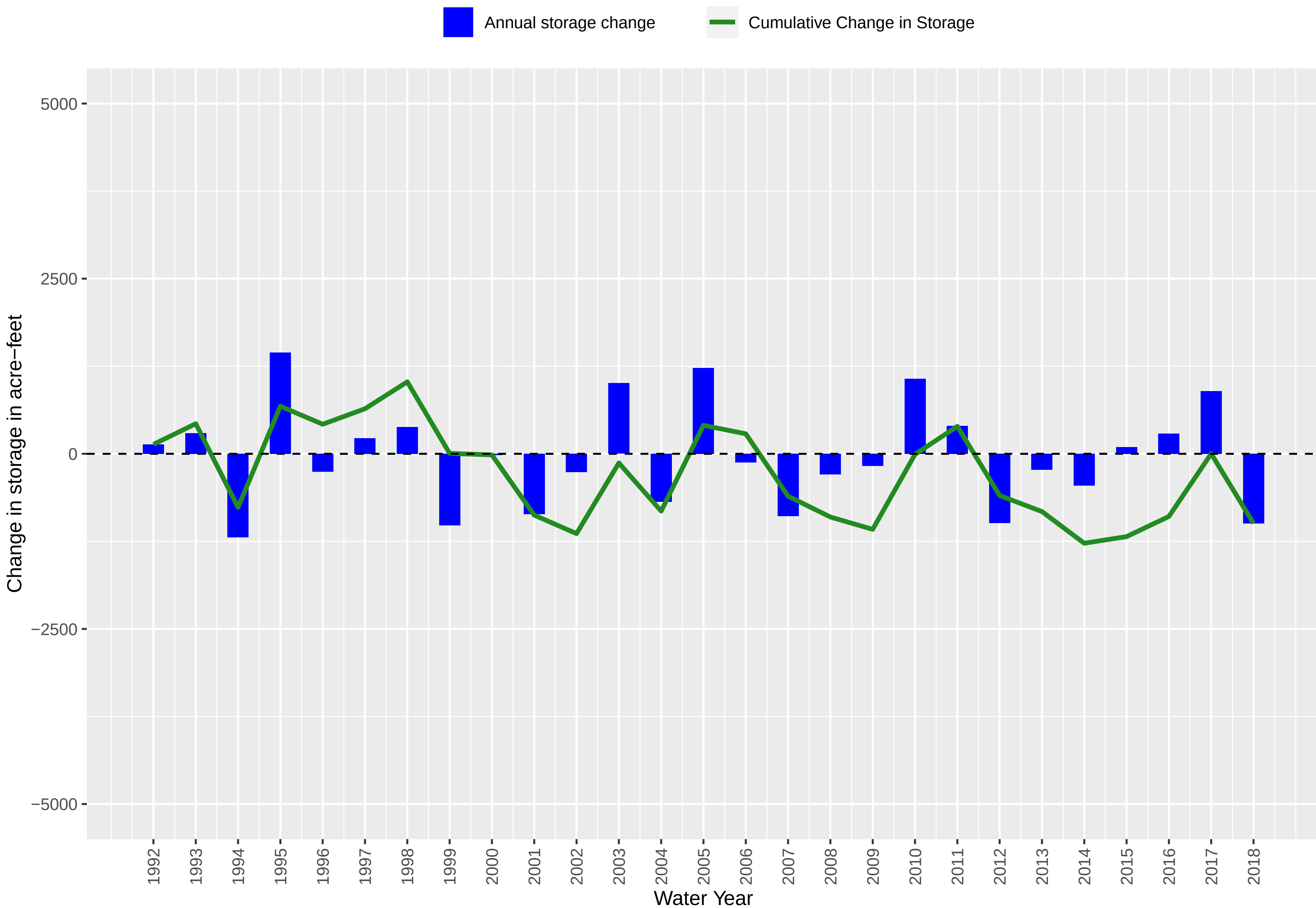

Figure 2.40: Change in groundwater storage in Ukiah Valley Groundwater Basin in water years 1992-2019.

2.2.2.3 Seawater Intrusion

Due to the distance between the Ukiah Valley Groundwater Basin and the Pacific Ocean, seawater intrusion is not evident nor of concern and therefore, is not applicable to the Basin.

2.2.2.4 Groundwater Quality

SGMA regulations require that the following be presented in the GSP, per §354.16 (d): Groundwater quality issues that may affect the supply and beneficial uses of groundwater including a description and map of the location of known groundwater contamination sites and plumes.

Basin Overview

Water quality includes the physical, biological, chemical, and radiological quality of water. The most important physical property of water quality is temperature. An example of a biological water quality constituent is *Escherichia coli (E. coli)* bacteria, commonly used as an indicator species for fecal waste contamination. Radiological water quality parameters measure the radioactivity of water. Chemical water quality refers to the concentration of thousands of natural and manufactured inorganic and organic chemicals. All groundwater naturally contains some microbial matter, chemicals, and has usually low levels of radioactivity. Inorganic chemicals that make up more than 90% of the total dissolved solids (TDS) in groundwater include calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^{+}), potassium (K^{+}), chloride (Cl^{-}), bicarbonate ($HCO3^{-}$), and sulfate ($SO4^{2-}$) ions. Water with a TDS content of less than 1,000 mg/L is generally referred to as “freshwater.” Brackish water has a TDS concentration between 1,000 mg/L and 10,000 mg/L. In saline water, TDS exceeds 10,000 mg/L. Water hardness typically refers to the concentration of calcium and magnesium cations in water.

When one or multiple constituents become a concern for either ecosystem health, human consumption, industrial or commercial uses, or for agricultural uses, the water quality constituent of interest becomes a “pollutant” or “contaminant.” Groundwater quality is influenced by many factors – polluted or not – including elevation, climate, soil types, hydrogeology, and human activities. Water quality constituents are therefore often categorized as naturally occurring, point source, or non-point source pollutants, depending on whether water quality is the result of natural processes, of contamination from anthropogenic point sources, or originates from diffuse (non-point) sources that are the result of human activity.

A 1965 study evaluated water quality of five hydrographic units, including the Russian River hydrographic unit, and identified boron, hardness, and electrical conductivity as focus areas for further evaluation (Fisher et al., 1965). The study found that the mineral characteristics of water supplies throughout the study area are suitable for beneficial uses. While groundwater throughout this hydrographic unit had mineral types similar to associated surface waters, concentrations were approximately four times greater than surface waters. Groundwater was moderately hard and contained moderate concentrations of total dissolved minerals along with high concentrations of boron. With the exception of their boron content, surface and subsurface waters of the hydrographic unit typically had an excellent mineral quality.

The content of chemical constituents in the Basin varies significantly on a local basis. The southern portion of the Basin contains calcium-bicarbonate groundwater, while the east-central portion of the Basin has magnesium-bicarbonate water. The recent formations of Quaternary Alluvium have slightly higher TDS and chloride levels than Russian River water (Cardwell, 1965). During the baseflow season (late spring to early fall), Lake Mendocino greatly influences specific conductance, total nitrate, and turbidity in the Russian River. During the wet season, Russian River water quality is influenced by stormwater flows that increase turbidity and suspended solid content along with surface runoff pollutants.

Groundwater in the Basin is generally of good quality and has relatively consistent water quality characteristics which meet local needs for municipal, domestic, and agricultural uses. Ongoing monitoring programs show that some constituents, including boron, iron, and manganese exceed water quality standards in parts of the Basin. According to Fisher et al. (1965), the groundwater produced from Aquifer II shows higher levels of TDS than Aquifer I. Exceedances may be caused by localized conditions and may not be reflective of regional water quality. In addition, there are potential risks of increasing salt and nutrient conditions from agricultural and municipal uses of water. Across the majority of the Basin, salt and nutrient concentrations are below levels of concern, with no upward trends, as described below. A few isolated areas show higher concentrations.

A summary of information and methods used to assess current groundwater quality in the Basin as well as key findings, are presented below. A detailed description of information, methods, and all findings of the assessment can be found in **Appendix 2-F** – Water Quality Assessment.

Existing Water Quality Monitoring Networks

Water quality data of at least one constituent – sometimes many - are available for some wells in the Basin but not most. Of those wells for which water quality data are available, most have only been tested once, but some are or have been tested multiple times, and in few cases are tested on a regular basis (e.g. annual, monthly). The same well may have been tested for different purposes (e.g., research, regulatory, or to provide owner information), but most often, regulatory programs drive water quality testing.

For this GSP, all existing water quality data were grouped first by well. All available data were collated, whatever the source or purpose for each well for which data are available and assign it to the well from which the water sample was collected. In a second step, wells were grouped into the following "monitoring networks":

- *Public water supply wells:* A public water system well provides water for human consumption including domestic, industrial, or commercial uses to at least 15 service connections or serves an average of at least 25 people for at least 60 days a year. A public water system may be publicly or privately owned. These wells are tested at regular intervals for a variety of water quality constituents. Data are publicly available through online databases.

- *State small water supply wells:* Wells providing water for human consumption, serving 5 to 14 connections. These wells are tested at regular intervals – but less often than public water supply wells – for bacteriological indicators and salinity. Data are publicly available through the CIWQS database.

- *Domestic wells:* For purposes of this GSP, this well type category includes wells serving water for human consumption in a single household or for up to 4 connections. These wells are not typically tested. When tested, test results are not typically reported in publicly available databases, except for individual studies or research projects.

- *Agricultural wells:* Wells that provide irrigation water, stock water, or water for other agricultural uses, but are not typically used for human consumption. When tested, test results are not typically reported in publicly available databases, except for individual studies or research projects.

- *Contamination site monitoring wells:* Monitoring wells installed at regulated hazardous waste and other potential contamination sites (e.g., landfills) for the purpose of site characterization, site remediation, and regulatory compliance. These wells are typically completed with 2 inces (in; 5 centimeters [cm]) or 4 in (10 cm) diameter PVC pipes and with screens at or near the water table. They may have multiple completion depths (multi-level monitoring), but depths typically do not exceed 200 ft (60 m) below the water table. Water samples are collected at frequent intervals (monthly, quarterly, annually) and analyzed for a wide range of constituents related to the type of contamination associated with the hazardous waste site.

- *Research monitoring wells:* Monitoring wells installed primarily for research, studies, information collection, ambient water quality monitoring, or other purposes. These wells are typically completed with 2 in (5 cm) or 4 in (10 cm) diameter PVC pipes and with screens at or near the water table. They may have multiple completion depths (multi-level monitoring), but depths typically do not exceed 200 ft (60 m) below the water table.

Data Sources for Characterizing Groundwater Quality

The assessment of groundwater quality for the Basin was prepared using available information obtained from the California Groundwater Ambient Monitoring and Assessment (GAMA) Program database, which includes water quality information collected by DWR; SWRCB, DDW; and USGS. These data were augmented with data supplied by the Department of Health Services (DHS) and data submitted to the CIWQS by permittees. In addition to utilizing GeoTracker GAMA for Basin-wide water quality assessment, GeoTracker was searched individually to identify data associated with groundwater contaminant plumes. Groundwater quality data, as reported in GeoTracker GAMA, have been collected in the Basin since 1950. **Figure 2.41** shows the Basin boundary, locations, and density of wells with available water quality data for the GSP constituents of interest collected in the past 30 years (1990–2020). Within the Basin, a total of 176 wells were identified and used to characterize water quality based on a data screening and evaluation process that identified constituents of interest important to sustainable groundwater management.

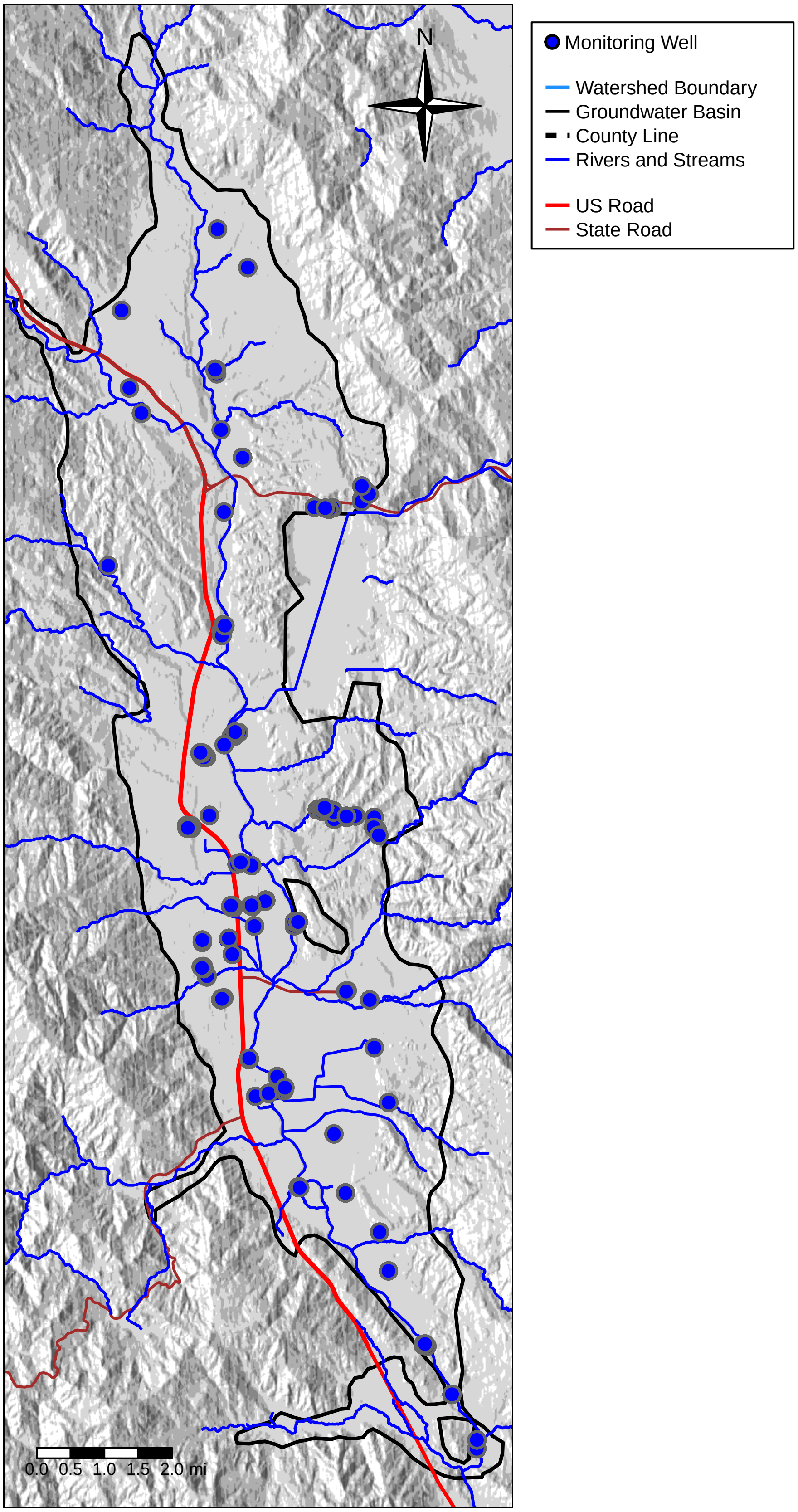

Figure 2.41: Spatial distribution of wells with measured water quality data within the Basin.

Classification of Water Quality

To determine what groundwater quality constituents in the Basin may be of current or near-future concern, a reference standard was defined to which groundwater quality data were compared. Numeric thresholds are set by state and federal agencies to protect water users (environment, humans, industrial and agricultural users). The numeric standards selected for the current analysis represent all relevant state and federal drinking water standards and state water quality objectives for the constituents evaluated and are consistent with state and Regional Water Board assessment of beneficial use protection in groundwater. The standards are compared against groundwater quality data to determine if a constituent's concentration exists above or below the threshold and is currently impairing or may impair beneficial uses designated for groundwater at some point in the foreseeable future.

Although groundwater is utilized for a variety of purposes, the use for human consumption requires that supplies meet strict water quality regulations. The federal Safe Drinking Water Act (SDWA) protects surface water and groundwater drinking water supplies. The SDWA requires the United States Environmental Protection Agency (USEPA) to develop enforceable water quality standards for public water systems. The regulatory standards are named maximum contaminant levels (MCLs) and they dictate the maximum concentration at which a specific constituent may be present in potable water sources. There are two categories of MCLs: Primary MCLs, which are established based on human health effects from contaminants and are enforceable standards for public water supply wells and state small water supply wells; and Secondary MCLs (SMCLs), which are unenforceable standards established for contaminants that may negatively affect the aesthetics of drinking water quality, such as taste, odor, or appearance.

The State of California has developed drinking water standards that, for some constituents, are stricter than those set at the federal level. The Basin is regulated under the North Coast Regional Water Quality Control Board (NCRWQCB) and relevant water quality objectives (WQOs) and beneficial uses are contained in the Water Quality Control Plan for the North Coast Region (Basin Plan). For waters designated as having a Municipal and Domestic Supply (MUN) beneficial use, the Basin Plan specifies that chemical constituents are not to exceed the Primary and Secondary MCLs established in Title 22 of the California Code of Regulations (CCR) (hereafter, Title 22).

Constituents may have one or more applicable drinking water standards or WQOs; for this GSP, a prioritization system was used to select the appropriate numeric threshold. The strictest value among the state and federal drinking water standards was used for comparison against available groundwater data. Constituents that do not have an established drinking water standard or WQO were not assessed with the exception boron which currently has notification levels set by California DDW. The complete list of constituents, numeric thresholds, and associated regulatory sources used in the water quality assessment can be found in **Appendix 2-F**. Basin groundwater quality data obtained for each well selected for evaluation were compared to a relevant numeric threshold.

Maps were generated for each constituent of interest showing well locations and the number of measurements for a constituent collected at a well. Groundwater quality data were further identified as a) not detected, b) detected below half of the relevant numeric threshold, c) detected below the relevant numeric threshold, and d) detected above the relevant numeric threshold.

To analyze groundwater quality that is representative of current conditions in the Basin, several additional filters were applied to the dataset. Though groundwater quality data are available dating back to 1950 for some constituents, the data evaluated were limited to those collected from 1990 to 2020. Restricting the time span to data collected in the past 30 years increases confidence in data quality and focuses the evaluation on information that is considered reflective of current groundwater quality conditions. A separate series of maps was generated for each constituent of interest showing well locations and the number of groundwater quality samples collected among the wells during the past 30 years (1990-2020) (see **Appendix 2-F**).

Finally, for each constituent, an effort was undertaken to examine changes in groundwater quality over time at a location. Constituent data collected in the past 30 years (1990-2020) were further limited to wells that have three or more water quality measurements. A final series of maps and timeseries plots showing data collected from 1990 to 2020 were generated for each constituent and well combination showing how data compare to relevant numeric thresholds. These maps and timeseries plots for each constituent of interest are provided in **Appendix 2-F**.

The approach described above was used to consider all constituents of interest and characterize groundwater quality in the Basin. **Appendix 2-F** contains additional detailed information on the methodology used to assess groundwater quality data in the Basin.

Table 2.20: Regulatory water quality thresholds for constituents of interest in the Ukiah Valley Groundwater Basin

Constituent	Water Quality Threshold	Regulatory Basis
Boron	1 mg/L	California Division of Drinking Water
Iron	300 micrograms/Litre (µg/L)	Title 22
Manganese	50 µg/L	Title 22
Nitrate as Nitrogen (N)	10 mg/L	Title 22
Specific Conductivity	900 micromhos	Title 22

Basin Groundwater Quality

All groundwater quality constituents monitored in the Basin that have a numeric threshold were initially considered. The evaluation process described above showed the following parameters to be important to sustainable groundwater management in the Basin: boron, iron, manganese, nitrate and specific conductivity. While the latter two do not historically show exceedances of their respective MCLs, they are important for tracking sustainability in the future. The following subsections present information on these water quality parameters in comparison to their relevant regulatory thresholds and how the constituent may potentially impact designated beneficial uses in different regions of the Basin. **Table 2.20** provides the list of constituents of interest identified for the Basin and their associated regulatory threshold.

Boron

Boron in groundwater can come from both natural and anthropogenic sources. As a naturally occurring element in rocks and soil, boron can be released into groundwater through weathering processes. Boron can be released into the air, water or soil from anthropogenic sources including industrial wastes, sewage and fertilizers. If ingested at high levels, boron can affect the stomach, liver, kidney, intestines and brain (ATSDR, 2010). California DDW has identified a notification level of 1.0 mg/L for boron.

In Aquifer I, there is only one well (Well 2310006-009, measured by DHS) with historically measured boron concentrations data and there is no exceedance from the notification level at this well. In the east-central portion of the Basin within Aquifer II, 18 wells used by the State Water Board for site cleanup purposes have historical boron concentrations data and the notification level is exceeded at all these wells.

Figure 2.42 shows the locations of these wells along with the number of times concentrations have or have not exceeded the notification level. Additionally, **Figures 2.43**, **2.44**, and **2.45** show the time series associated with boron concentrations at each of these wells. While there is no exceedance from the notification level in Aquifer I, about 67% of measured concentrations of this constituent in Aquifer II tend to exceed the notification level and 13% exceed half but not the whole notification level. All of these exceedances are locally occurring within a limited area overlaid by the City of Ukiah Solid Waste Disposal Site and the measurements have been taken due to the existence of this clean up site. However, boron concentrations below the notification level in Aquifer I and its high concentrations in Aquifer II suggest that boron is primarily a naturally occurring constituent in the Basin.

Aquifer II
Boron, Total Wells = 18
NL = 1 mg/L from
California Division of Drinking Water

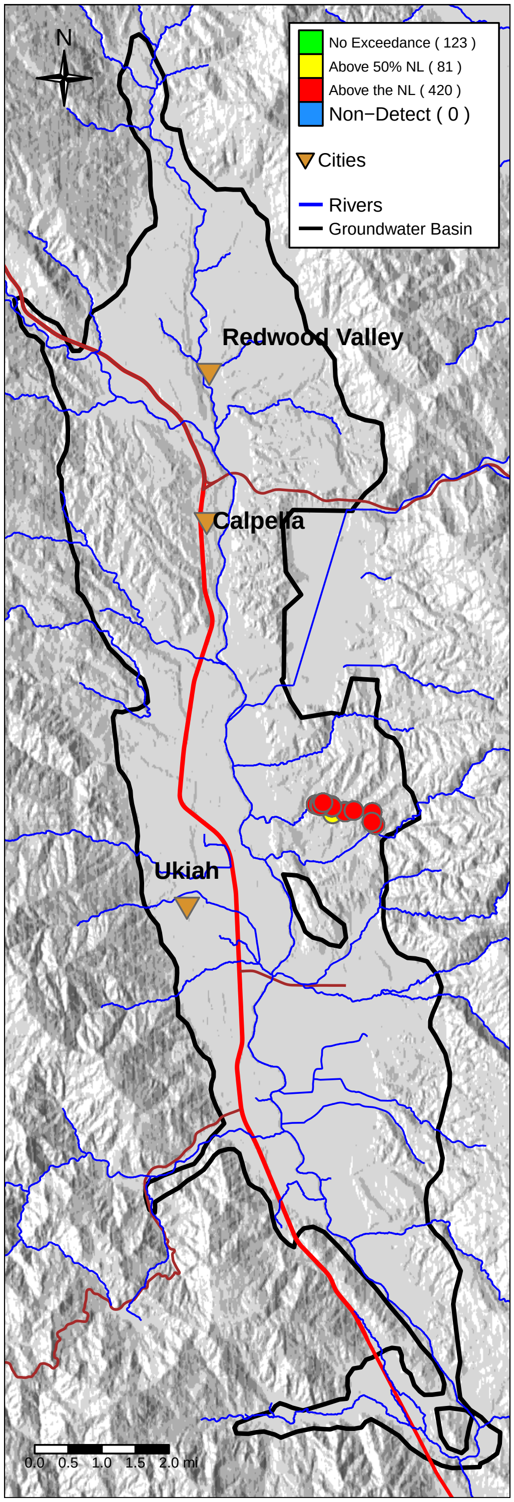

Figure 2.42: Wells with measured boron concentration data in Aquifer II within the Basin.

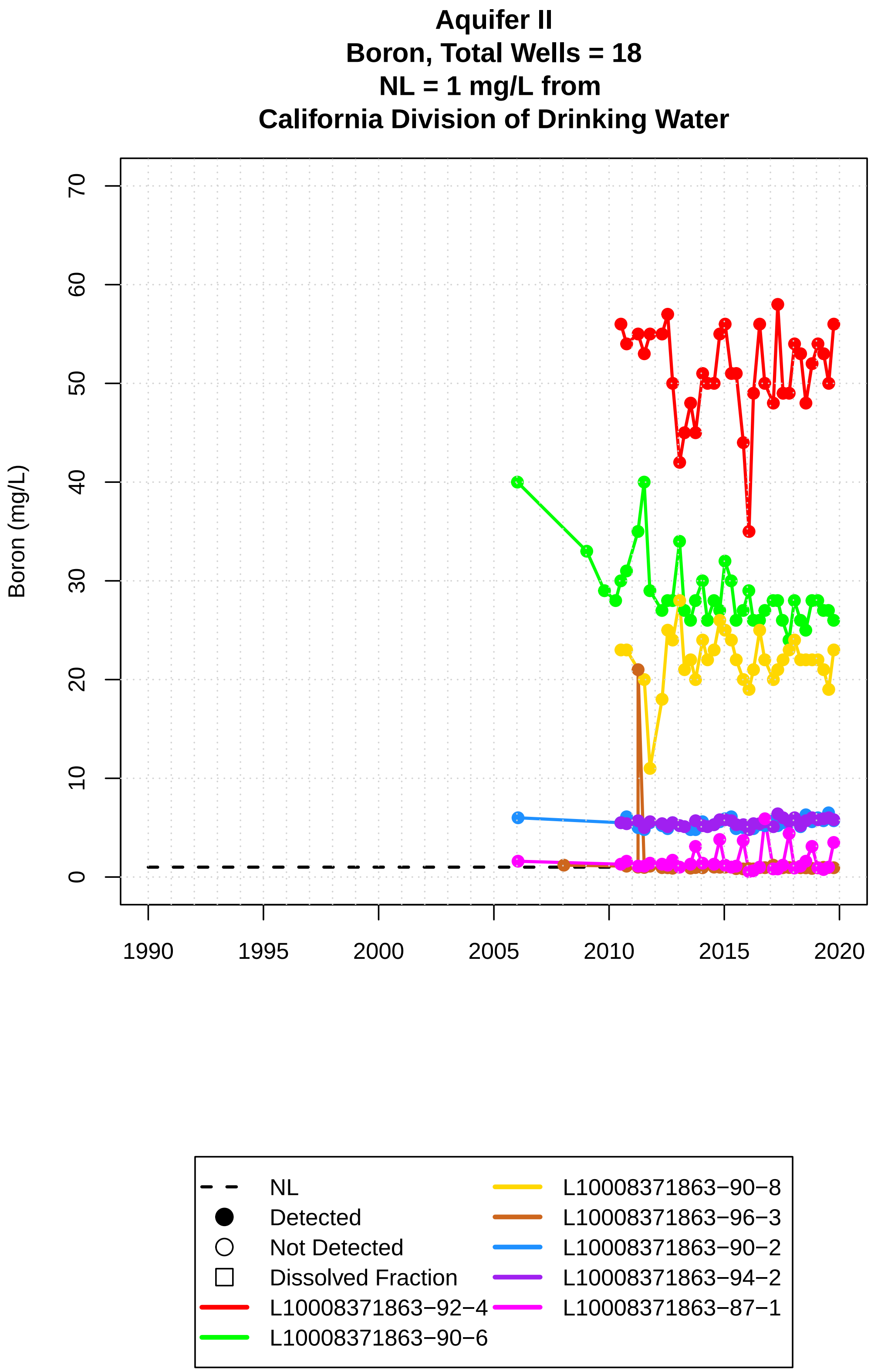

Figure 2.43: Boron concentration timeseries at wells in Aquifer II.

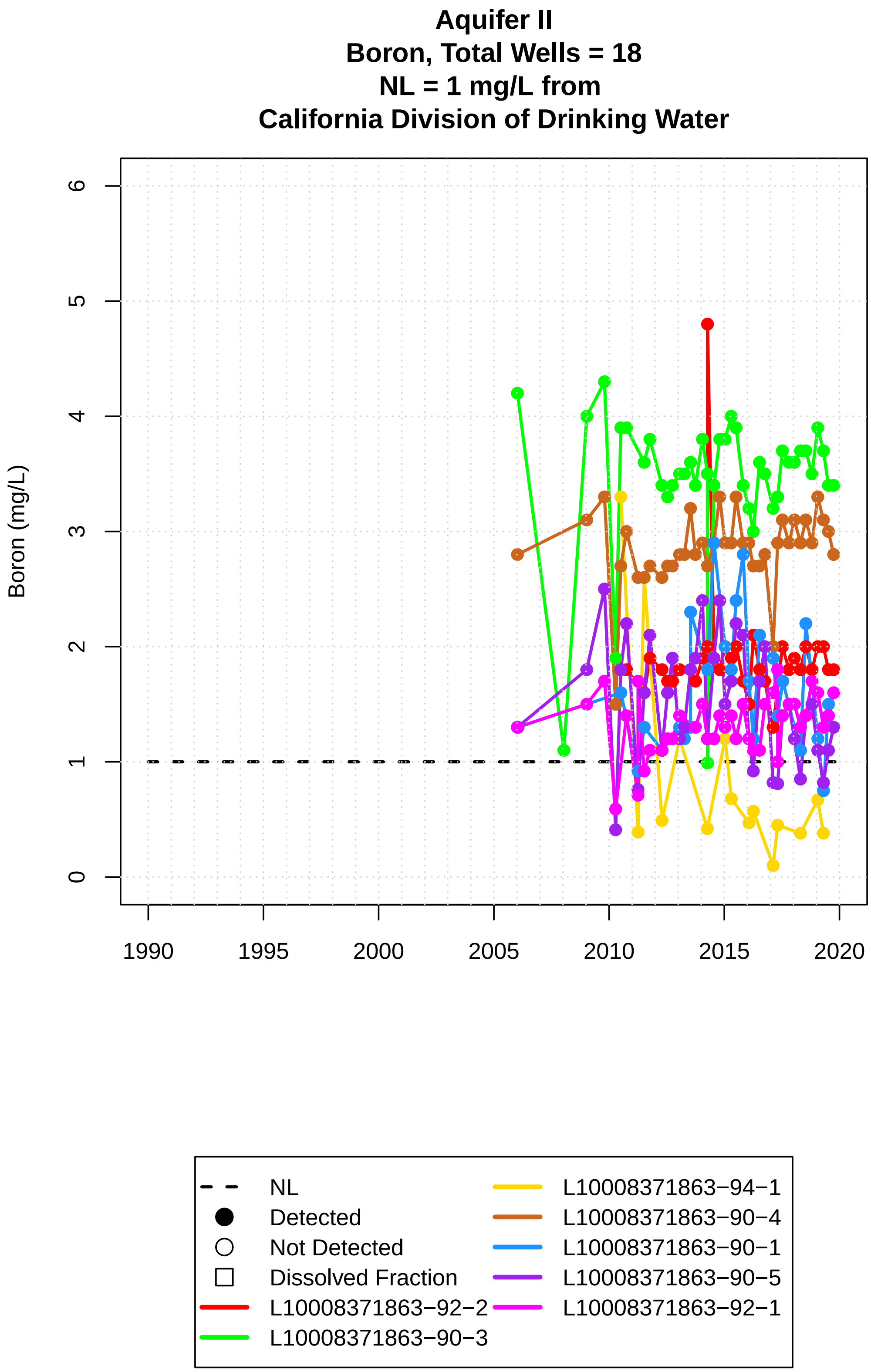

Figure 2.44: Boron concentration timeseries at wells in Aquifer II.

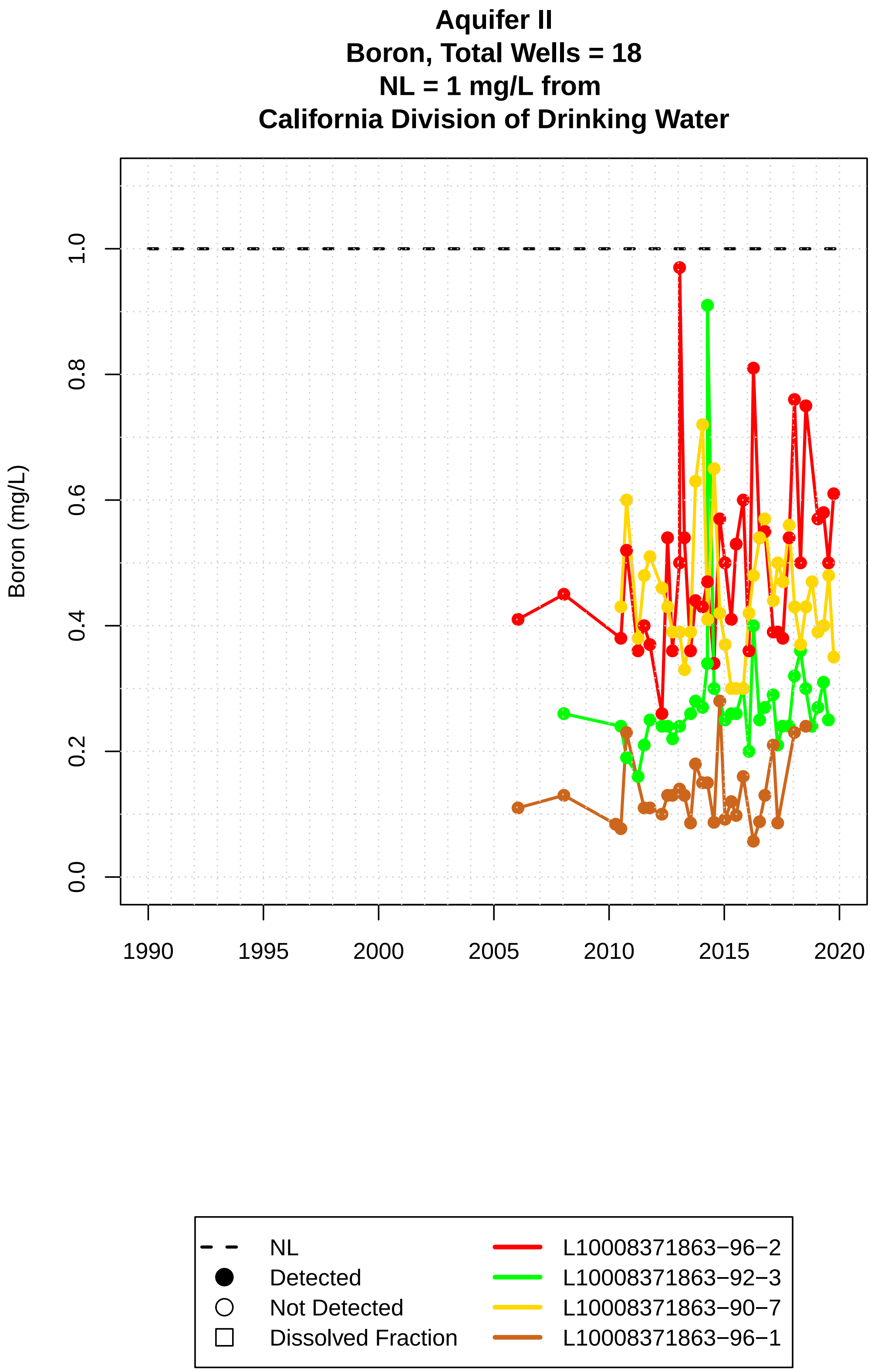

Figure 2.45: Boron concentration timeseries at wells in Aquifer II.

Iron and Manganese

Iron and manganese are geogenic metals and occur naturally in groundwater. As abundant metal elements in rocks and sediments, iron and manganese can be mobilized under favorable geochemical conditions. Under oxygen-limited conditions, iron and manganese are in the dissolved phase. Anthropogenic sources of iron and manganese can include waste from human activities including industrial effluent, mine waste, sewage and landfills. As essential nutrients for human health, iron and manganese are only toxic at very high concentrations. Concerns with iron and manganese in groundwater are commonly related to the aesthetics of water and the potential to form deposits in pipes and equipment. The Title 22 SMCLs, for iron and manganese are 300 μg/L and 50 μg/L, respectively.

Review and analysis of historical iron and manganese concentrations show only a few exceedances from the Title 22 SMCLs in Aquifer I, which has seven wells with iron and manganese concentrations data. These wells are mainly located in the southern half of the Basin. Exceedances from iron SMCL in Aquifer I occur at a well east of the City of Ukiah close to the main stem of the Russian River and another one in the southern part of the Basin (**Figure 2.46(A)**). The latter well also shows exceedances of the manganese SMCL.

Concentrations of iron and manganese tend to frequently exceed their corresponding SMCLs in Aquifer II in the east-central portion of the Basin, in both North and South of Lake Mendocino. About 75% of measured concentrations exceed the SMCLs for iron and approximately 84% of measured concentrations exceed the SMCLs for manganese, while there are about 10% half but not the full SMCLs for these constituents. **Figures 2.46(B)** and **2.47** show the location of these wells and number of exceedances. Similar to boron, the relatively low number of exceedances of iron and manganese SMCLs observed in Aquifer I when compared to significantly more frequent exceedances in Aquifer II suggest that these constituents are primarily naturally occurring in the Basin.

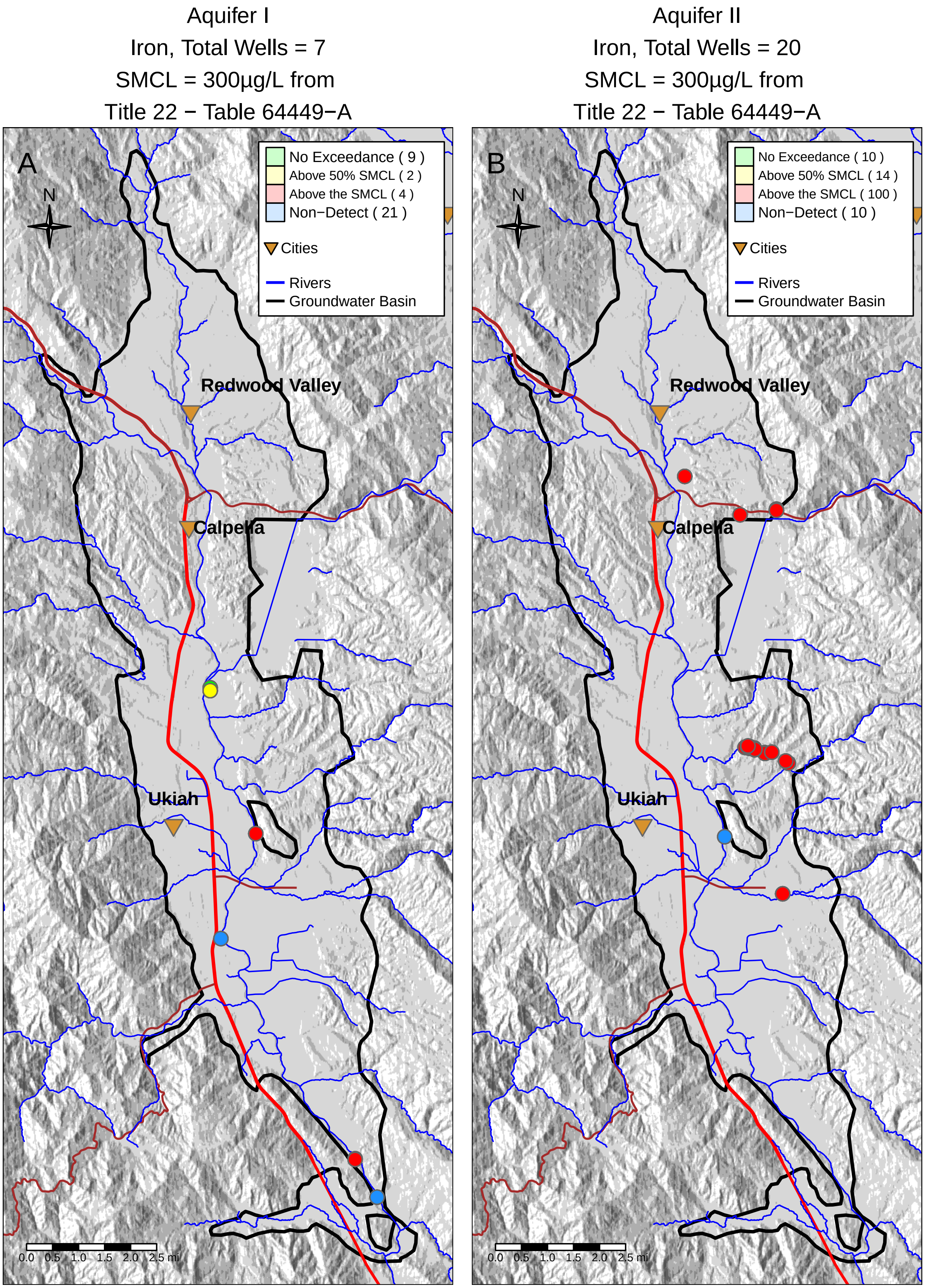

Figure 2.46: Wells with measured iron concentration data in (A) Aquifer I and (B) Aquifer II within the Basin.

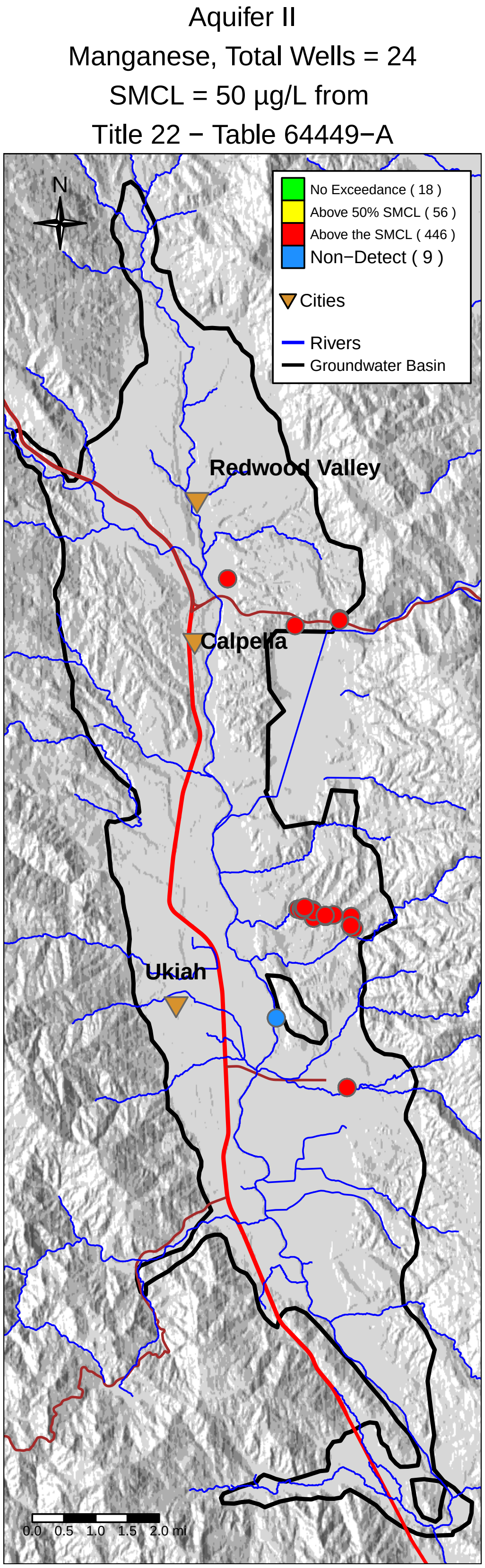

Figure 2.47: Wells with measured manganese concentration data in Aquifer II within the Basin.

Nitrate

Nitrate is one of the most common groundwater contaminants and is generally the water quality constituent of greatest concern. Natural concentrations of nitrate in groundwater are generally low. In agricultural areas, application of fertilizers or animal waste containing nitrogen can lead to elevated nitrate levels in groundwater. Other anthropogenic sources, including septic tanks, wastewater discharges, and agricultural wastewater ponds may also lead to elevated nitrate levels. Nitrate poses a human health risk, particularly for infants under the age of 6 months who are susceptible to methemoglobinemia, a condition that affects the ability of red blood cells to carry and distribute oxygen to the body. The MCL for nitrate is 10 milligrams per liter as nitrogen (mg/L as N).

There is generally no water quality concern associated with nitrate concentrations within the Basin. While wells measuring nitrate concentrations screened in Aquifer I are mainly located in the southern half of the Basin, those screened in Aquifer II cover the east-central portion of the Basin. Aside from a few instances when nitrate concentrations exceed half of the MCL, there are no exceedances from the nitrate MCL within the Basin. **Figure 2.48** shows the location of wells with nitrate data in each aquifer and the corresponding number of measurements.

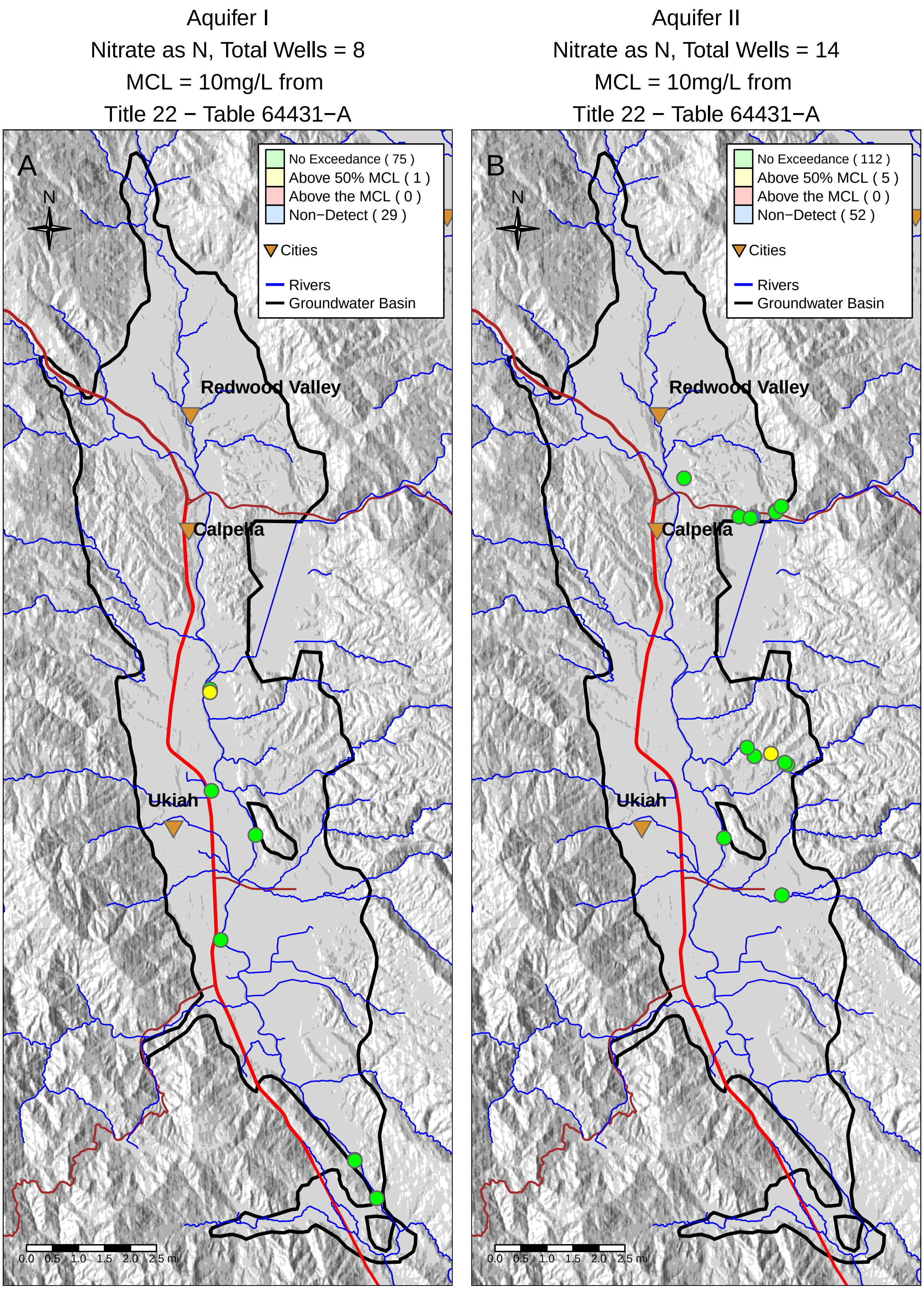

Figure 2.48: Wells with measured nitrate concentration data in (A) Aquifer I and (B) Aquifer II within the Basin.

Specific conductivity

Specific conductivity (electrical conductivity normalized to a temperature of 25°C) quantifies the ability of an electric current to pass through water and is an indirect measure of the dissolved ions in the water. Natural and anthropogenic sources contribute to variations in specific conductivity in groundwater. Increases of specific conductivity in groundwater can be due to the dissolution of rock and organic material and uptake of water by plants as well as anthropogenic activities including the application of fertilizers, discharges of wastewater and discharges from septic systems or industrial facilities. High specific conductivity can be problematic as it can have adverse effects on plant growth and drinking water quality.

Except for a few slight exceedances from the recommended SMCL for specific conductivity in Aquifer II, there are generally no exceedances in the other aquifers across the Basin. The two wells at which specific conductivity exceeds the SMCL are located just north of Lake Mendocino as shown in **Figure 2.49**. **Figure 2.50** shows the corresponding timeseries.

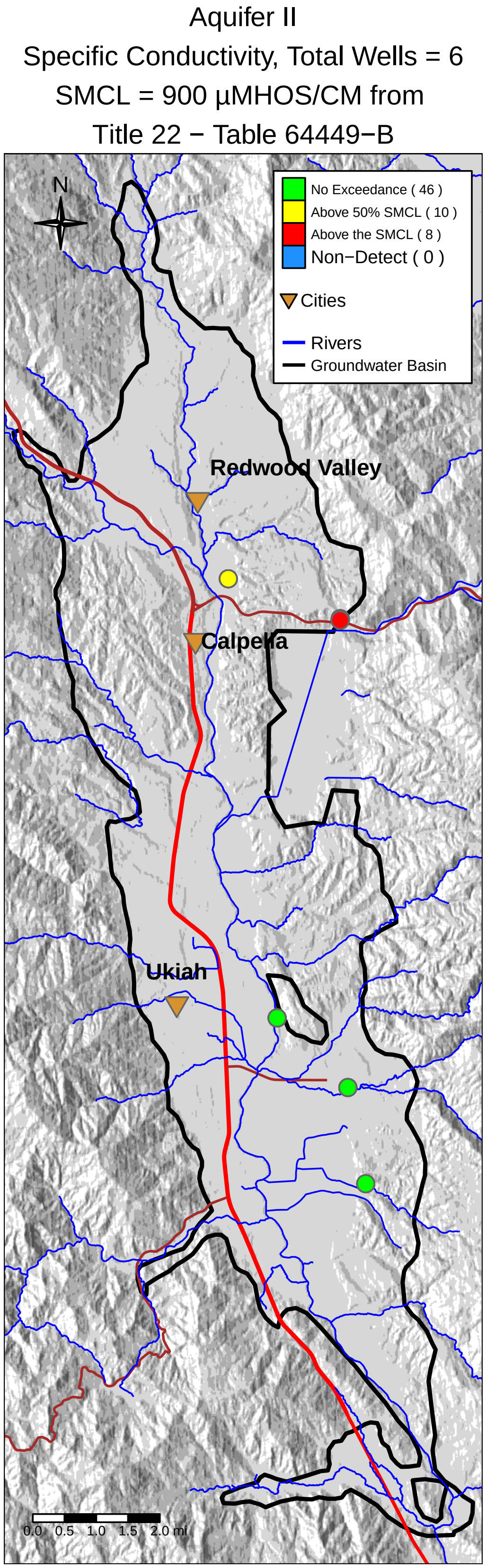

Figure 2.49: Wells with measured specific conductivity concentration data in Aquifer II within the Basin.

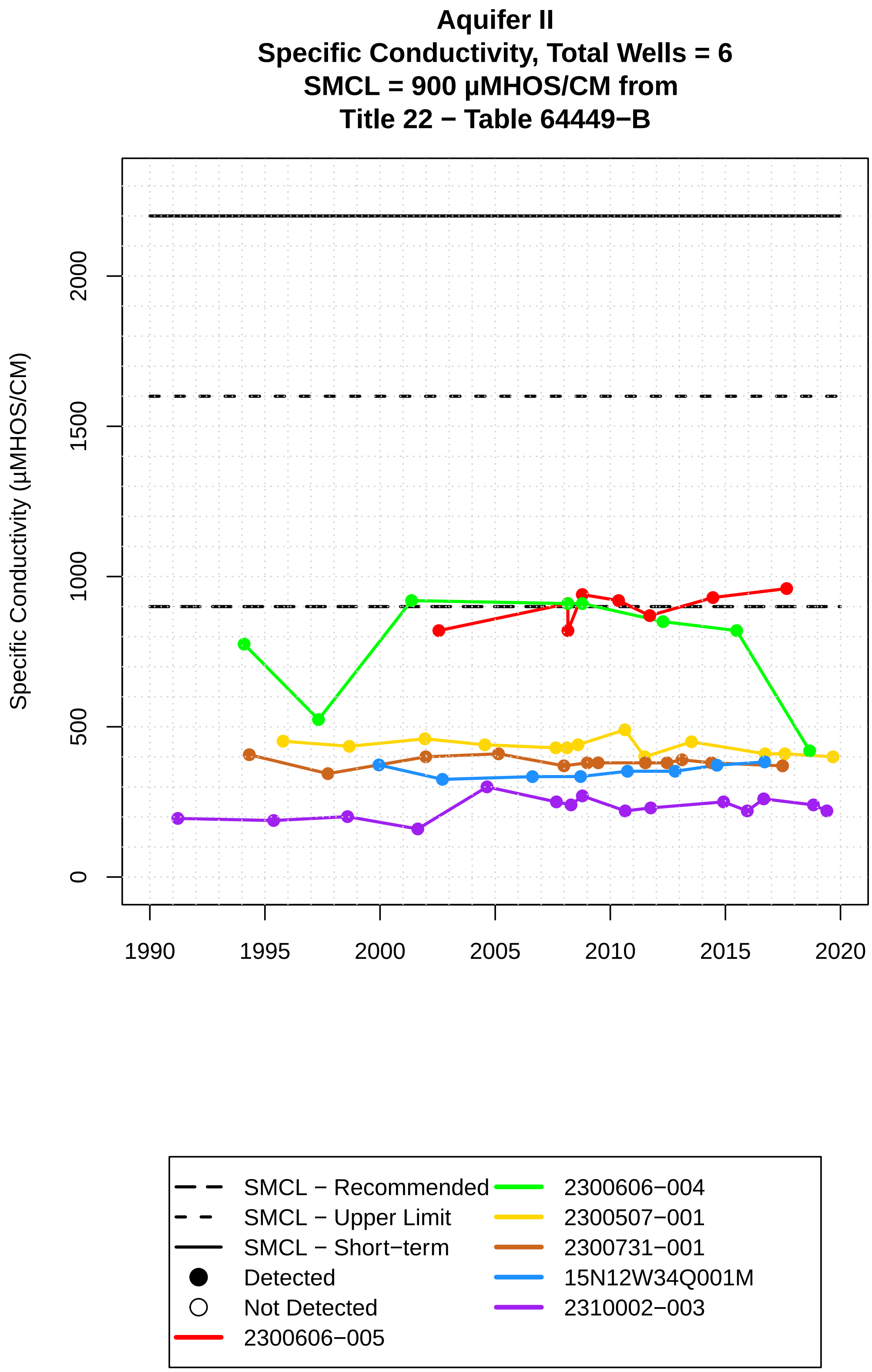

Figure 2.50: Specific conductivity concentration timeseries at wells in Aquifer II.

Contaminated Sites

Groundwater monitoring activities also take place in the Basin in response to known and potential sources of groundwater contamination including from LUST sites. These sites are subject to oversight by regulatory entities, and any monitoring associated with these sites can provide information and opportunities to improve the regional understanding of groundwater quality.

To identify known plumes and contamination within the Basin, SWRCB GeoTracker was reviewed for active clean-up sites of all types. The GeoTracker database shows that there are open LUST Cleanup Sites, Cleanup Program Sites and DTSC Cleanup Sites within the Basin.

A brief overview of notable information is provided below; however, an extensive summary for each of the contamination sites is not presented.

Underground storage tanks (UST) are containers and tanks, including piping, that are completely or significantly below ground and are used to store petroleum or other hazardous substances. Soil, groundwater and surface water near the site can all be affected by releases from USTs. The main constituents of concern due to contamination plumes in the Basin are tetrachloroethane (PCE) and contaminants associated with releases of gasoline including fuel oxygenates including methyl tertiary butyl ether (MTBE) and benzene, toluene, ethylbenzene and xylenes (BTEX), as well as lead scavengers including ethylene dibromide (EDB) and 1, 2-dichlororethane. There are nine open LUST sites throughout the Basin, with seven of the nine sites in or near the City of Ukiah. These sites include retail locations, service stations and the City of Ukiah Corporation Yard. The status of the open sites ranges from site assessment to eligible for closure.

Cleanup program sites are regulated by the SWRCB's Site Cleanup Program or a NCRWQCB program and encompass a wide variety of site types and constituents of concern. There are 18 open cleanup program sites within the Basin, with most sites concentrated in or near the City of Ukiah. These sites include cases that have been open dating back to 1981, with three of the 18 sites opened in the last decade. The primary potential contaminants of concern listed at these sites include 1,1,1-trichloroethane (TCA), other chlorinated hydrocarbons, PCE, polynuclear aromatic hydrocarbons (PAHs), gasoline, diesel and other petroleum, non-petroleum hydrocarbons, BTEX compounds, arsenic, chromium and copper. Seven of these sites are open and inactive, meaning that while the sites are open no regulatory actions are currently being conducted by the lead agency, the NCRWQCB. Three of these sites are in the project phase of site assessment, two are under assessment and interim remedial action and two are eligible for closure.

The Geotracker database also includes DTSC sites, also listed on DTSC's EnviroStor database. The DTSC sites include permitted hazardous waste facilities and sites where DTSC participated in the investigation or remediation work. These sites include Federal Superfund sites and State Response sites such as Military Facility and State Superfund Sites among others.

There are nine DTSC sites in the Basin. Of these nine sites, only one has an "active" status, a previous elementary school with a potential contaminant of concern of lead. The other DTSC sites include either have no further action required, have been referred to the RWQCB or are inactive and require action. There is one Federal Superfund Site in the Basin, added by the US Environmental Protection Agency (EPA) in 1983. The cleanup status of this site has been in operation and maintenance since 2011. The potential contaminants of concern at this site, previously an active wood preserving facility are arsenic and hexavalent chromium. Soil remedial goals were met in February of 2020 but groundwater monitoring will continue until remedial goals are met for arsenic, hexavalent chromium and total chromium. **Figure 2.51** shows the locations of all contaminated sites within the Basin.

From a review of all available information, none of the sites listed above have been determined to have an impact on the aquifer and the potential for groundwater pumping to induce contaminant plume movement towards water supply wells is negligible. Currently, there is not enough information to determine if the contaminants are sinking or rising with groundwater levels.

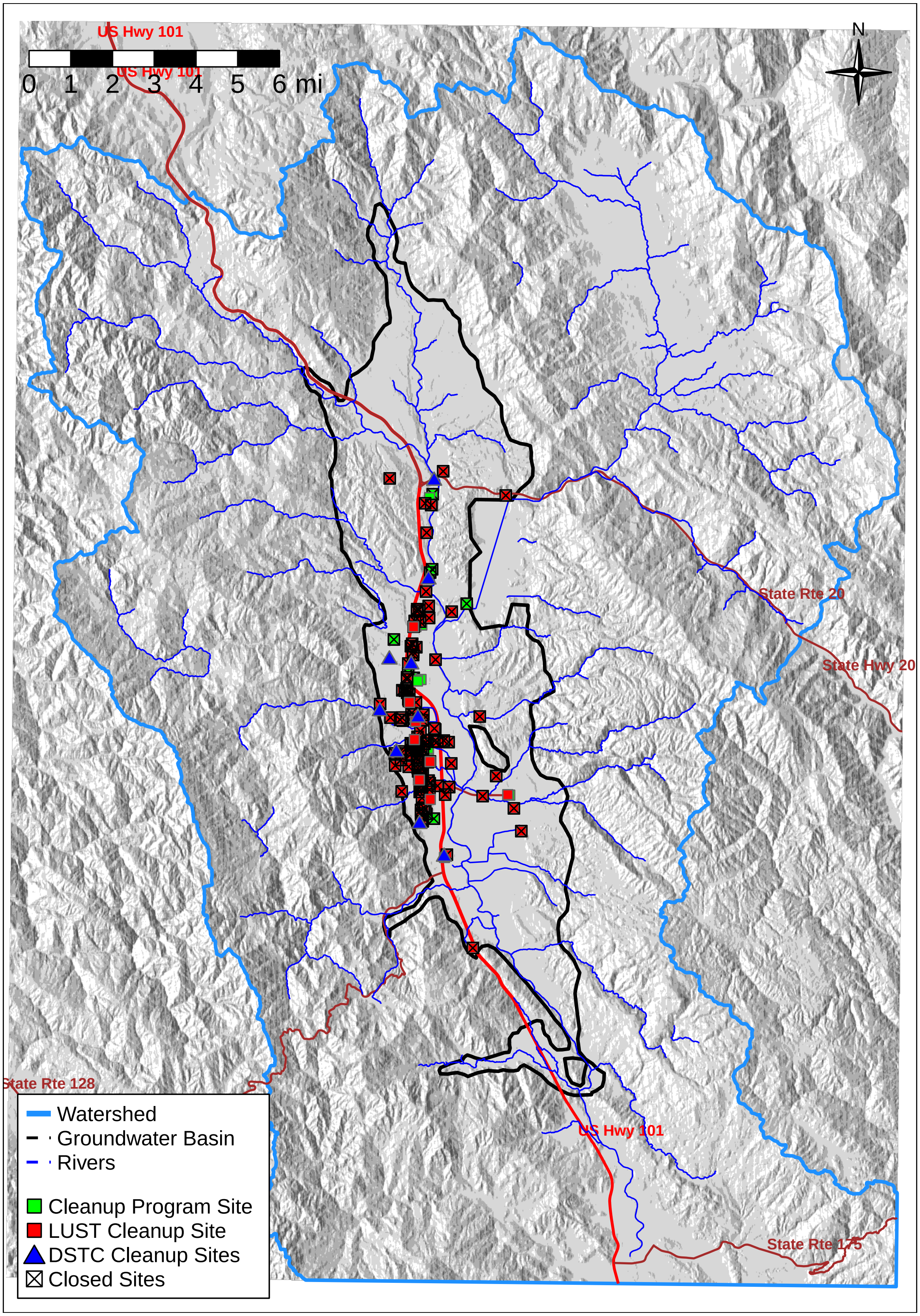

Figure 2.51: Contaminated Sites within the Basin.

2.2.2.5 Land Subsidence

Land subsidence is the lowering of the ground surface elevation. This is often caused by pumping groundwater from below thick clay layers. Land subsidence can be elastic or inelastic. Inelastic subsidence is generally irreversible. Elastic subsidence is small, reversible lowering and rising of the ground surface and can be cyclical with seasonal changes year to year. Land subsidence is not known to be historically or currently significant in the Ukiah Valley.

DWR has made available InSAR satellite data on their SGMA Data Viewer web map as well as downloadable raster datasets that are used to estimate subsidence. These are the only data used for estimating subsidence in this GSP and are the only known subsidence-related dataset for this Basin. The TRE Altamira InSAR dataset provides estimates of total vertical displacement from June 2015 to September 2019 (see **Figure 2.52**).

It should be noted that the InSAR data provided by DWR is subject to measurement error. DWR has stated that, on a statewide level, for the total vertical displacement measurements between June 2015 and September 2019, the errors are as follows (Brezing, personal communication):

1. The error between InSAR data and continuous GPS data is 16 mm (0.052 feet) with a 95% confidence level.
2. The measurement accuracy when converting from the raw InSAR data to the maps provided by DWR is 14 mm (0.048 feet) with a 95% confidence level.

By simply adding errors 1 and 2, the combined error is 0.1 feet (0.03 m). While this is not a robust statistical analysis, it does provide an estimate of the potential error in the InSAR maps provided by DWR. A land surface change of less than 0.1 ft (0.03 m) is therefore within the noise of the data and is not indicative of subsidence in the Basin. Additionally, the InSAR data provided by DWR reflect both elastic and inelastic subsidence. While it is difficult to compensate for elastic subsidence, visual inspection of monthly changes in ground elevations suggest that elastic subsidence is largely seasonal.

Using the TRE Altamira InSAR dataset provided by DWR, it is observed that the majority of the vertical displacement values in the Ukiah Valley are essentially zero, within the range of 0.01 ft (uplift; 0.003 m) to -0.02 ft (-0.006 m; **Figure 2.52**). These values are roughly one order of magnitude smaller than the combined data and raster conversion error and are essentially noise in the data. Any actual signals at this level could be due to a number of possible activities, including land use change and/or agricultural operational activities at the field scale. For perspective, during this same period, sections of the San Joaquin Valley in California's Central Valley experienced -3.5 ft (1.1 m) of subsidence.

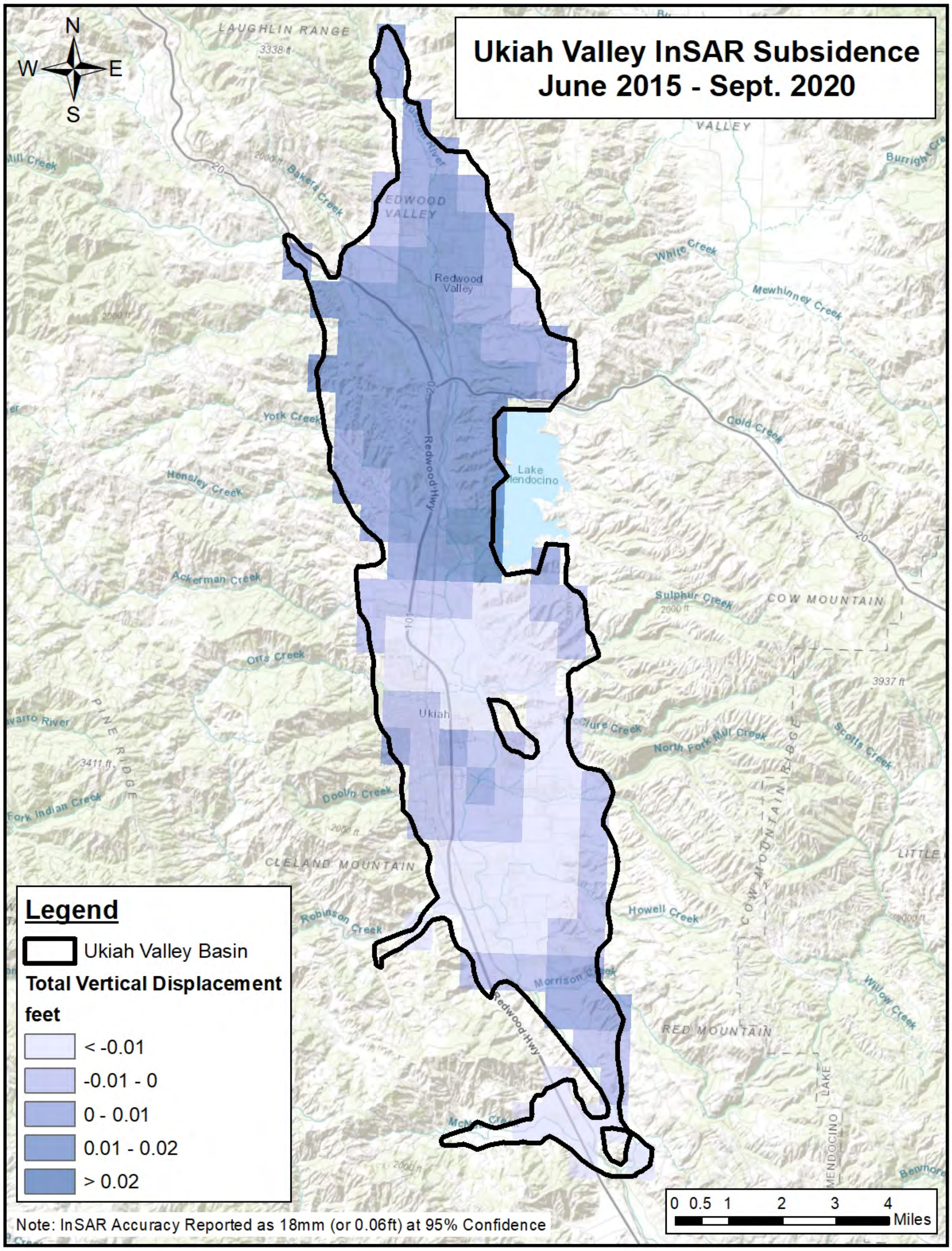

Figure 2.52: Ukiah Valley InSAR Subsidence from June 2015 to September 2019

2.2.2.6 Identification of Interconnected Surface Water Systems

SGMA calls for the identification of interconnected surface waters (ISWs) in each GSP. ISWs are defined under SGMA as:

23 CCR § 351 (o): "Interconnected surface water" refers to surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted.

Because the water table in parts of Ukiah Valley can be relatively shallow, the Russian River surface water network contains several miles of stream channel that are connected to groundwater, especially along its mainstem. The direction of flow exchange (i.e., gaining vs losing stream reaches) varies over both space and time.

Another distinction relevant to GSP management goals is categorizing streams as either flowing or in baseflow or dry conditions (i.e., during the summer or late fall). In the mainstem of Russian River, however, releases from Lake Mendocino highly influence streamflow, especially during the baseflow season from May to November with an average monthly streamflow of 12.1 Thousand Acre Feet (TAF) based on observations at Station 11462500 on Russian River, North of Hopland, between 1987 and 2019.

To identify river reaches that are interconnected to groundwater, assumed streambed elevations were compared to representations of groundwater elevations above mean sea level. A review of stream centerlines from available surface water mapping resources such as the USGS National Hydrography Dataset (NHD) showed that mapped streambeds did not appear to align with aerial imagery or the institutional knowledge of stakeholders within the Basin. The watershed tool within geographic information system (GIS) Esri's ArcGIS platform was used to establish the location of likely streambeds based on topography represented by the USGS one-meter resolution digital elevation model (DEM) for Mendocino County.[12] A comparison of assumed stream centerlines generated through geospatial processing indicated agreement with aerial imagery. Assumed stream centerlines were translated into a discretized series of points representing a location every 50 meters along the mapped streambed. A buffer with a radius of 10 meters was applied to each point (yielding a circular area with a radius of 10 meters around each point) and the "zonal statistics"[13] function was used to compute the lowest elevation within the buffered area. The lowest elevation in the 1-meter DEM within that buffered area was assumed to represent that streambed elevation for that point along the assumed stream centerline.

Mapped representations of interpolated groundwater elevation above mean sea level (amsl) were developed using ordinary kriging and observed groundwater elevations obtained from the Periodic Groundwater Level Database.[14] A total of 12 gridded representations of groundwater elevations were developed for spring and fall seasons between the spring of 2015 and the fall of 2020 as sufficient groundwater level data to carry out an analysis is available during this timeframe. These groundwater elevations provide the best available representation of relatively modern depths to groundwater given the somewhat extensive data gaps and data availability limitations in the Ukiah Basin pending estimates from the groundwater flow model in development. The zonal statistics

[12] The Esri Watershed tool, specifically the flow direction (D8 method) and Flow Accumulation tools was supplemented with the "Breachdepressionsleastcost" tool from "Whitebox Tools." https://www.whiteboxgeo.com/

[13] The zonal statistics function calculates summary statistics of values within a mapped grid surface for specific areas such as the buffered circles every 50 meters along the assumed mapped stream centerlines used here.

[14] https://data.cnra.ca.gov/dataset/periodic-groundwater-level-measurements

function was then used again to calculate the average groundwater elevation for each 10-meter diameter circle corresponding to a stream centerline.

Assumed streambed elevations were then compared to assumed groundwater elevations for each of the 12 spring and fall seasons between the spring of 2015 and the fall of 2020. Stream centerline locations where and when the representation of groundwater was greater than the assumed streambed elevations were assumed to interconnected to groundwater. Conversely, stream centerline locations where streambed elevations were greater than groundwater elevations were assumed to not be connected to groundwater. Two additional sets of analyses were carried out to account for uncertainty regarding the thickness of the saturated zone or wetting front across space as a function of a range of hydrogeologic factors. While it is clear that gaining reaches where groundwater elevations are above streambed elevations are connected to groundwater, losing reaches are not inherently disconnected. A losing reach where groundwater elevations are below streambed elevations may be connected if the channel is connected to groundwater by a saturated zone. This saturated zone or wetting front varies over space and is an often complex function of a variety of hydrogeologic factors. If the geology of the streambed area has low conductivity and there is an absence of a strong hydraulic gradient, the depth of the saturated zone may be quite small. Conversely, if the geology is characterized by high conductive materials and there is a substantial hydraulic gradient, the depth of the saturated zone may be significant. The location of smaller tributaries to the Russian River were not effectively mapped precluding the effective characterization of streambed geology.

An additional analysis was carried out to account for the assumed presence of saturated zones by applying reasonable thresholds based on the location of the watershed and the broader geological setting. An assumed saturated zone depth threshold of 10 feet was applied to the main stem of the Russian River with a threshold of 5 feet applied to tributaries effectively reducing the elevation of connection for each stream centerline point in the initial analysis by that amount. For this saturated zone threshold analysis, if the representation of groundwater elevation was within 5 feet of the assumed streambed elevation for a tributary, that stream centerline point was assumed to be connected. Interconnected and disconnected surface water classifications for each buffered point area were translated to lines by assigning the 50-meter-long streambed segment upgradient of each point the classification assigned to the point at its downstream end.

This analysis showed that 72 percent of the 50-meter long streambed segments are not connected to groundwater during any of the fall representations of groundwater elevations with 63 percent of the reaches similarly not connected in any of the spring groundwater elevation representations. Consequently, 28 percent of the 50-meter streambed segments are connected to groundwater in fall and 37 percent of the streambed segments are connected to groundwater during one or more representations in the spring. **Figure 2.53** shows the ISWs based on the assumption that stream segments must be connected to groundwater during all fall seasons in the analysis period. Similarly, **Figure 2.55** shows the ISWs assuming a needed connection to groundwater during all spring seasons. **Figure 2.55** presents the distribution of assumed ISWs for groundwater representations when connection during all seasons is required.

This ISW characterization relying on the relationship between assumed streambed and groundwater elevations was further refined based on best professional judgment to more effectively reflect the conceptual understanding of the surface water conditions along the mainstem of the Russian River and recognize the extensive data gaps in observed groundwater conditions, streambed elevations, tributaries and mainstem streamflows. The distribution of assumed ISWs presented in **Figure 2.55** suggests that a few segments of the mainstem of the Russian River are not ISWs based on the relationship between the assumed riverbed and groundwater elevations. These segments of the Russian River mainstem were reclassified as assumed ISWs based on feedback from stakeholders and anecdotal observations of river flows.

This revised and reclassified representation of the distribution of assumed ISWs was translated to classes of “likely ISW” and “unlikely ISW” to reflect the inherent uncertainty of the datasets used to complete the analysis including assumed representations of the locations of surface water streambeds in tributaries to the Russian River and groundwater conditions. In addition, the Russian River mainstem and some of its tributaries, mostly south of Lake Mendocino, have been historically incised. The spatial extent of this incision is not known accurately, and is considered a data gap and a source of uncertainty for this analysis. Tributaries in the northern portion of the Basin where data gaps are most pronounced were classified as assumed ISW in the automated spatial analysis comparing streambed and groundwater elevations. Representations of streambed locations assumed streambed elevations, and groundwater elevation in these areas toward the boundaries of the Basin are considered preliminary and will be revised as data gaps are addressed and the conditions are more comprehensively understood. An estimated 45% of assumed 50-meter long stream and river bed segments were classified as likely ISW following the revision of the Russian River mainstem leaving 55% of surface water segments as unlikely ISW. The spatial distribution of likely ISW representing the ISW characterization within the Ukiah Basin is presented in **Figure 2.56**.

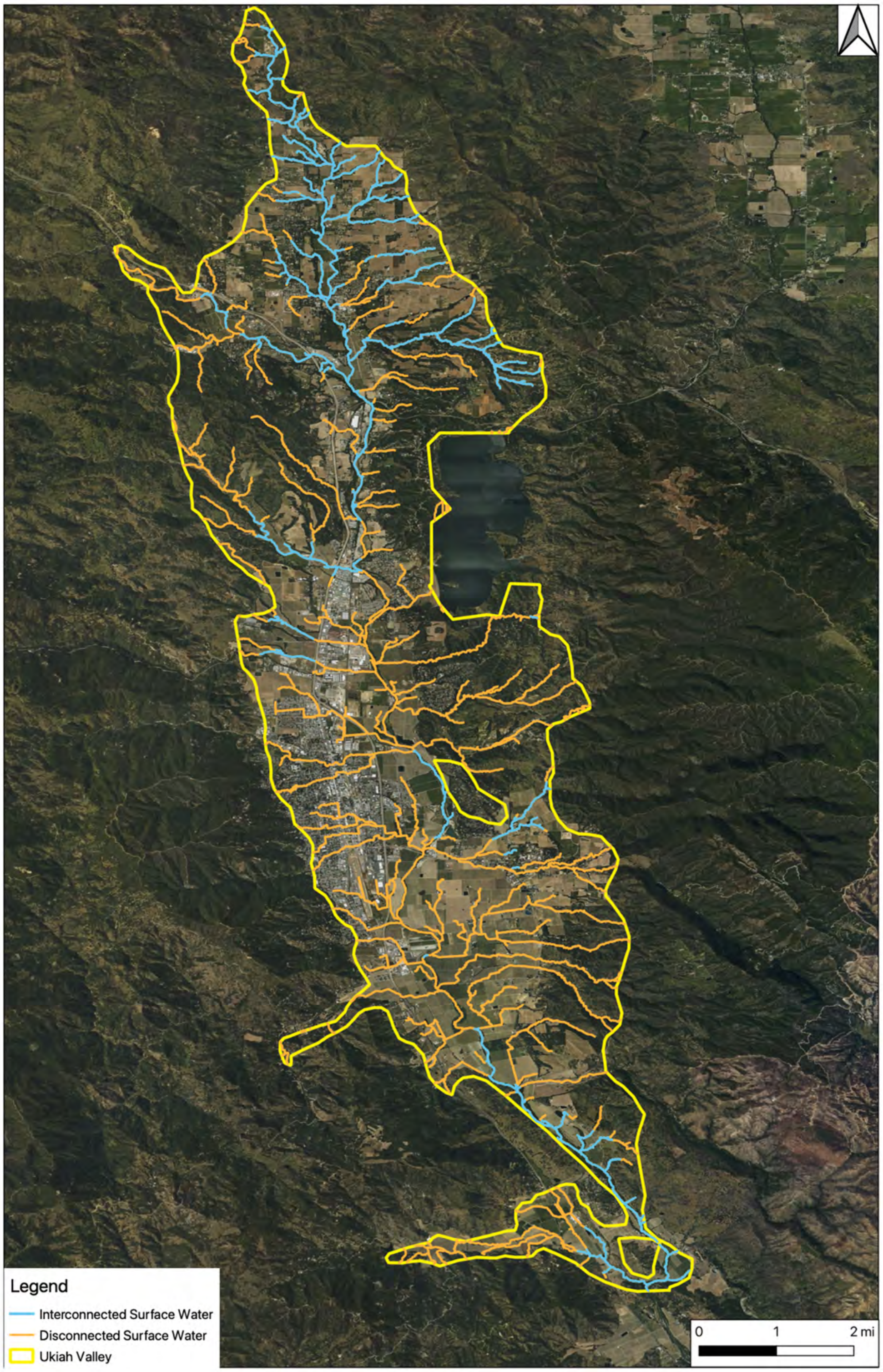

Figure 2.53: Assumed Interconnected Surface Water reaches along the Russian River and its tributaries during fall from 2014 to 2020.

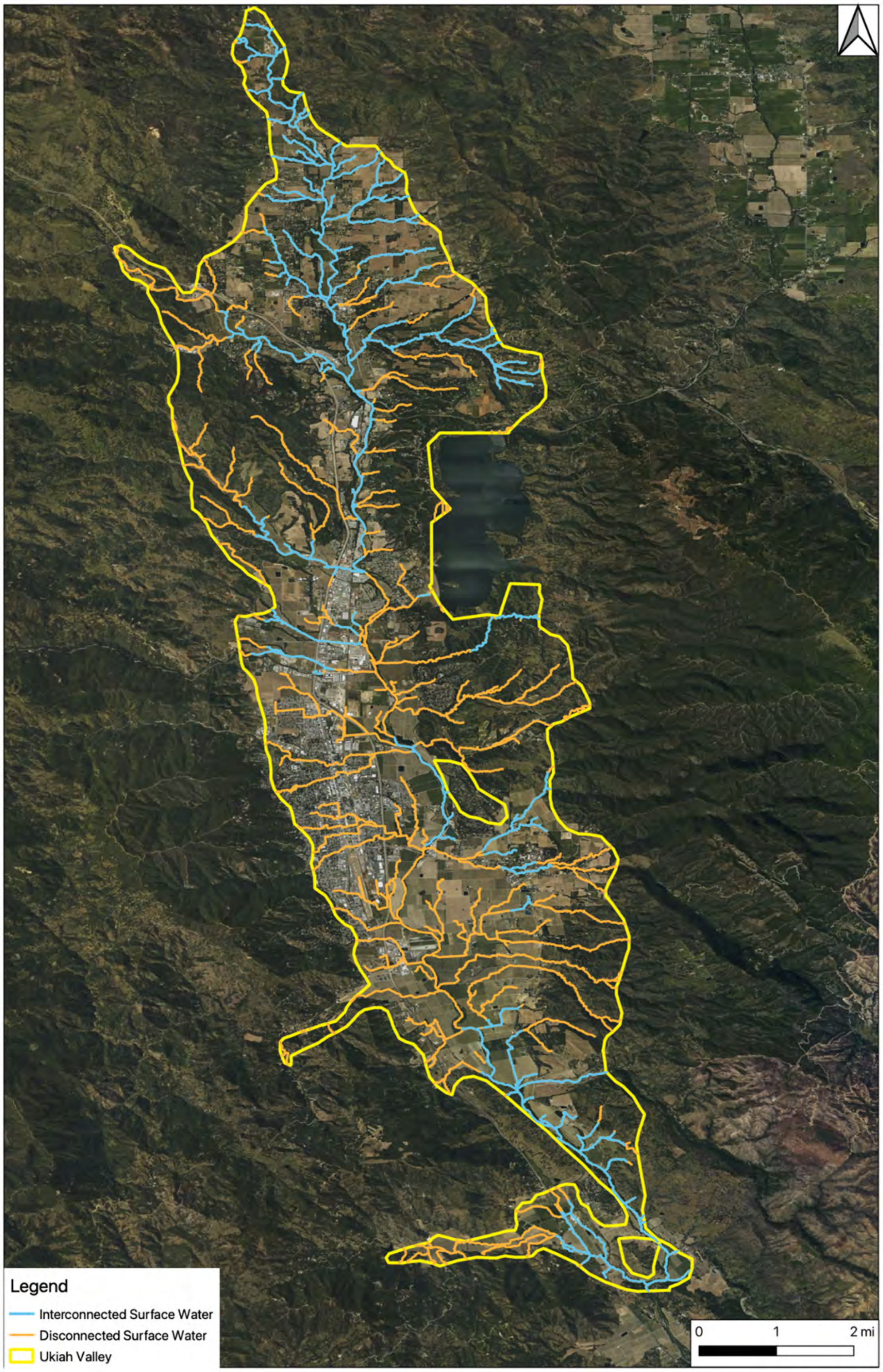

Figure 2.54: Assumed Interconnected Surface Water reaches along the Russian River and its tributaries during spring from 2014 to 2020.

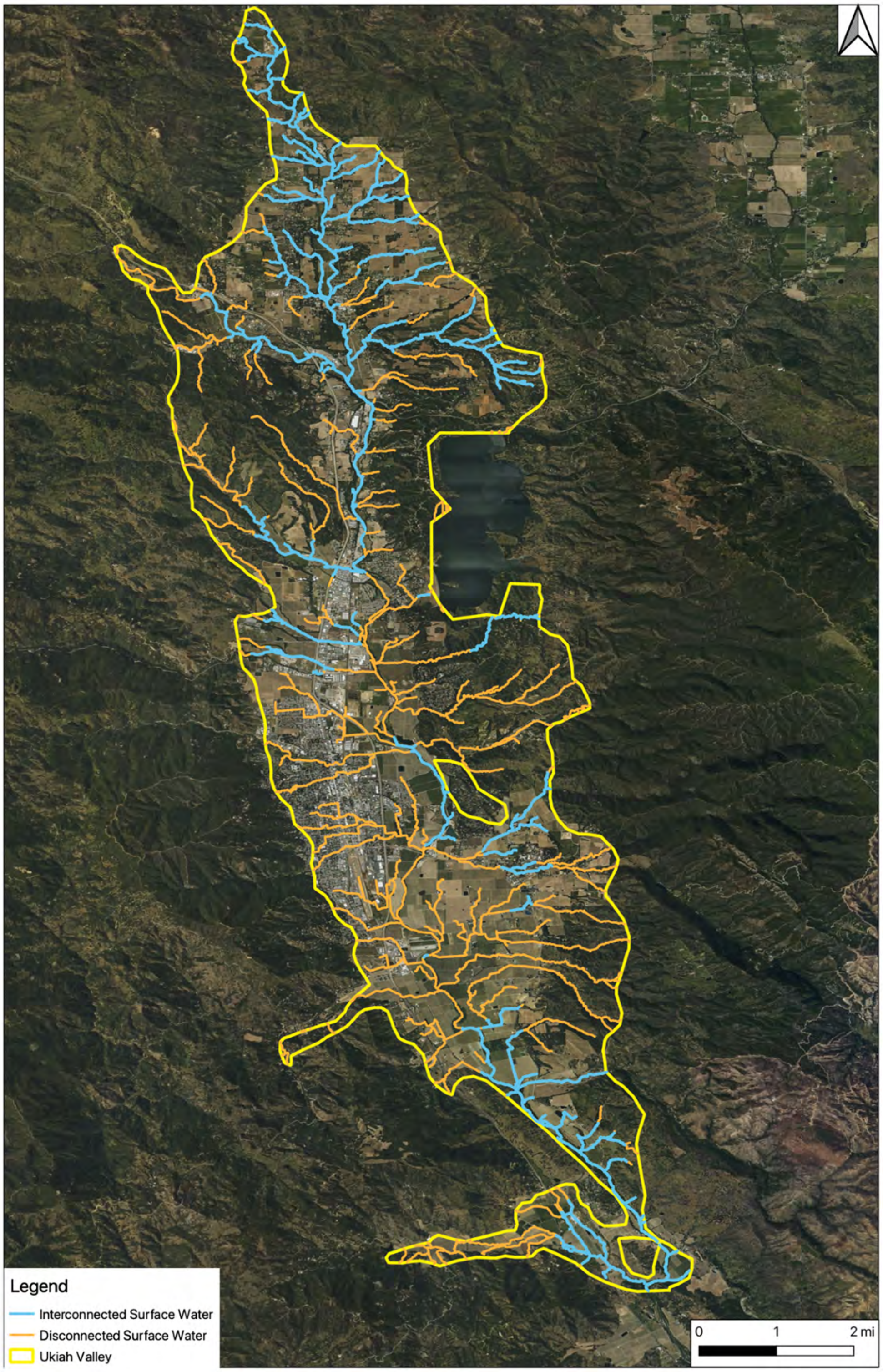

Figure 2.55: Assumed Interconnected Surface Water segments along the Russian River and its tributaries during all seasons (spring and fall) from 2014 to 2020.

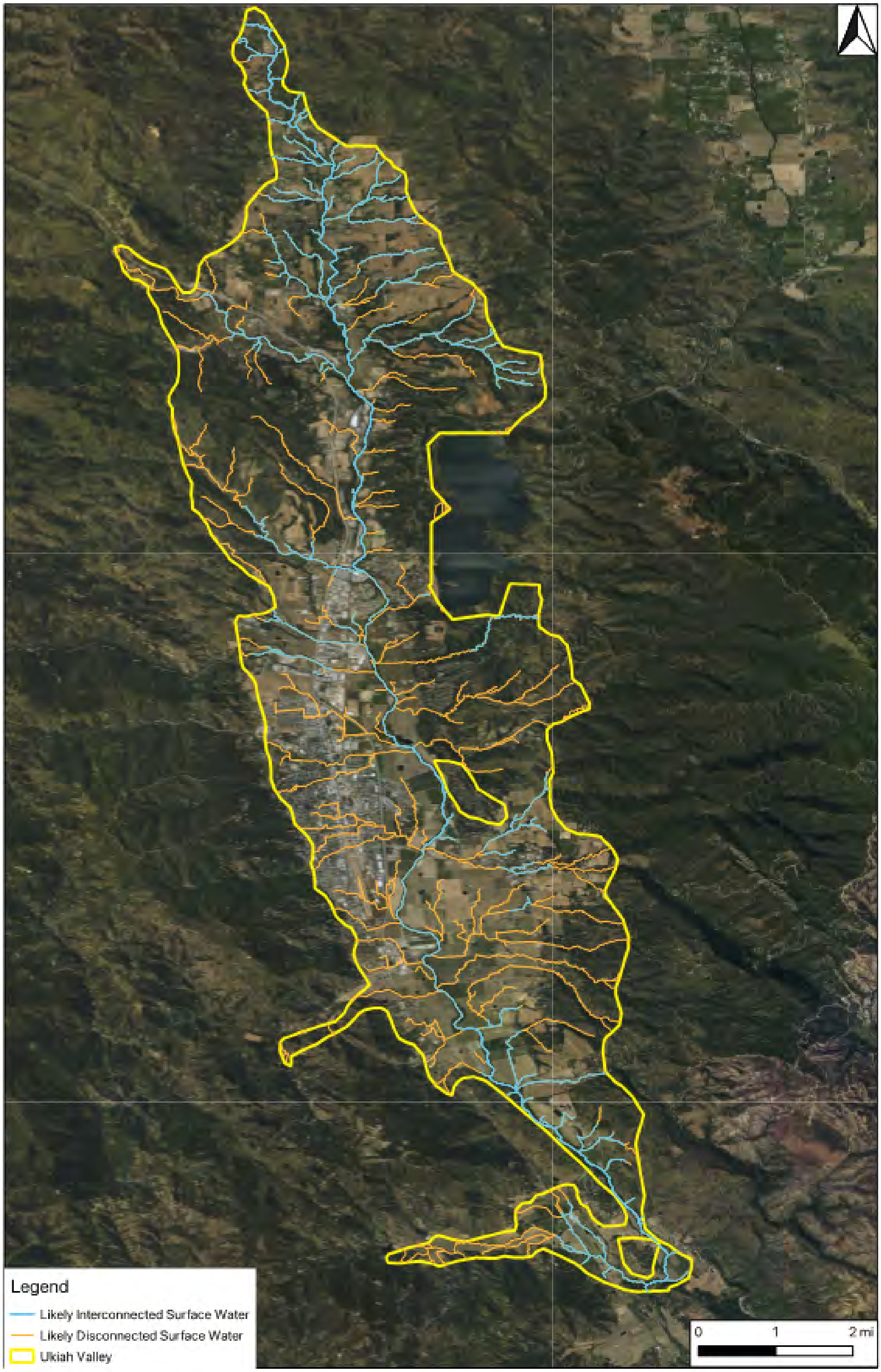

Figure 2.56: Likely Interconnected Surface Water segments along the Russian River and its tributaries.

2.2.2.7 Identification of Groundwater-dependent Ecosystems

Section 354.16(g) of the GSP Regulations[15] requires identification of groundwater dependent ecosystems (GDEs). Section 351(m) of these regulations refers to GDEs as *"ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface."*

In order to adequately consider potential effects of the regional aquifer system's operations on all beneficial uses and users of groundwater and interconnected surface water, including both human and natural beneficial uses, GDEs within the Basin area must be identified and potential effects of the Basin operations on GDEs must be determined. Such information should then be used to establish sustainable management criteria, improve the monitoring network, and define projects and management actions that help improve or maintain conditions for each GDE to achieve the sustainability goal in the Basin, as discussed in **Chapters 3**, **4**, and **5**, respectively.

Environmental Beneficial Water Uses and Users within the Basin

To establish sustainable management criteria for the depletions of surface water sustainability indicator, GSAs are required to prevent adverse impacts to beneficial users of surface water, including environmental users. Thus, identifying these users and uses of surface water is the first step to address undesirable results due to surface water depletions.

The Ukiah Valley Basin encompasses two California ecoregions as identified by EPA Level III Ecoregions of California[16] (**Figure 2.57**):

- Central California Foothills and Coastal Mountains ecoregion (Ecoregion 6), which covers the majority of the Basin. This ecoregion is characterized by its Mediterranean climate of hot dry summers and cool moist winters, and associated vegetative cover comprising primarily chaparral and oak woodlands; grasslands occur in some low elevations and patches of pine are found at high elevations.

- Klamath Mountains and California High North Coast Range (Ecoregion 78), encompasses less than 5% of the Basin area mainly on the northwest side. It contains the highly dissected ridges, foothills, and valleys of the Klamath and Siskiyou Mountains and includes ultramafic substrates, such as serpentinite and mafic lithologies that directly affect vegetation. The region's diverse flora is rich in endemic and relic species. The mild, sub-humid climate of Ecoregion 78 is characterized by a lengthy summer drought.

Per 23 CCR section 354.8(a)(3), CDFW recommends identifying CDFW-owned or CDFW-managed lands within the Basin, and carefully considering all environmental beneficial uses and users of water on CDFW lands to ensure fish and wildlife resources are being considered when developing the GSP. Reviewing maps provided in the CDFW lands website, which catalogues CDFW properties and their managed habitat importance, no CDFW public access lands were identified within the Basin borders.

The CDFW Biogeographic Information and Observation System (BIOS) Viewer was used to identify threatened and endangered species that may be present within the Ukiah Basin. A total of two

[15] 23 CCR § 350 et seq.

[16] Griffith, G.E., Omernik, J.M., Smith, D.W., Cook, T.D., Tallyn, E., Moseley, K., and Johnson, C.B., 2016, Ecoregions of California (poster): U.S. Geological Survey Open-File Report 2016–1021, with map, scale 1:1,100,000, //dx.doi.org/10.3133/ofr20161021.

species are listed as endangered by the State of California. No species that may be present within the Basin are listed as endangered at the federal level though four species are listed as Birds of Conservation Concern and the petition to list the Foothill Yellow-legged Frog is currently under review. It is worth noting that the California Fish and Game Commission determined in their Notice of Findings (March 10, 2020) that listing the Northwest/North Coast clade of Foothill Yellow-legged frog as threatened is not warranted, which applies to the Basin area. The species is still designated by CDFW as a "Species of Special Concern" but is not listed/protected under the California Endangered Species Act in this region. An additional ten species are listed as Species of Special Concern at the state level with the Baker's Meadowfoam also assigned rare status.

A summary of endangered, threatened, rare, or species of special concern for the Ukiah Basin is presented in CDFW's BIOS houses many biological and environmental datasets including the California Natural Diversity Database (CNDDB), which is an inventory of the status and locations of rare plants and animals in California. BIOS also presents the extent of suitable habitat for a subset of the species presented in **Table 2.21**. In addition, National Oceanic and Atmospheric Administration (NOAA) Protected Resources App[17] indicates that the Russian River mainstem, Forsythe Creek, Mariposa Creek, and Salt Hollow Creek are critical habitats for threatened-listed Steelhead (Oncorhynchus mykiss). Russian River mainstem is also listed as critical habitat for Chinook Salmon (Oncorhynchus tshawytscha), listed as threatened.

[17] https://www.fisheries.noaa.gov/resource/map/protected-resources-app

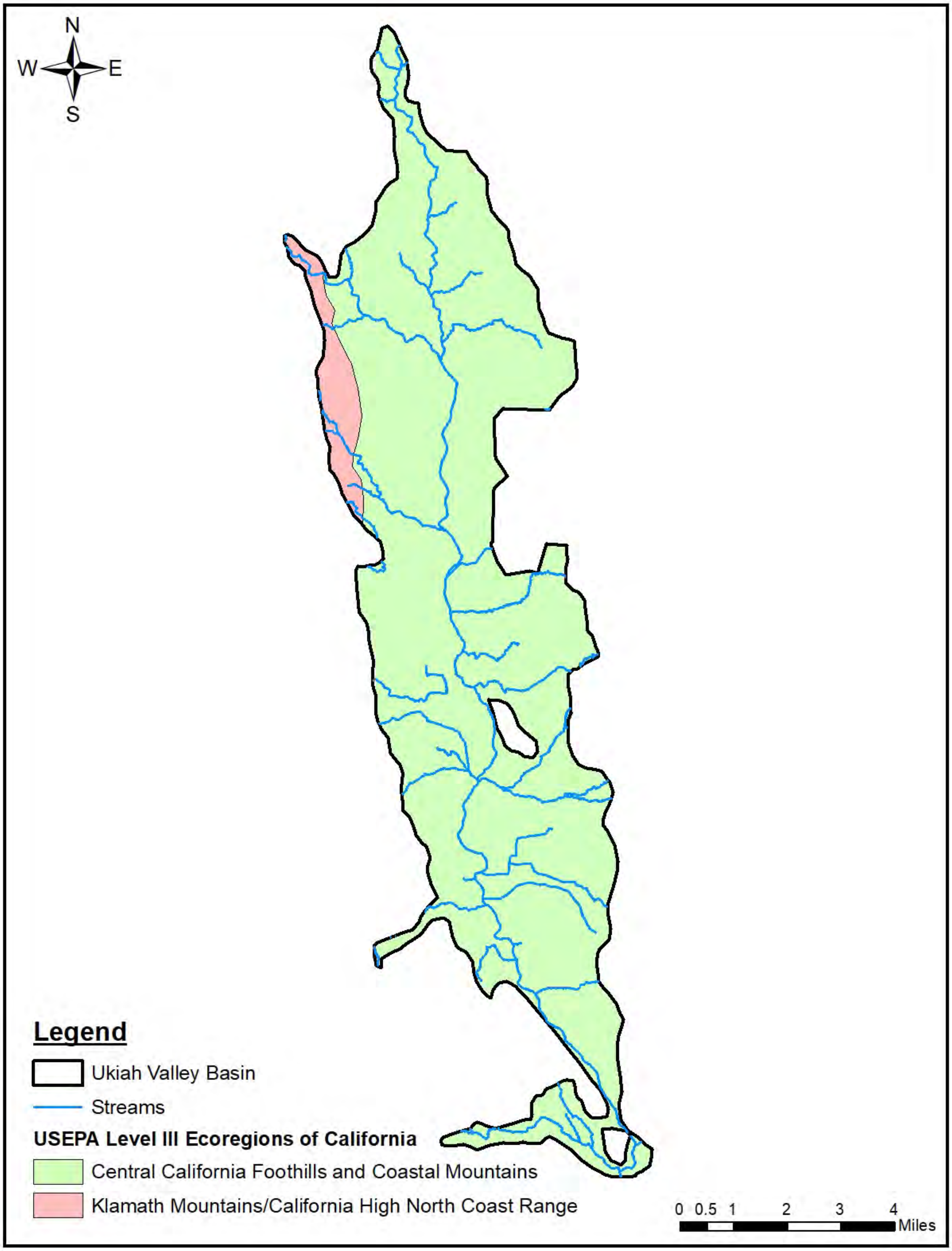

Figure 2.57: USEPA Level III Ecoregions of California within the Basin.

Table 2.21: Endangered, Rare, and Special Concern Species within the Basin

Species Common Name	Scientific Name	Group	State Status	Federal Status
Willow Flycatcher	Empidonax traillii	Animals - Birds	Endangered	Bird of Conservation Concern
Bald Eagle	Haliaeetus leucocephalus	Animals - Birds	Endangered	Bird of Conservation Concern
Baker’s Meadowfoam	Limnanthes bakeri	Plants	Rare	None
Western Pond Turtle	Actinemys marmorata	Animals - Amphibians	Species of Special Concern	None
Foothill Yellow-legged Frog	Rana boylii	Animals - Amphibians	Species of Special Concern	Under Review in the Candidate or Petition Process
Coast Range Newt	Taricha torosa	Animals - Amphibians	Species of Special Concern	None
Tricolored Blackbird	Agelaius tricolor	Animals - Birds	Species of Special Concern	Bird of Conservation Concern
Redhead	Aythya americana	Animals - Birds	Species of Special Concern	None
Black Tern	Chlidonias niger	Animals - Birds	Species of Special Concern	None
Black Swift	Cypseloides niger	Animals - Birds	Species of Special Concern	Bird of Conservation Concern
Yellow-breasted Chat	Icteria virens	Animals - Birds	Species of Special Concern	None
American White Pelican	Pelecanus erythrorhynchos	Animals - Birds	Species of Special Concern	None
Yellow-headed Blackbird	Xanthocephalus xanthocephalus	Animals - Birds	Species of Special Concern	None

A preliminary visual GIS analysis on the downloaded data showed that the range or habitat of one of the endangered species and seven of the species of special concern are not within the Basin area. These species have been identified by an asterisk in **Table 2.21**. The BIOS Viewer system did not include the layer for Baker's Meadowfoam (identified as a rare species by the state). The habitat suitability for each of the remaining endangered species or species of special concern are shown in **Figures 2.58** through **2.61**. Brief descriptions about these species and their water demand are provided below:

- The western pond turtle's preferred habitat is permanent ponds, lakes, streams or permanent pools along intermittent streams, associated with standing and slow-moving water. A potentially important limiting factor for the western pond turtle is the relationship between water level and flow in off-channel water bodies, which can both be affected by groundwater pumping.
- The North Coast clade of Foothill Yellow-legged frog is rarely encountered far from permanent water. Tadpoles require water for at least three or four months while completing their aquatic development. Adults eat both aquatic and terrestrial invertebrates, and the tadpoles graze along rocky stream bottoms. Groundwater pumping that impairs streamflow could have negative impacts on foothill yellow-legged frog populations.

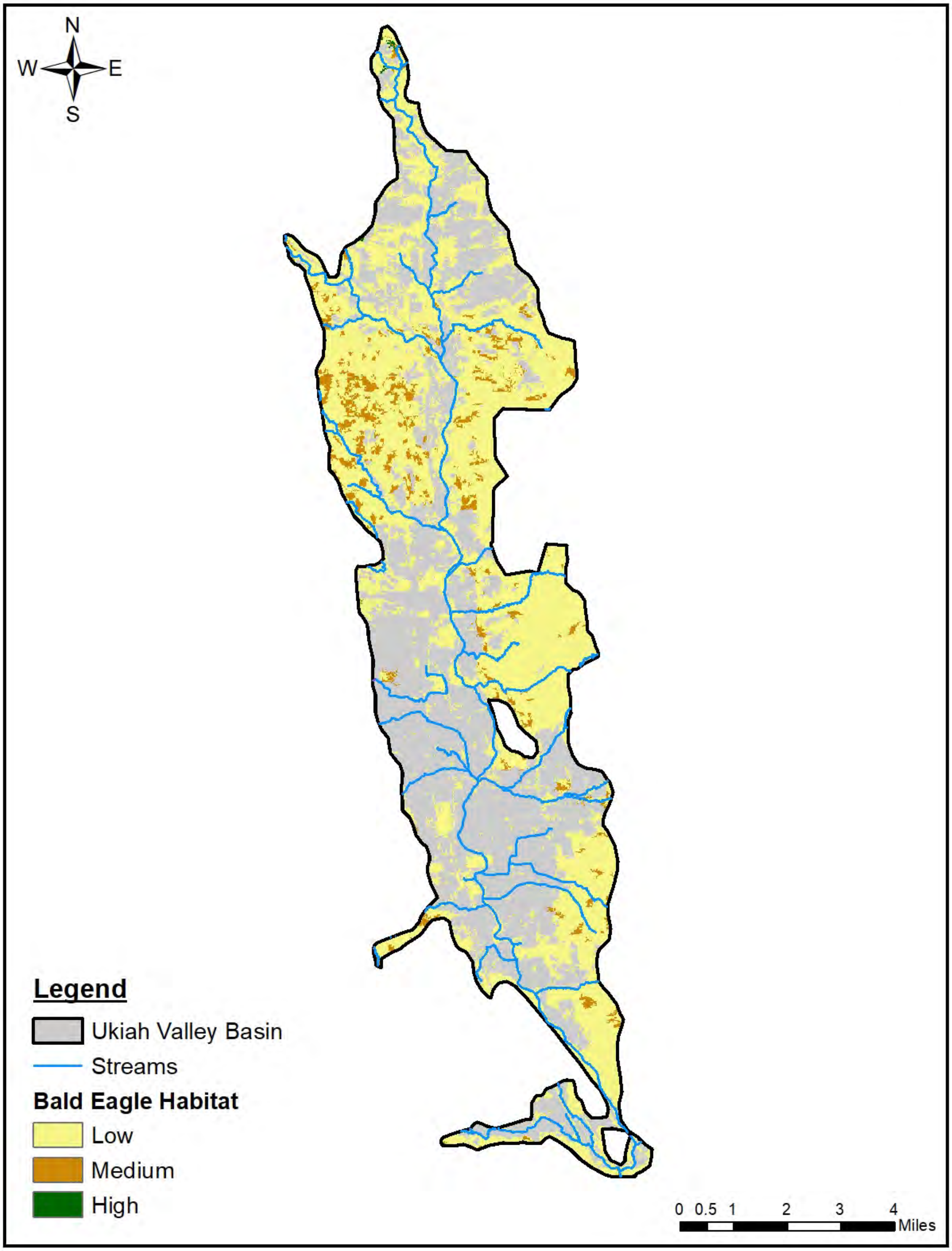

Figure 2.58: Species of Special Concern – Bald Eagle habitat suitability within the Basin.

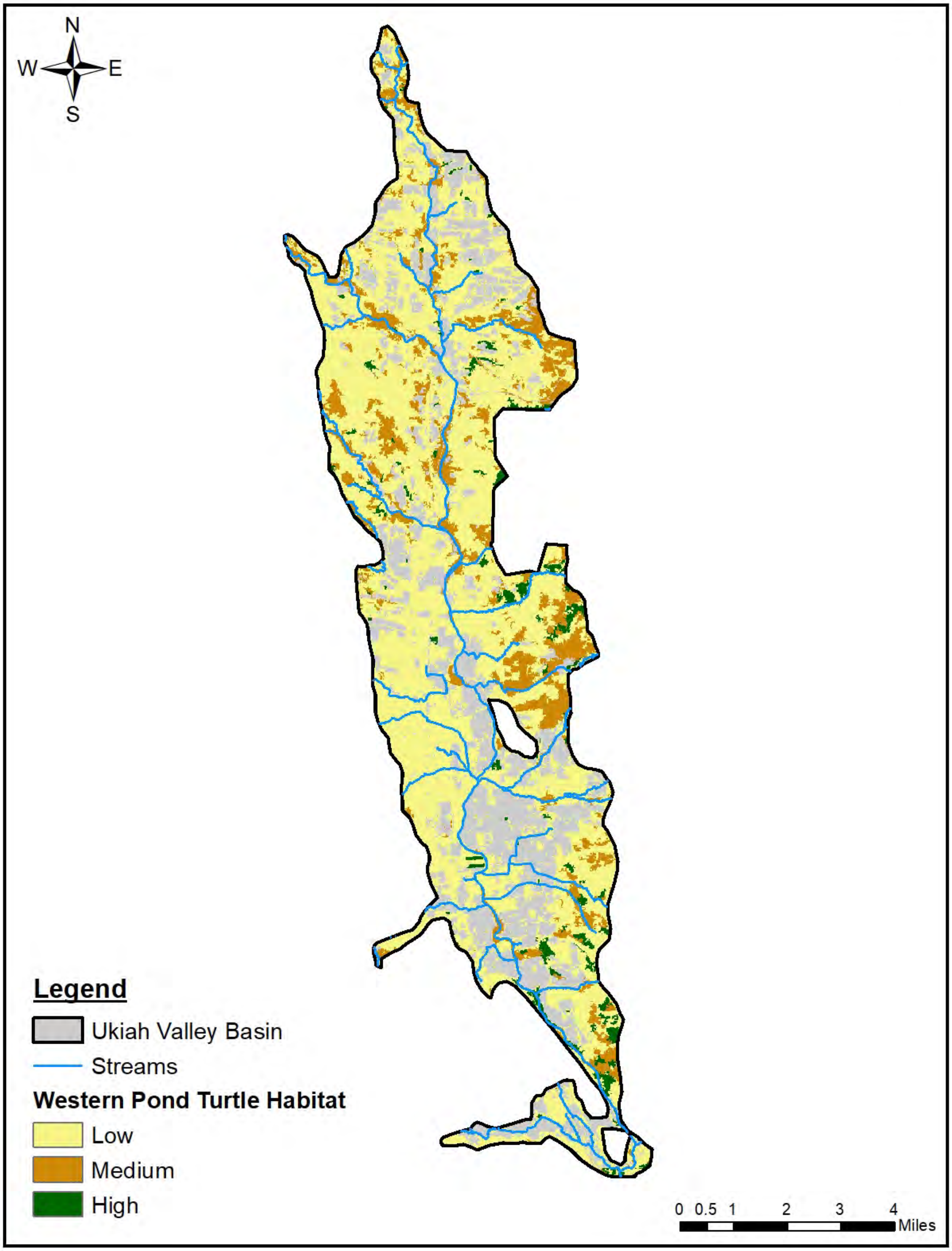

Figure 2.59: Species of Special Concern – Western Pond Turtle habitat suitability within the Basin.

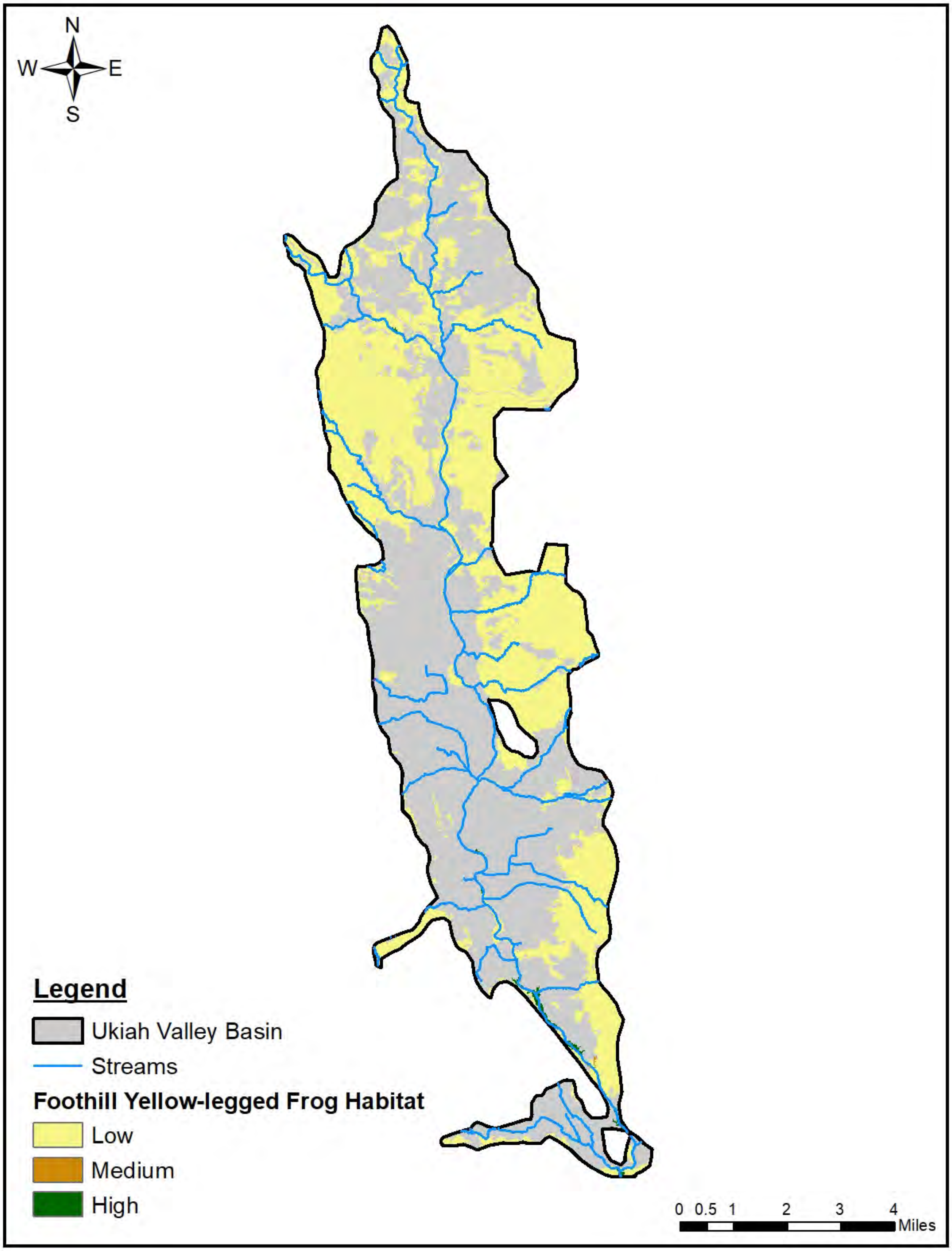

Figure 2.60: Species of Special Concern – Foothill Yellow-legged Frog habitat suitability within the Basin.

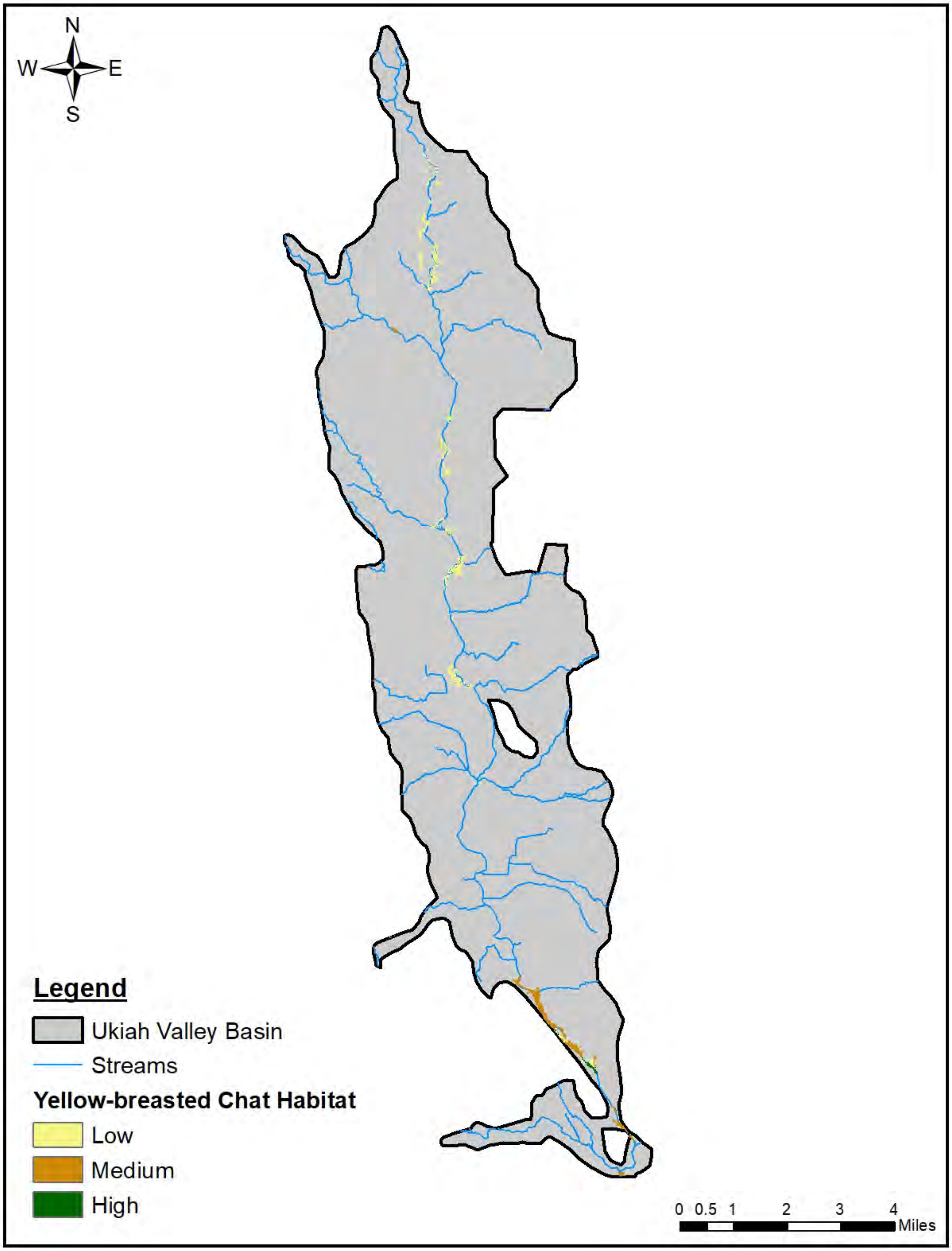

Figure 2.61: Species of Special Concern – Yellow-breasted Chat habitat suitability within the Basin.

Vegetative GDE Identification and Classification

The following section discusses the process of identifying potential GDEs and their classification based on the likelihood that they have access to groundwater. This analysis is carried out using three key building blocks:

- Mapping potential GDEs based on available resources;
- Assigning rooting depths based on predominant assumed vegetation type; and
- Establishing representations of depth to groundwater.

The following subsections discuss the process of assembling these three building blocks and the subsequent GDE categorization based on the relationship between them.

Mapped Potential Groundwater Dependent Ecosystems

The primary resource used to establish the spatial extent of mapped GDEs is the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset.[18] The NCCAG dataset includes separate vegetation communities and wetland geospatial data layers for each of the groundwater basins identified in Bulletin 118. These layers identify potential locations of GDEs, which identify the phreatophytic vegetation, perennial streams, regularly flooded natural wetlands, and springs and seeps that may indicate the presence of/and or communities that and depend on groundwater, and therefore can be considered as indicators of GDEs. Representations of mapped potential GDEs from the NCCAG vegetation and wetlands datasets are presented in **Figures 2.62** and **2.63**, respectively.

[18] https://gis.water.ca.gov/app/NCDatasetViewer/

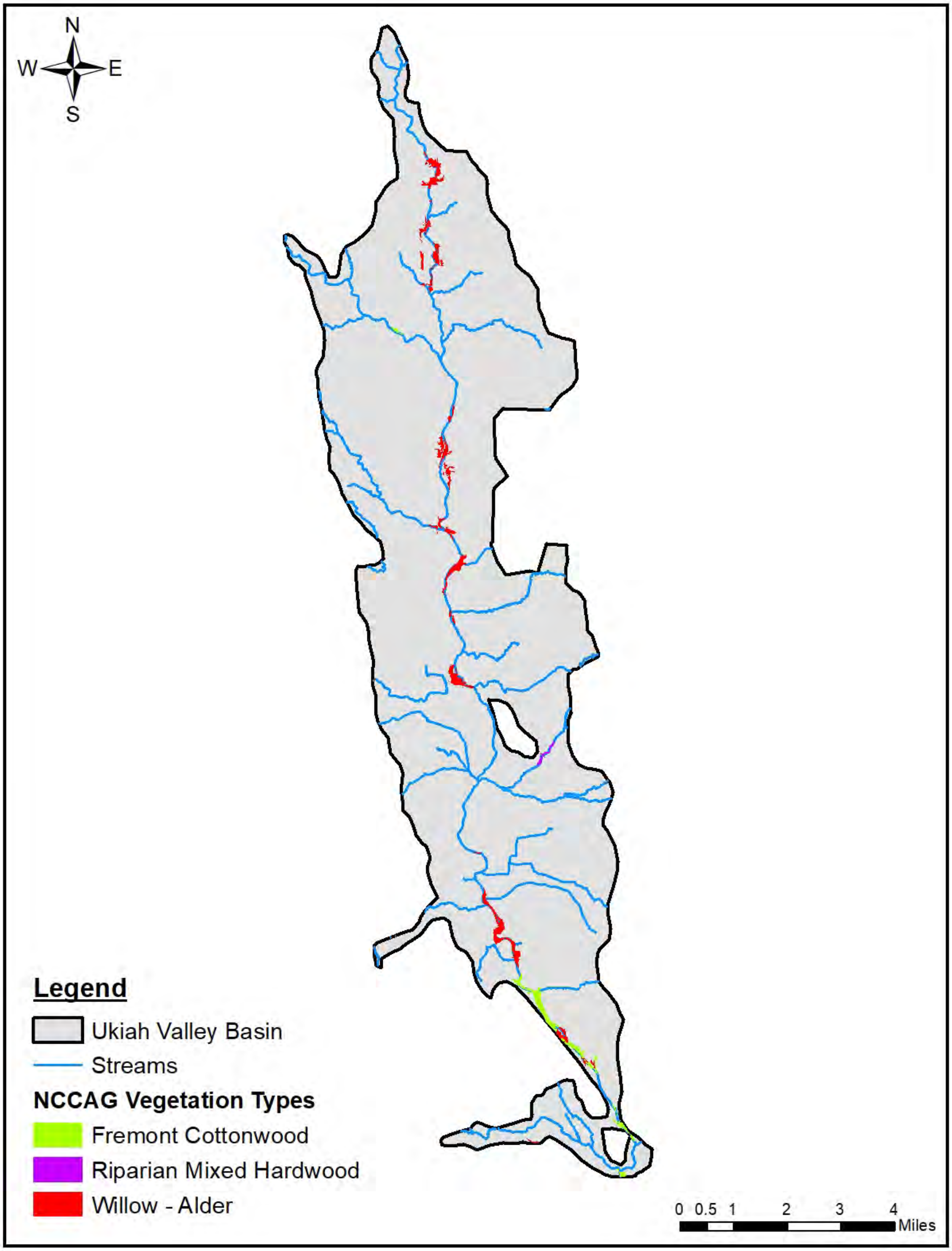

Figure 2.62: Assumed vegetation types within the Basin according to the NCCAG Vegetation Dataset.

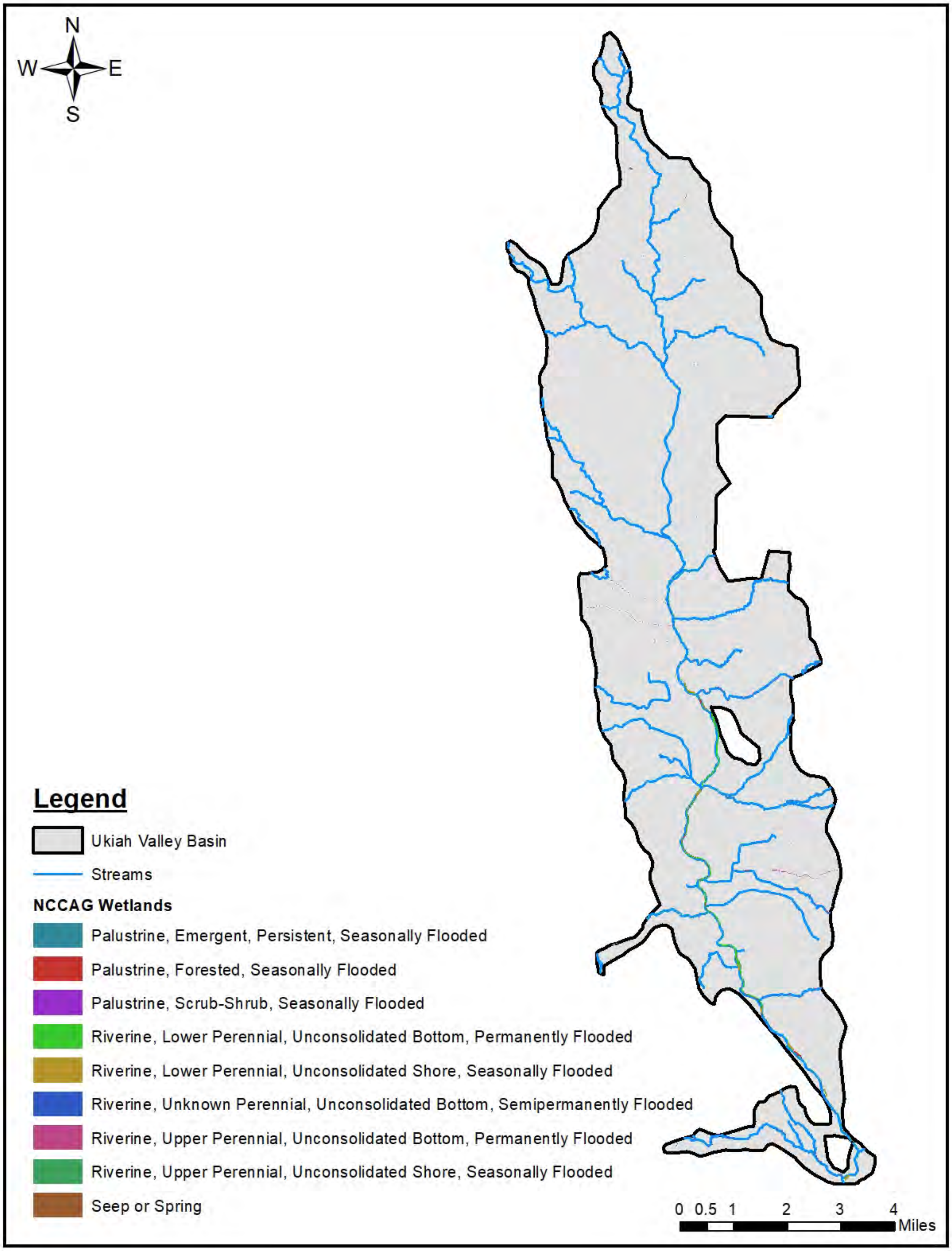

Figure 2.63: Assumed wetland types within the Basin according to the NCCAG Dataset.

An initial review of NCCAG mapped potential GDEs for the Basin and a comparison to available land use mapping resources suggested that riparian communities were not effectively represented in some cases and mapped GDEs were identified in urban, agricultural, or managed vegetated areas. A subset of mapped lands use and land cover (LU/LC) and crop mapping datasets from DWR were incorporated into the analysis to more effectively represent mapped potential GDEs for the Ukiah Basin. These datasets include 2010 DWR LU/LC as well as 2014 and 2016 DWR crop mapping for Mendocino County. LU/LC and crop mapping classes, with corresponding narrative descriptions, are presented in **Table 2-G-2, Table 2-G-3, and Table 2-G-4** in **Appendix 2-G**, for the 2010 LU/LC, 2014 crop mapping, and 2016 crop mapping datasets, respectively.

The NCCAG vegetation and wetland layers were overlaid or unioned in a GIS yielding a dataset where areas mapped as potential vegetation GDEs, wetland GDEs, or both vegetation and wetland GDEs are represented. This combined or unioned[19] NCCAG dataset was intersected[20] with the unioned or combined DWR LU/LC and crop mapping datasets for Mendocino County yielding a combination of classifications for all five datasets for the area covered by either the NCCAG vegetation or wetland datasets.

A new field was created by combining or concatenating the relevant fields in each dataset identified in **Table 2.22** below. All observed combinations of combined fields were summarized in a master table and grouped into one of the five categories presented in **Table 2.23** based on best professional judgment. A summary of these relationships between combined fields and assumed actions is presented in **Table 2-G-5** in **Appendix 2-G**.

If, as an example, the NCCCAG Wetland dataset identified an area as class "PEM1C" corresponding to a "Palustrine, Emergent, Persistent, Seasonally Flooded" mapped potential wetland GDE and the combined DWR LU/LC and crop mapping dataset classified the same area with a "UR" representing "Urban Residential," that area was assigned a "Remove Urban/Paved" classification and was subsequently removed. If, as a second example, neither the NCCAG Wetland nor Vegetation datasets identified an area as a mapped GDE but the combined DWR LU/LC and crop mapping dataset assigned that area an "NW1" class representing "River or stream (natural freshwater channels)," the area was included in the combined representation of mapped potential GDEs. Combined LU/LC or crop mapping classes assigned a "Retain Check" or "Check Remove Irrigated" classification were qualitatively evaluated using aerial imagery and included or removed based on best professional judgment. As shown in **Figures 2.64**, a comparison of the initial potential GDEs and the reviewed and refined GDEs based on this analysis did not drastically change the coverage of the potential GDEs and only removed polygons that did not correlate with other existing data and information. Representation of the refined mapped potential GDEs is presented in **Figures 2.65** below.

[19] A union is a geospatial process where the coverage and attributes of multiple layers in all area are combined into one spatial dataset.

[20] An intersection is a geospatial process where the coverage and attributes of multiple layers are combined into one spatial dataset only in areas where they share area or overlap.

Table 2.22: Field Used to Create a Combined Representation of Mapped Potential GDE Coverage

Dataset	Field Used
NCCAG Vegetation	Vegetation
NCCAG Wetland	ORIGINAL_C
2010 DWR Mendocino County Land Use/Land Cover	LABEL
2010 DWR Mendocino County Land Use/Land Cover	LABEL
2014 DWR Mendocino County Crop Mapping	Crop2014
2016 DWR Mendocino County Crop Mapping	CROPTYP2

Table 2.23: Summary of action and corresponding classification description to refine the combined land use, land cover, and crop mapping dataset for the Ukiah Basin

Action	Classification Description
Retain Natural	Combined DWR LU/LC and crop mapping indicates natural vegetation present.
Retain Check	Combined DWR LU/LC and crop mapping indicates natural vegetation may be present therefore retain or verify before removing
Remove Ag	Combined DWR LU/LC and crop mapping indicates agricultural land is present which could warrant polygon removal.
Remove Urban Paved	Combined DWR LU/LC and crop mapping indicates urban/paved land is present which could warrant polygon removal
Check Remove Irrigated	Combined DWR LU/LC and crop mapping indicates non-native irrigated land is present which could warrant polygon removal.

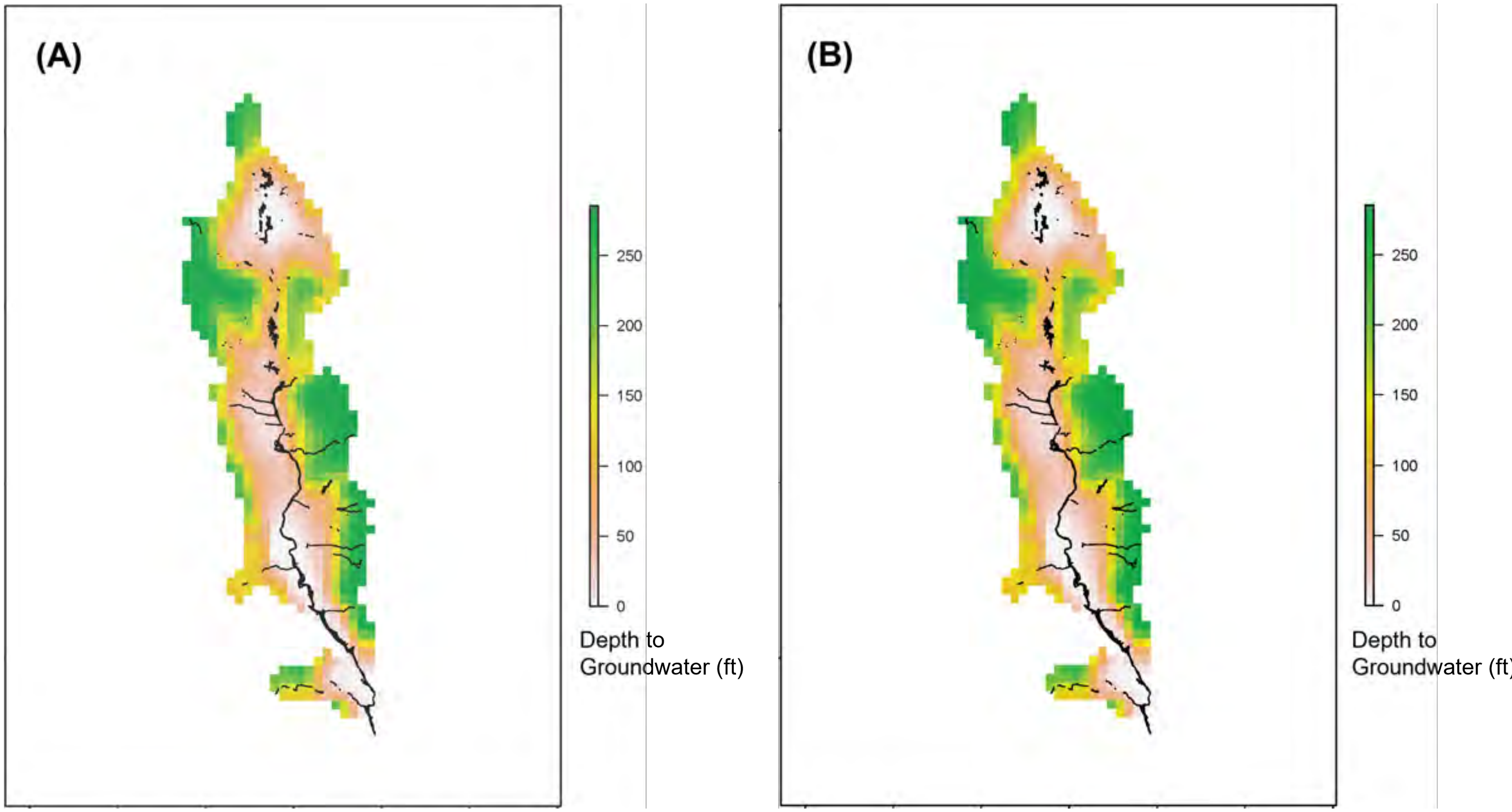

Figure 2.64: Initial and refined mapped potential GDEs underlain by the estimated Spring 2016 groundwater levels.

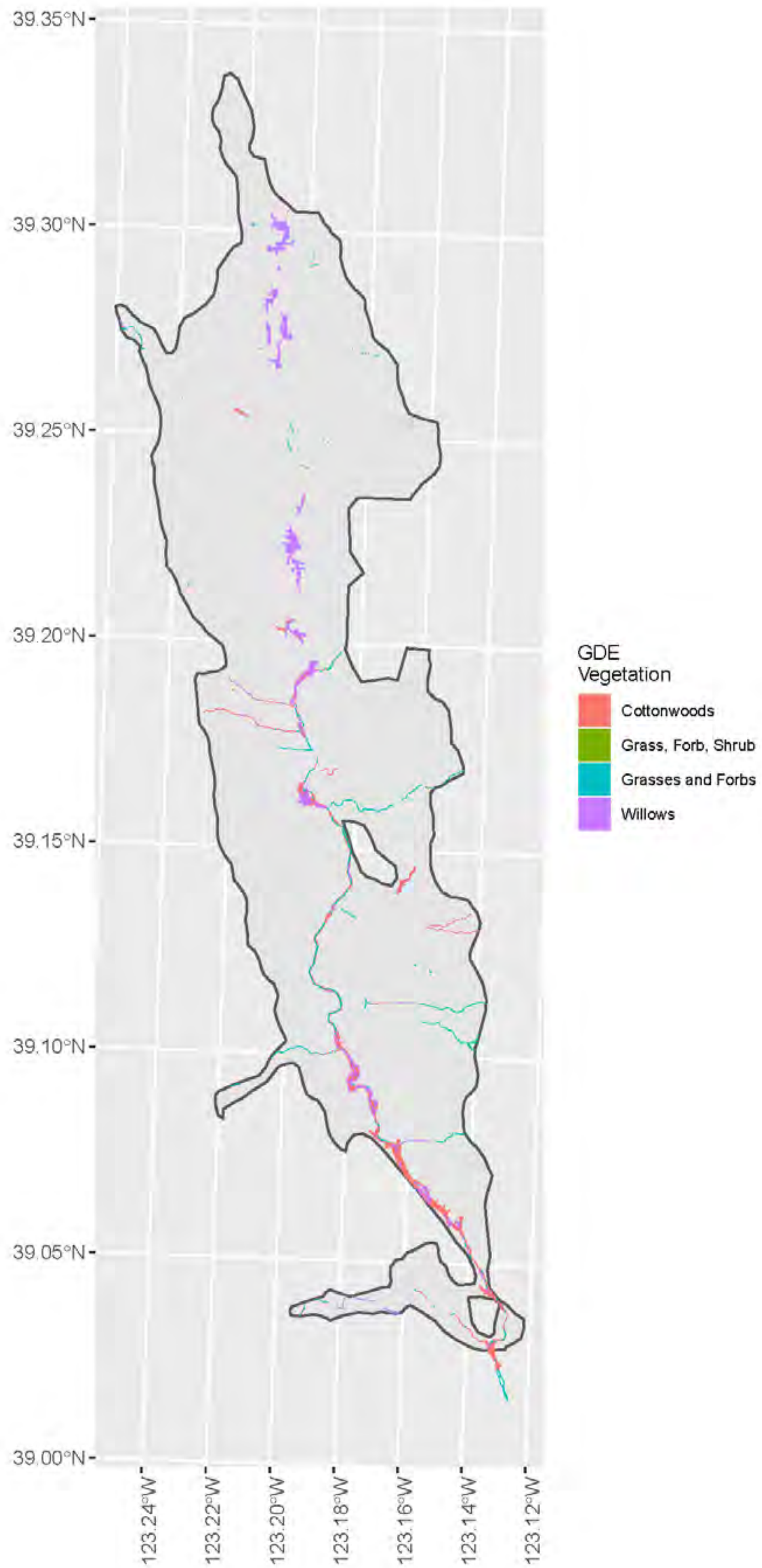

Figure 2.65: Mapped potential GDEs for the Ukiah Basin.

Table 2.24: Assumed Rooting Zone Depth and Representative Vegetation for Classes Within the NCCAG Vegetation Dataset.

Vegetation Class	Assumed Rooting Zone Depth (ft)	Assumed Representative Vegetation
Fremont Cottonwood	30.0	Cottonwood
Riparian Mixed Hardwood	30.0	Cottonwood
Willow - Alder	13.1	Willow

Assumed Rooting Zone Depths

Rooting zone depths were assigned to all combined or concatenated values for the NCCAG vegetation, NCCAG wetland, and combined DWR LU/LC and crop mapping for Mendocino County using a simple decision tree approach. A dominant or representative vegetation was assumed for the best available dataset for each area or polygon within the mapped potential GDE dataset. Classifications from the NCCAG vegetation dataset were used to assign rooting zone depths based on the presumed higher level of mapping accuracy and more descriptive classes present with values such as "Fremont Cottonwood" or "Willow - Alder" present within the Ukiah Basin. Classifications from the NCCAG wetland dataset were then used given their presumed lower level of accuracy and more general vegetative community classification with values such as "palustrine, emergent, persistent, seasonally flooded" and "riverine, upper perennial, unconsolidated bottom, permanently flooded." All vegetation classification in areas mapped by either the NCCAG vegetation or wetland datasets were compared to the combined DWR LU/LC and crop mapping dataset for Mendocino County and a predominant or representative vegetation was assigned based on best professional judgment.

A review of available literature served as the foundation for assigning assumed rooting zone depths for each vegetative class present in the aggregated mapped representation of potential GDEs. Vegetation classifications were grouped into three broad categories based on best professional judgment. The relationship between mapped vegetation categories, assumed predominant or representative vegetation, and assumed rooting zone depths is presented in **Table 2.24**, **Table 2.25**, and **Table 2.26** for the NCCAG vegetation, NCCAG wetland, and the combined DWR LU/LC and crop mapping dataset for Mendocino County, respectively. The distribution of assumed rooting zone depths is presented in **Figures 2.65**.

All classes directly referring to cottonwoods, forested areas, hardwoods, or riparian communities were assumed to be effectively represented by an assumed rooting depth of 30 ft consistent with literature values for Cottonwoods (Niswonger & Fogg, 2008). Classes directly referring to willows as well as those referring to scrub riparian areas or stream channels were assumed to be effectively represented by an assumed 13.1 ft rooting zone depths for willows. Relevant literature suggests a range for willow rooting depths of 2.62 ft to 7.35 ft (Niswonger & Fogg, 2008) indicating that this assumed depth of 13.1 ft is very conservative and is likely to yield more assumed GDEs while additional resources suggest that rooting zone depths of 13.1 ft are consistent with mean values for deciduous broadleaf trees which would have deeper rooting depths than willows (Fan, Miguez-Macho, Jobbágy, Jackson, & Otero Casal, 2017).

Other vegetation classes do not specifically identify predominant species and are therefore assumed to be emergent and limited to grasses, forbs, sedges, and rushes that are common in wetland communities. Rooting zone depths are assigned as the mean of reported values of 4.8 ft or maximum of mean values of 9.6 ft from aggregated measurements presented in literature

Table 2.25: Assumed Rooting Zone Depth and Representative Vegetation for Classes Within the NCCAG Wetland Dataset.

Wetland Community Class	Assumed Rooting Zone Depth (ft)	Assumed Representative Vegetation
Palustrine, Emergent, Persistent, Seasonally Flooded	4.8	Grasses, Forbs, Sedges, and Rushes Mean Rooting Depth
Palustrine, Forested, Seasonally Flooded	30.0	Cottonwood
Palustrine, Scrub-Shrub, Seasonally Flooded	13.1	Willow
Riverine, Lower Perennial, Unconsolidated Bottom, Permanently Flooded	4.8	Grasses, Forbs, Sedges, and Rushes Mean Rooting Depth
Riverine, Lower Perennial, Unconsolidated Shore, Seasonally Flooded	30.0	Cottonwood
Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded	4.8	Grasses, Forbs, Sedges, and Rushes Mean Rooting Depth
Riverine, Upper Perennial, Unconsolidated Bottom, Permanently Flooded	4.8	Grasses, Forbs, Sedges, and Rushes Mean Rooting Depth
Riverine, Upper Perennial, Unconsolidated Shore, Seasonally Flooded	30.0	Cottonwood
Seep or Spring	9.6	Grasses, Forbs, Sedges, and Rushes Maximum of Mean Rooting Depths

Table 2.26: Assumed Rooting Zone Depth and Representative Vegetation for Classes Within the Combined DWR LU/LC and Crop Mapping Datasets for Mendocino County.

Land Use/Land Cover Class	Assumed Rooting Zone Depth (ft)	Assumed Representative Vegetation
Dry Stream Channel	13.1	Willow
Riparian	30.0	Cottonwood
Water Surface	13.1	Willow

(Schenk & Jackson, 2002). Assumed rooting zone depths were generally conservative given the absence of the consistent and comprehensive coverage identifying predominant species for each community and reflected best professional judgment based on the broad classes of vegetation that could reasonably be present.

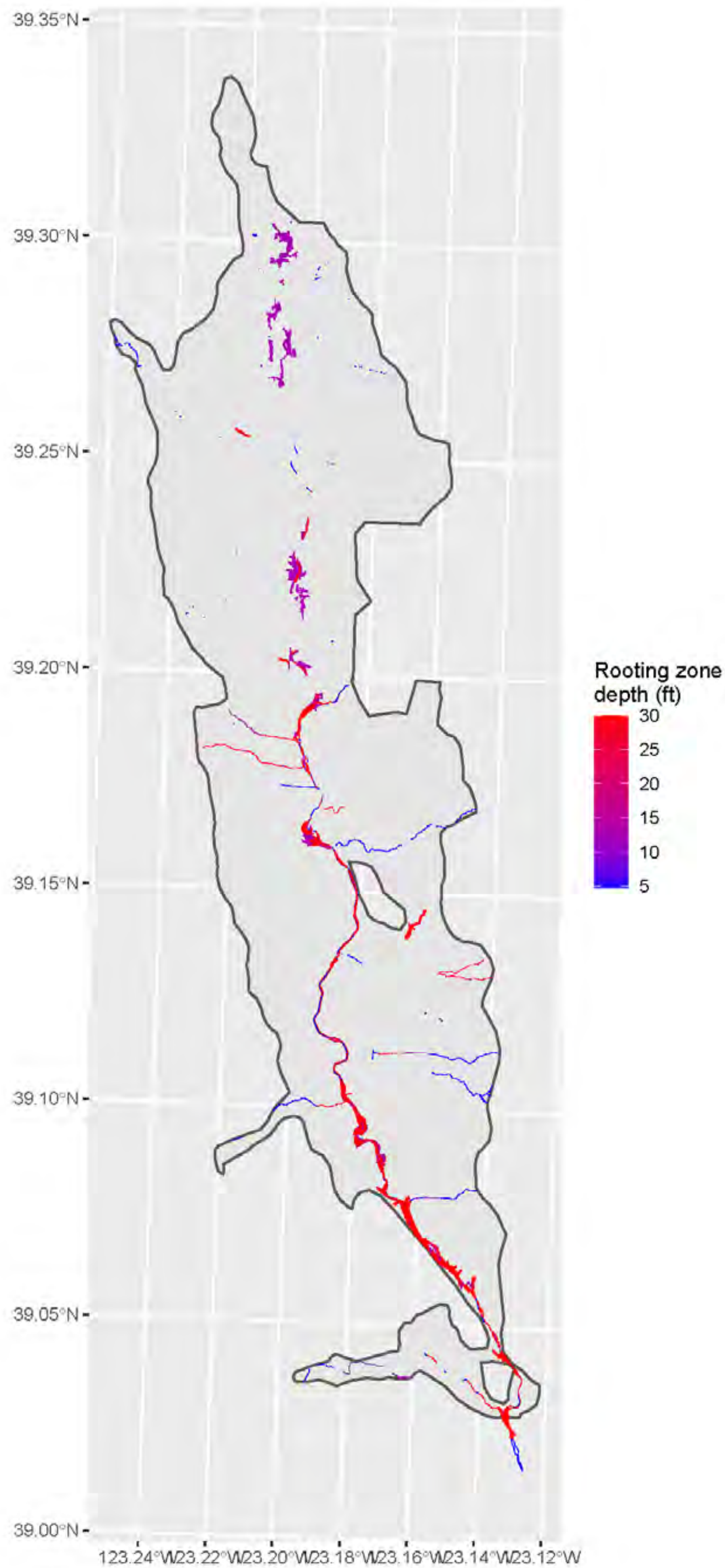

Figure 2.66: Distribution of assumed rooting zone depths in the Ukiah Basin.

Depth to Groundwater

Mapped representations of depth to groundwater were calculated consistent with the standard approach (e.g., TNC Best Practices for using the NC Dataset, 2019), as the difference between land surface elevation and interpolated groundwater elevation above mean sea level. Interpolation was carried out using ordinary kriging (Wackernagel, 1995), and observed groundwater elevations were obtained from the Periodic Groundwater Level Database.[21] Altogether, depth to groundwater conditions were developed for 12 seasons (spring and fall) between spring of 2015 and fall of 2020, as groundwater level data is available during this timeframe. These depths to groundwater provide the best available representation of relatively modern depths to groundwater, pending estimates from the groundwater flow model. Fall and spring season depth to groundwater estimations are shown in **Figures 2.67** and **Figures 2.68**, respectively.

Relationship Between Rooting Zone Depths and Depth to Groundwater

This subsection discusses the method used to evaluate the relationship between assumed rooting zone depths and depth to groundwater for each mapped potential GDE area.

Grid-Based GDE Analysis

The grid-based analysis relied on the grid or raster-based representations of depth to groundwater. This grid-based analysis was carried out using three general geospatial processing steps.

The first step involved computing an area-weighted statistical representation of depth to groundwater for each mapped potential GDE area using the zonal statistics function available in many GIS programs. This zonal statistics function identifies what cells of the depth to groundwater grid or raster dataset fall within the bounds of each mapped potential GDE polygon and then computes an area-weighted average for that area. The zonal statistics analysis was carried out for each of the 12 representations of depth to groundwater between spring 2015 and fall 2020 yielding 12 columns summarizing the average depth to groundwater for each mapped potential GDE area.

The second step involved simply subtracting the calculated depth to groundwater for each mapped potential GDE from the assumed rooting zone depth that was previously assigned based on assumed predominant vegetation. This field calculation was carried out in GIS for each of the 12 representation of depth to groundwater and was added as a new field for each calculation.

The third step of the grid-based geospatial processing effort involved identifying which mapped potential GDE areas can reasonably be assumed to have access to groundwater for each period. Mapped potential GDEs where the difference between assumed rooting zone depth and computed depth to groundwater is positive or above zero are assumed to be connected to groundwater for that season and year representation as the rooting zone depth is greater than the depth to groundwater. Conversely, mapped potential GDEs where the difference between assumed rooting zone depths and computed depth to water is negative or below zero suggests that roots do not have access to groundwater. These areas are therefore assumed to be disconnected from groundwater for that season and year representation of conditions.

Mapped Potential GDE Classification

Mapped potential GDEs were characterized based on the percentage of season and year representations when vegetation with their assumed rooting zone depth would reasonably have access to groundwater. Areas with assumed vegetation that appear to have access to groundwater for

[21] https://data.cnra.ca.gov/dataset/periodic-groundwater-level-measurements

Table 2.27: Translation of Grid-Based Classification to GDE Classification.

Grid-Based Classification	GDE Classification
Mapped potential GDE has access to groundwater for = 50% of the period	Likely connected
Mapped potential GDE has access to groundwater for < 50% of the period	Potential GDE
Mapped potential GDE does not have access to groundwater for during the period	Likely disconnected

greater than 50 percent of the period of record are assumed to be "likely connected" to groundwater. During the period of record, and generally common for the Basin, spring groundwater levels are higher than fall levels. Therefore, this criteria translates into the ability of assumed vegetation GDEs to access groundwater during all springs and their growing period.

Areas with assumed vegetation and rooting zone depths that appear to have access to groundwater for less than 50% of the period of record are considered to be "potential GDEs" to account for the uncertainty and data gaps discussed here and in **Appendix 2-E**. Potential GDEs will be re-evaluated upon collection of additional data and information. GDEs that do not have access to groundwater in any season during the period of record are assumed to be "likely disconnected" from groundwater.

A summary of this classification is presented in **Table 2.27**. The relative percentage of seasons when mapped potential GDEs are assumed to have access to groundwater is presented in **Figures 2.69**. The distribution of classified GDEs for the Ukiah Basin is presented in **Figures 2.70**.

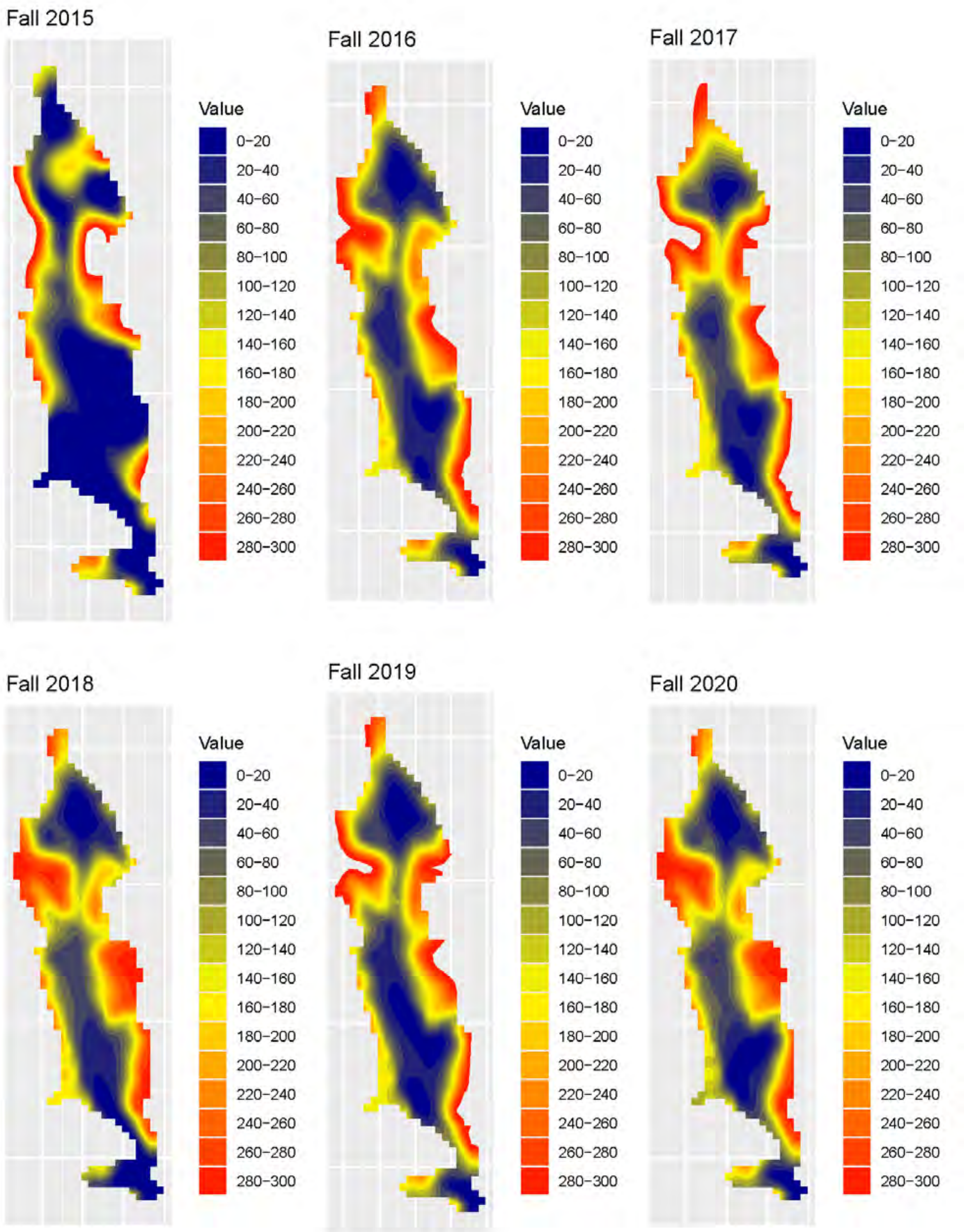

Figure 2.67: Depth to groundwater estimations from available CASGEM groundwater elevation measurements for Fall seasons.

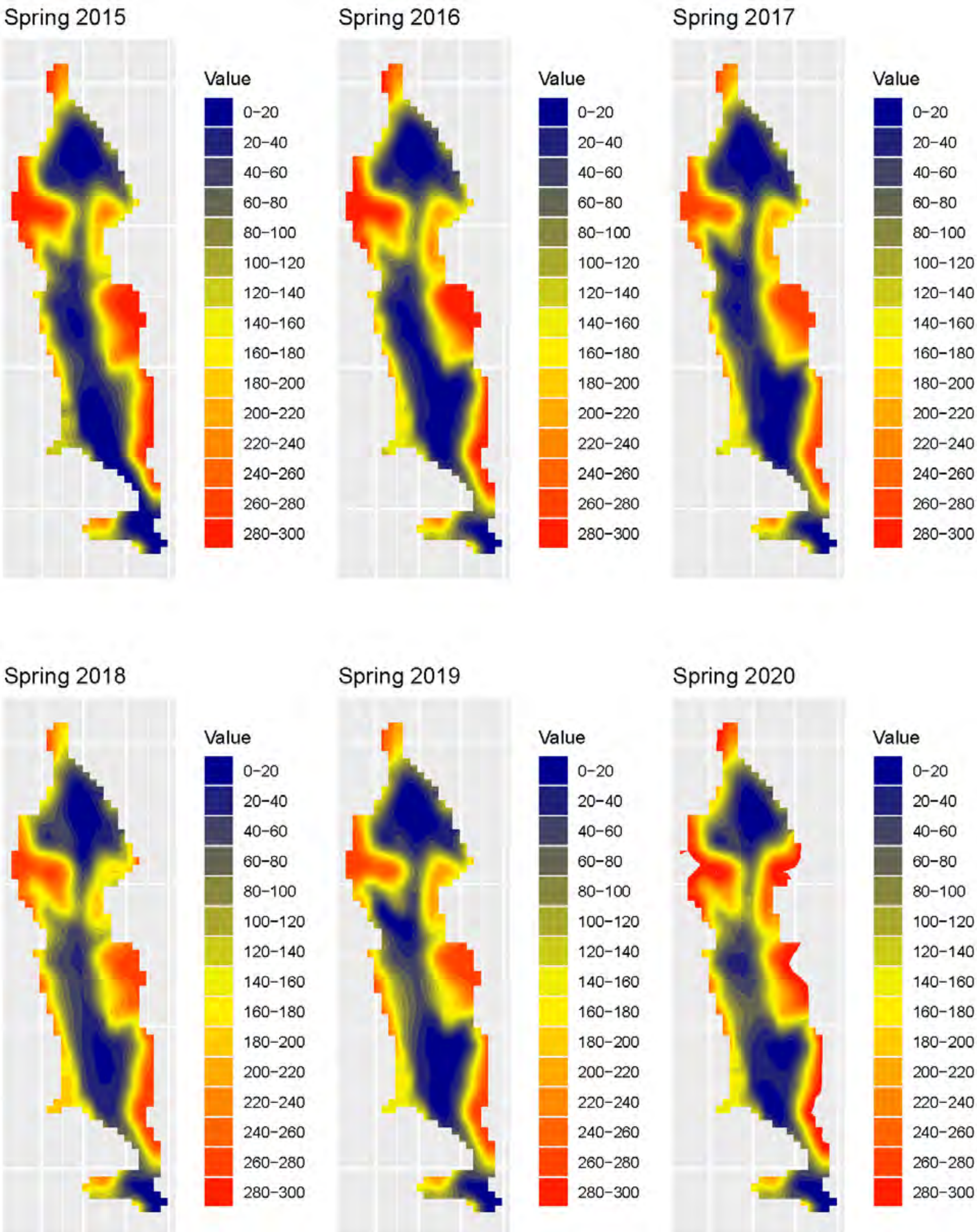

Figure 2.68: Depth to groundwater estimations from available CASGEM groundwater elevation measurements for Spring seasons.

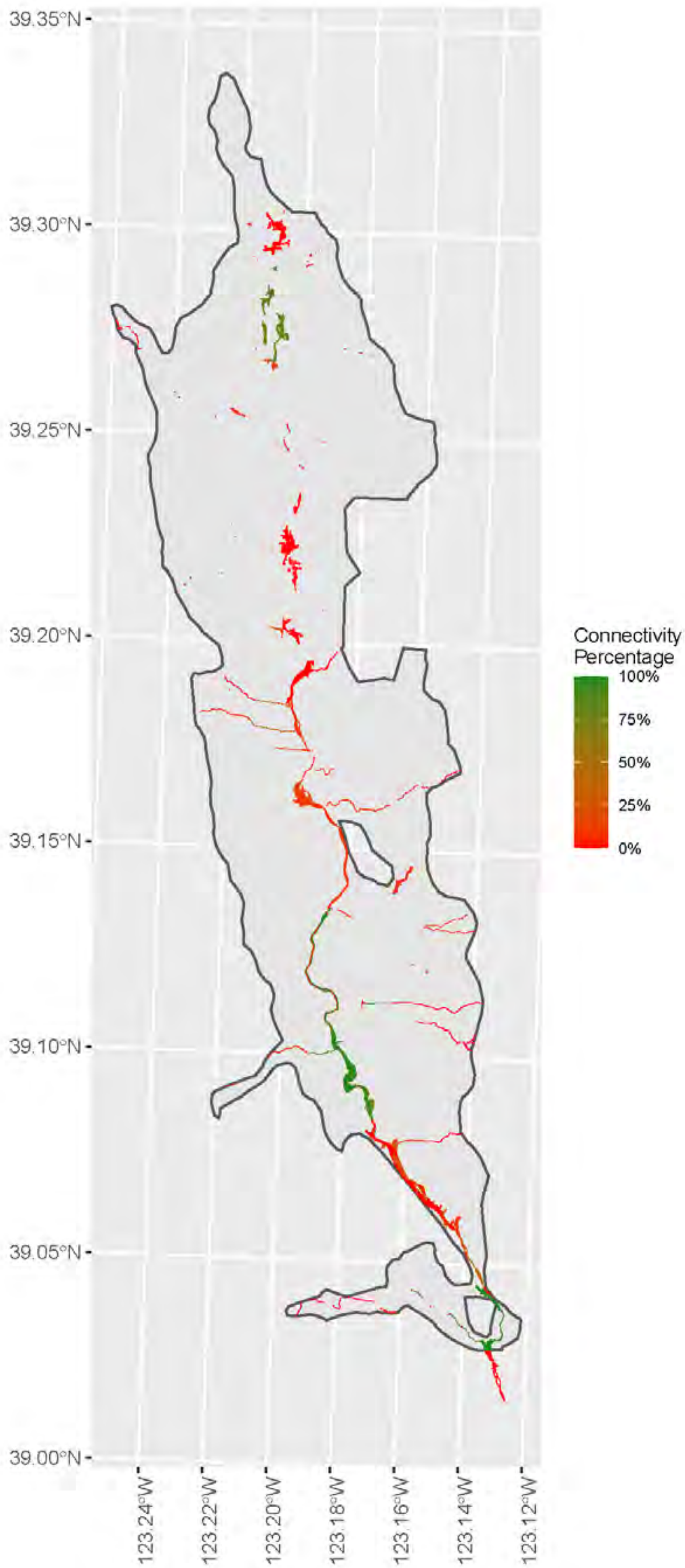

Figure 2.69: Percentage of seasons when mapped potential GDEs are assumed to have access to groundwater in the Ukiah Basin.

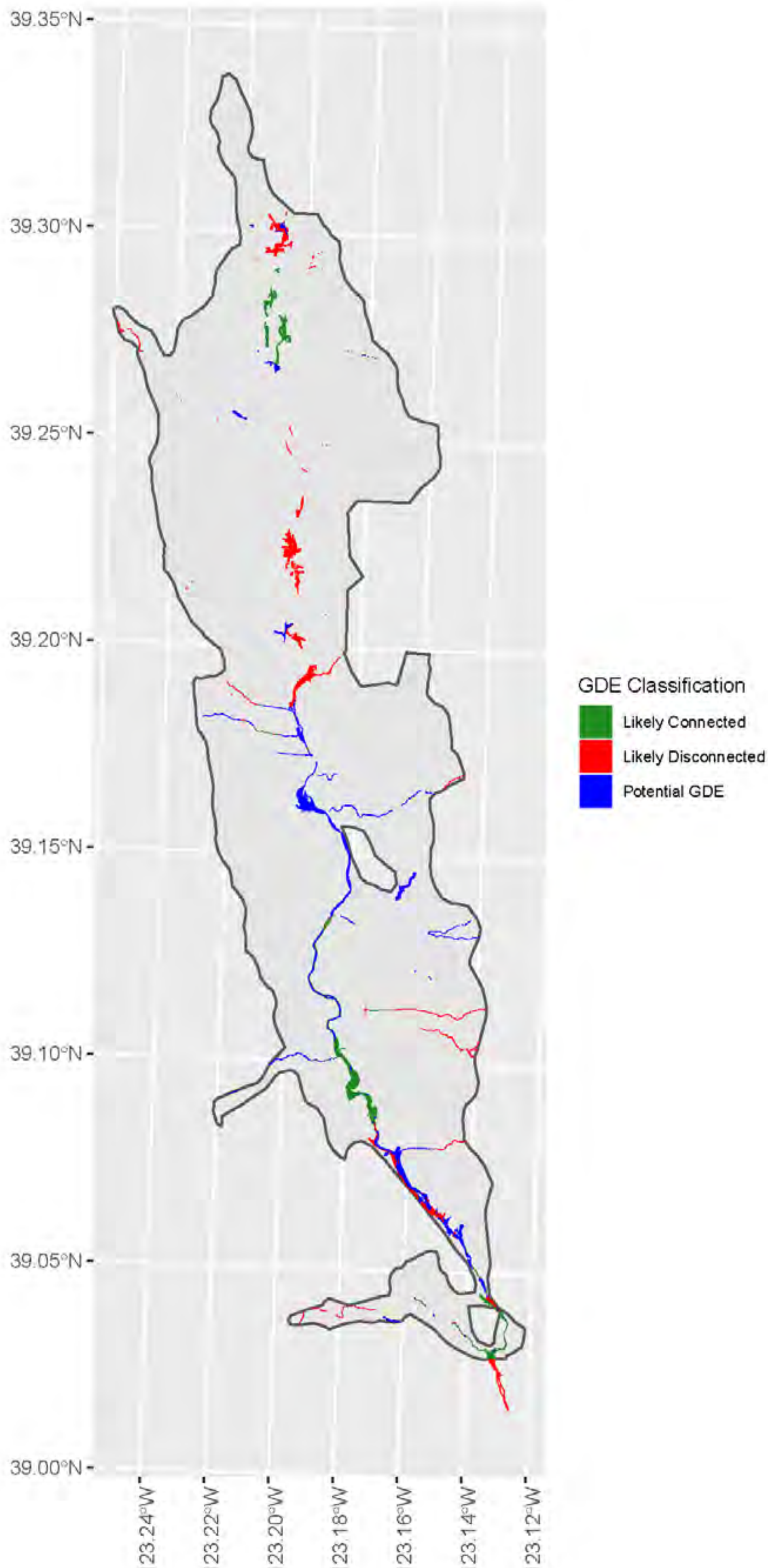

Figure 2.70: Classification of mapped potential GDEs into likely connected and likely disconnected for the Ukiah Basin.

Assumptions and Uncertainty

The approach developed and carried out to identify and evaluate GDEs within the Ukiah Basin represents a conservative application of best available science through the formulation of reasonable assumptions. Representations of mapped potential GDEs were developed based on available geospatial datasets, though these resources cannot be assumed to be definitive. The vegetation classes present in the datasets outlined in the mapped potential GDEs section above are broad and could reasonably represent an array of vegetation types requiring the development of conservative assumptions to guide the assignment of assumed rooting zone depths. Groundwater conditions were represented by the interpolation of observed conditions in the Basin's well network. These interpolated groundwater elevations may not reflect smaller scale variations in conditions both in space (less than 500 meters) and time (sub-seasonal). Because the groundwater elevations used herein represent regional, seasonal trends, they cannot capture the impact of perched aquifers on GDE health.

Notably, GDEs are not necessarily static and can vary in time and space depending on water year type and other environmental conditions. As such, this analysis is not intended to be a definitive cataloging of each class of GDE, but rather a survey of the maximum possible extent of above-ground, vegetated GDEs in the Ukiah Basin. A physical determination of GDEs must show that roots are connected to groundwater, which would require an infeasible subsurface geophysical survey across the Basin.

In the first 5 years of GSP development, more data will be collected and used to better refine the characterization of GDEs throughout the Basin. Data suggested for further improvement of characterization of groundwater levels and ISW will also provide critical information for GDEs (see **Appendix 2-E** for further discussion on data gaps). The current groundwater level information, for example, are too sparse in space and time to allow a less uncertain map of GDEs. In the data gap section, we will carefully highlight which new data will support better definition of GDEs over the next 5 years.

2.2.3 Water Budget

A summary of the water budget information for the Basin estimated by the UVIHM is described in this section. Detailed information on the water budget and model documentation is provided in **Appendix 2-D**.

Water budgets quantify the inflows and outflows to an area of interest. Land surface inflows in the Basin are dominated by precipitation, surface water supply, and groundwater supply to meet water demands, which are primarily agricultural and municipal. Recycled water is also another relatively minor inflow. Land surface outflows in the Basin are dominated by evapotranspiration of precipitation and applied water, infiltration, deep percolation and groundwater recharge, and surface runoff and streamflows. The Basin is a subarea of the Upper Russian River watershed area modeled by the UVIHM. Land surface processes in the Basin are impacted by inflows transported from upper watershed areas outside of the Basin. Therefore, in addition to the groundwater budget for the Basin, a water budget was calculated for the entire modeled area of the Upper Russian River Watershed.

Groundwater budgets show inflows and outflows to the aquifer from the bottom of the root zone, down through all aquifer layers. The Basin is underlain by two principal aquifers: Aquifer I and Aquifer II as described in **Section 2.2.1.4**. Groundwater inflows to the Basin are dominated by deep percolation and recharge from the overlying land surfaces as well as streambed recharge from the Russian River and its tributaries including inflow from the outer watershed area that flows through the Basin and is eventually recharged into the aquifer. Groundwater outflows are mainly comprised of pumping for irrigation and municipal uses, discharge to the Russian River and its tributaries including water that flows out of the Basin as part of the Russian River. The difference between groundwater inflows and outflows represents the net change in groundwater storage.

SGMA regulations also require GSAs to assess and consider the impacts of climate change in their projected water budgets. DWR has provided climate change data in the form of spatially and temporally distributed precipitation and evapotranspiration multipliers for 2030 and 2070 central tendency scenarios and two extreme scenarios reflecting drier conditions with extreme warming and wetter conditions with moderate warming, respectively. The two 2030 and 2070 central tendency scenarios were used in this GSP to summarize potential impacts of climate change on the projected water budget and other sustainability indicators.

2.2.3.1 Water Budget Data Sources

Water budget estimates provided in this section are calculated using the UVIHM model. UVIHM uses the USGS GSFLOW modeling software that is an integrated surface water and groundwater model combining the functionalities of Precipitation-Runoff Modeling System (PRMS) and Modular Groundwater Flow Model (MODFLOW) models. These platforms were selected primarily by the GSA in coordination with Sonoma Water and USGS efforts to develop a watershed wide integrated hydrological model for the Russian River Watershed. A detailed discussion of the UVIHM and its components, its setup and calibration processes, inputs, outputs, and final results are provided in **Appendix 2-D**.

The UVIHM covers the entire Upper Russian River watershed encompassing the Basin (**Figure 2.71**). This includes the entire Upper Russian River, water entering the watershed from the Potter

Valley Project, and water released from the Coyote Valley Dam and Lake Mendocino. The extent of the modeled area ends and drains around the City of Hopland.

The UVIHM was calibrated using measured groundwater level data from CASGEM monitoring program, streamflow data from three USGS gages, and solar radiation data from one California Irrigation Management Information System (CIMIS) station. A brief overview of water budget components is provided in **Table 2.28**.

Model input data shown in **Table 2.28** were gathered from various existing and available public data sources, as shown in **Table 2.29**. Further refinement of the model and results were made based on local and stakeholder input and local and regional observations.

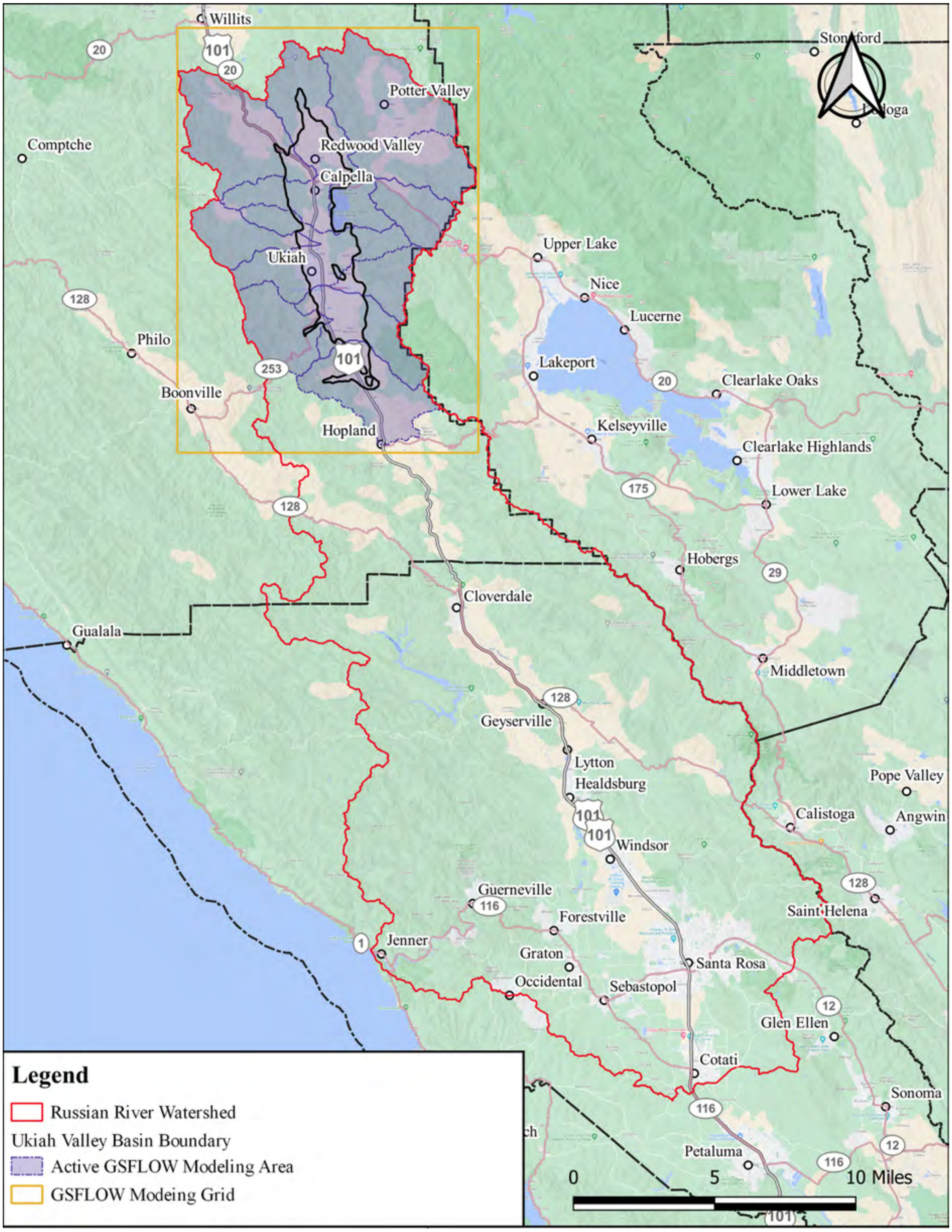

Figure 2.71: UVIHM model domain

Table 2.28: Water budget components estimated by UVIHM and their associated limitations

Water Budget Component	Model Input or Model Result	Source of Data	Limitations
Precipitation	Input Data	Measured precipitation from weather gages spatially distributed by PRMS precipitation distribution module. Similar precipitation and distribution method is used for historical and future budget. Climate change scenarios use spatially distributed precipitation multiplied by change factors produced for DWR climate change scenarios.	Spatial precipitation distribution may change with changing climate. Distribution method imposes uncertainties onto the model. Inherent measurement errors from gages and gaps in their measurement impose further uncertainties.
Managed Streamflow Releases	Input Data	Simulated using measured streamflow at East Fork Russian River USGS gage.	Dam Releases from Coyote Valley Dam. Area discharging surface water to the Mendocino Lake is skipped in the simulations since the output to the basin is simulated using the streamflow gage at East Fork Russian River.
Surface Water Diversions (Agricultural and Municipal)	Input Data (Agricul-tural pumping is estimated by the IDC)	Based on available data from municipalities. Most data used were up to 2015 and considered constant afterwards. Agricultural demands are estimated using IDC model.	Municipal data is mostly up to 2015 and considered constant and the same as 2015 afterwards. Future municipal use is also considered equal to 2015. Agricultural demand for future is estimated using IDC for future similar to the historical period. Land use and soil types are considered constant and the same as 2010 land use map.

Table 2.28: Water budget components estimated by UVIHM and their associated limitations *(continued)*

Water Budget Component	Model Input or Model Result	Source of Data	Limitations
Groundwater Pumping: Municipal Pumping and Agricultural Pumping	Input Data (Agricultural pumping is estimated by the IDC)	Metered for historical municipal pumping and some small water systems data was used for municipal pumping. Agricultural pumping was estimated using IDC model, climatic data, crop type, and land and soil data.	Municipal data is mostly up to 2015 and considered constant and the same as 2015 afterwards. Future municipal use is also considered equal to 2015. Agricultural demand for future is estimated using IDC for future similar to the historical period. Land use and soil types are considered constant and the same as 2010 land use map.
Land Surface Infiltration	Model Result	Simulated by the model.	Infiltration to the soil zone of the model simulated by the PRMS.
Inflow from Upper Watershed Tributaries	Model Result	Flow from Area Upstream of Basin, simulated from calibrated model for all creeks.	Tributaries do not have data for calibration.
Overland Runoff	Model Result	Simulated from calibrated model. Impervious and pervious areas are determined using 2010 Land Use map for the County.	Based on calibration of streamflow to available data from gauged streams. Land use is considered constant for the entire period.
Groundwater Boundary Inflow	Model Result	Simulated from calibrated model. Impervious and pervious areas are determined using 2010 Land Use map for the County.	Groundwater inflow from Basin boundaries simulated by the model. Due to definition of boundary conditions, this term is negligible.

Table 2.28: Water budget components estimated by UVIHM and their associated limitations *(continued)*

Water Budget Component	**Model Input or Model Result**	**Source of Data**	**Limitations**
Evapotranspiration (ET)	Model Result	Measured and gaged temperature is spatially distributed by PRMS temperature distribution module. Potential ET is simulated by PRMS using temperature and solar radiation. Solar radiation is calculated by PRMS and calibrated based on measured and gaged date. Actual ET is modeled by the model. For agricultural fields, soil zone ET is simulated using same data, reference evaporation from CIMIS gage, and appropriate crop coefficients by the IDC model. ET for climate change scenarios uses the historical and future simulations and multiplies them by change factors provided for DWR climate change scenarios.	Not simulated from surface water bodies. Distribution method imposes uncertainties onto the model. Inherent measurement errors from gages and gaps in their measurement impose further uncertainties. Crop coefficients are based on best available literature and considered constant through out the modeling area for each crop type. Available solar radiation data was limited and constrained solar radiation calibration.
Direct Percolation/Recharge	Model Result	Deep percolation of distributed precipitation from measured gages is simulated by the calibrated model.	Assumes percolation applies directly as recharge to water table without delay through unsaturated-zone flow (UZF) package option. Uses soil parameters from NRCS SSURGO dataset and 2010 DWR land use map for surficial permeability. These data along with aquifer characteristics are considered constant throughout the simulation.

Table 2.28: Water budget components estimated by UVIHM and their associated limitations *(continued)*

Water Budget Component	Model Input or Model Result	Source of Data	Limitations
Stream Loss to Groundwater	Model Result	Simulated from calibrated model.	Calibration was done to streamflow and groundwater levels and no seepage estimations, streambed characterization, or measured data was available for enhancing calibration observations.
Stream Gain from Groundwater	Model Result	Simulated from calibrated model.	Calibration was done to streamflow and no seepage estimations, streambed characterization, or measured data was available for enhancing calibration observations.
Groundwater Outflow from Basin	Model Result	Simulated outflow from Basin boundaries from calibrated model.	Subsurface outflow to adjacent basins was estimated to be very small.
Russian River Outflow from Upper Watershed	Model Result	Simulated from calibrated model.	Streamflow leaving the Basin area through mainstem Russian River.
Boundary Inflow to Upper Watershed	Model Result	Simulated from calibrated model.	Flows and fluxes entering the Upper Russian River Watershed from outside. This term is negligible.
Stream Exchange to(+)/from(-) Aquifer	Model Result	Simulated from calibrated model.	Streamflow lost to groundwater (+) or water gained from the aquifer (-). Signs are defined with reference to aquifers' water balances.

Table 2.29: Public data and gages used for UVIHM and water budget

Source	Station Name	Data Type	Unit	Start Date	End Date	Latitude	Longitude	Elevation (ft-amsl)
CDEC	CDW	Evaporation	Inches/Day	2010-02-08	2018-12-31	39.203	-123.185	670
CIMIS	CIMIS 106	Evaporation	Inches/Day	1991-01-01	2018-12-31	38.983	-123.089	525
CDEC	CDM	Gauge Height	Feet	2010-02-08	2018-12-31	39.198	-123.186	614
CDEC	MRK	Gauge Height	Feet	2016-09-14	2018-12-31	39.332	-123.235	955
CDEC	Q03	Gauge Height	Feet	2014-02-06	2016-03-21	39.377	-123.328	1447
CDEC	RRU	Gauge Height	Feet	2010-02-08	2018-12-31	39.196	-123.194	599
CDEC	CDW	Precipitation	Inches	2010-02-08	2018-12-31	39.203	-123.185	670
CDEC	LYO	Precipitation	Inches	2010-12-23	2017-04-09	39.125	-123.071	3200
NOAA	POTTER VALLEY POWERHOUSE, CA US	Precipitation	Inches	1991-01-01	2018-12-31	39.362	-123.129	1018
NOAA	UKIAH 4 WSW, CA US	Precipitation	Inches	1991-01-01	2018-11-30	39.127	-123.272	1328
NOAA	UKIAH MUNICIPAL AIRPORT, CA US	Precipitation	Inches	2001-01-01	2018-12-31	39.126	-123.201	601
NOAA	UKIAH, CA US	Precipitation	Inches	1991-01-01	2013-05-24	39.147	-123.210	636
CDEC	WIL	Precipitation	Inches	1991-01-01	2018-12-31	39.351	-123.322	1925
NOAA	WILLITS 1 NE, CA US	Precipitation	Inches	1991-01-01	2012-09-27	39.419	-123.343	1353
CDEC	CDW	Relative Humidity*	%	2010-02-08	2017-04-09	39.203	-123.185	670
CDEC	LYO	Relative Humidity*	%	1995-01-01	2018-12-31	39.125	-123.071	3200
CDEC	PVP	Relative Humidity*	%	2009-11-23	2018-12-31	39.367	-123.133	1020
CDEC	CDW	Solar Radiation**	Watts/Square Meters	2010-12-23	2018-12-31	39.203	-123.185	670
CDEC	LYO	Solar Radiation**	Watts/Square Meters	2010-12-23	2014-04-26	39.125	-123.071	3200
USGS	11461000	Stream Discharge	cfs	1991-01-01	2018-12-31	39.195	-123.195	599
USGS	11461500	Stream Discharge	cfs	1991-01-01	2018-12-31	39.247	-123.130	788
USGS	11462000	Stream Discharge	cfs	1991-01-01	2011-10-01	39.197	-123.188	614
USGS	11462080	Stream Discharge	cfs	2009-08-06	2018-12-31	39.113	-123.183	560
USGS	11462500	Stream Discharge	cfs	1991-01-01	2018-12-31	39.027	-123.131	498

Table 2.29: Public data and gages used for UVIHM and water budget *(continued)*

Source	Station Name	Data Type	Unit	Start Date	End Date	Latitude	Longitude	Elevation (ft-amsl)
USGS	11471000	Stream Discharge	cfs	1991-01-01	2017-09-30	39.367	-123.128	0
NOAA	BOONVILLE CALIFORNIA, CA US	Temperature	Degree Fahrenheit	1991-01-01	2018-12-31	38.988	-123.349	644
CDEC	CDW	Temperature	Degree Fahrenheit	2010-02-08	2018-12-31	39.203	-123.185	670
NOAA	HOPLAND CALIFORNIA, CA US	Temperature	Degree Fahrenheit	2001-10-04	2018-12-31	39.031	-123.081	2682
CDEC	LYO	Temperature	Degree Fahrenheit	1991-06-01	2018-12-31	39.125	-123.071	3200
NOAA	POTTER VALLEY POWERHOUSE, CA US	Temperature	Degree Fahrenheit	1991-01-01	2018-12-31	39.362	-123.129	1018
CDEC	Q03	Temperature	Degree Fahrenheit	2014-01-10	2016-03-21	39.377	-123.328	1447
NOAA	UKIAH MUNICIPAL AIRPORT, CA US	Temperature	Degree Fahrenheit	2001-01-01	2018-12-31	39.126	-123.201	601
NOAA	UKIAH, CA US	Temperature	Degree Fahrenheit	1991-01-01	2013-05-24	39.147	-123.210	636
CDEC	WIL	Temperature	Degree Fahrenheit	2009-10-27	2013-06-12	39.351	-123.322	1925
NOAA	WILLITS 1 NE, CA US	Temperature	Degree Fahrenheit	1991-01-01	2012-09-27	39.419	-123.343	1353
CDEC	CDW	Wind Speed*	Miles/Hour (MPH)	2010-12-23	2018-12-31	39.203	-123.185	670
CDEC	LYO	Wind Speed*	Miles/Hour (MPH)	1995-01-01	2018-12-31	39.125	-123.071	3200

* Data from these gages were not used directly in the UVIHM due to the selection of computation modules ad their required data.
** Solar radiation was estimated by the UVIHM and calibrated to the limited data available from the gages.

2.2.3.2 Model Assumptions and Uncertainty Related to the Water Budget

Like any other modeling application, the UVIHM and its modeling platform, GSFLOW, have inherent structural uncertainty and their results should be interpreted as reasonable representations of conditions based on the information available. In addition, unpredictability in climate, water demands, and impacts of climate change introduce further uncertainties into the model and its outputs. Simplifying assumptions made through the development of the model that include, but are not limited to, representations of geological and climatic heterogeneity, projections of land use, soil types, and water demands all contribute to uncertainty regarding the projections presented in these historical and projected water budgets.

Furthermore, data gaps and lack of understanding regarding key hydrologic and hydrogeologic conditions within the Basin and the broader Russian River Watershed are significant sources of uncertainty. Temporal and spatial gaps in groundwater elevation measurements, streamflow measurements, streambed elevation and conductance combined with uncertainties in geologic and hydrogeologic information in the Basin constrain the model's ability to produce and project highly refined results.

A detailed discussion of data gaps and model uncertainties and assumptions are provided in **Appendix 2-E** and **Appendix 2-D**, respectively. Despite existing data gaps and uncertainties, model inputs were carefully selected and the model's structure was thoughtfully developed based on the best available data and information to provide a well-suited tool for assessing historical and current conditions and provide projections to support efforts to effectively manage groundwater resources through informed decision making. Uncertainties and data gaps were also carefully considered and estimated to assist in decision making and determine where and when a more conservative approach is needed to be taken for the management of the Basin.

Accordingly, due to spatially and temporally sparse groundwater measurements in Aquifer I, uncertainty in its spatial extent, and other data gaps, water budget is not estimated for each principal aquifer separately. Water budget is estimated for the entire Basin. Water budgets will be re-assessed and updated during 5-year reviews of the plan, and separate water budgets for principal aquifers will be developed as additional data and information are collected that enhance the performance of the UVIHM.

2.2.3.3 Historical Water Budget

The historical water budget for the Basin was estimated using the UVIHM for the period October 1992 through September 2018. The 27-year simulation period includes water years ranging from critical (e.g., 2008 and 2009) to wet (e.g., 2017) and multiple cyclical changes in wet and dry periods, as shown in **Figure 2.72**. Because surface water conditions and the potential occurrence of undesirable results (defined in **Chapter 3**) are heavily dependent on water year type, this section will include water budget quantities for each average water year type, as well as for the overall 27-year model period. The historical annual water budget is shown in **Figure 2.73** and average monthly values of budget components for each water year type are shown in **Figure 2.74**.

Main inflows to the Basin include deep percolation or recharge from precipitation and agricultural irrigation, stream recharge, and inflow from upper watershed tributaries. All three of these inflows are directly dependent on precipitation. Recharge of the aquifers is therefore primarily the result of infiltrated precipitation that moves downward and reaches the principal aquifers. Streambed recharge is dependent on streamflows and the interaction of surface water bodies and groundwater aquifers. This interaction, although complex, is heavily impacted by direct runoff resulting from precipitation and managed reservoir releases that are determined by precipitation and streamflow.

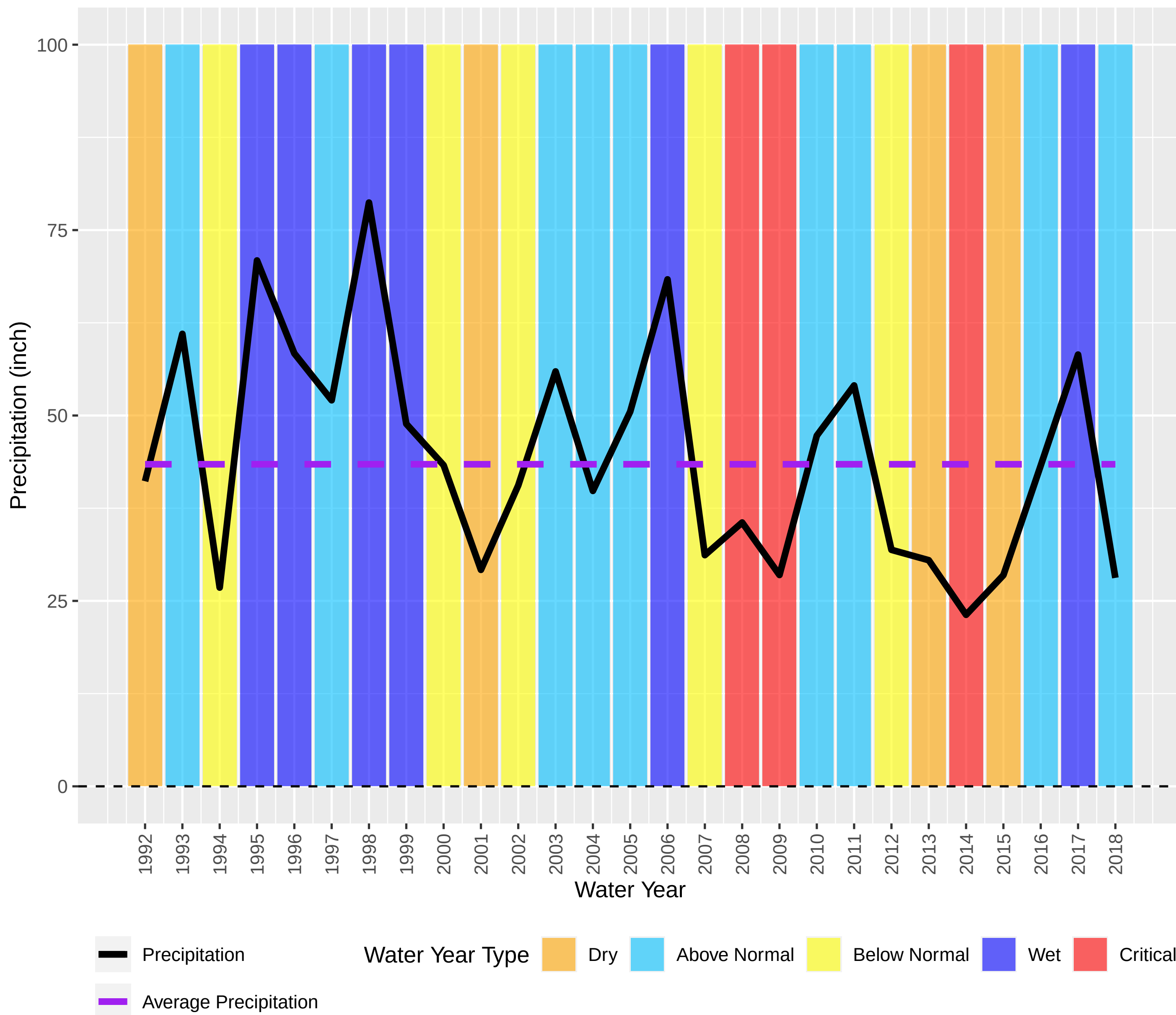

Figure 2.72: Historical precipitation and water year types for the Upper Russian River Watershed (UVIHM active modeling area).

Inflow from upper watershed tributaries is similarly directly correlated with precipitation. Due to the GSFLOW structure and how the UVIHM is set up, inflow from upper watershed tributaries may be overestimated for the groundwater budget and have a slight impact on the values of stream loss to and gain from the aquifers. The UVIHM was developed to model the entire Upper Russian River watershed for surface water processes that contribute flows to the Ukiah Valley Groundwater Basin. A very shallow aquifer with a negligible depth was implemented as the extension of the upper aquifer in the Basin to cover the entire Upper Russian River watershed. This provides the connection between the surface water calculation module (PRMS) and groundwater flow modeling module (MODFLOW) in the coupled GSFLOW model to simulate the integration of these resources and the impact of surface water processes of the entire Upper Russian River watershed on the Basin. This simplified characterization of groundwater conditions outside of the Basin to address a key data and understanding gap may be over or underestimating the volume of surface runoff reaching the Basin and contributing to recharge.

The three sources of inflow mentioned above provide the entire water input to the groundwater budget and can vary depending on the water year type and precipitation, as shown in **Table 2.30**. Groundwater inflow from Basin boundaries was considered negligible.

Main outflows from the Basin and groundwater budget are groundwater use and production, groundwater loss to the stream network, and water that flows out of the Basin through the Russian River stream channel. Groundwater outflow from Basin boundaries is considered negligible and outflow from the Basin primarily occurs through the Russian River surface and subsurface channel.

Groundwater production in the Basin satisfies multiple demand categories such as agricultural, municipal, domestic, and industrial uses. The major historical producers of groundwater in the Basin have been the agricultural and municipal sectors. Municipal pumping has been implemented in the UVIHM based on the data received from major water suppliers in the Basin. Most of the municipal pumping data shared with the GSA covered the period up to 2015. Therefore, municipal pumpage is considered constant and equal to the 2015 water year for the following three years through 2018. Depending on the water year type, municipal pumpage can be between 1 to 2 TAF in the Basin (**Table 2.30**).

Agricultural pumpage was estimated using the Integrated Water Flow Model Demand Calculator (IDC) program. The IDC estimates applied water based on climatic data, crop type, land use, soil types, and acreage of irrigation. Input data for the IDC was collected from the same sources that were used to develop the GSFLOW model. The major crop in the Basin as mentioned in **Section 2.1.1** is grapes. Pears and pasture are also farmed in the Basin to a lesser extent. Agricultural demand estimated by the IDC is around 5 TAF and slightly changes due to water year types. Based on observational input from stakeholders in the Basin, more than 60% of the agricultural demand is satisfied using surface water diversions. Therefore, agricultural groundwater pumpage is representative of less than 40% of the total demand.

Stream gain from the aquifers normally occurs during wet periods (mid-November to mid-June) as shown in **Figure 2.74**. Stream gain from the aquifers can significantly vary based on the water year type and precipitation patterns, from less than 2 TAF during critical and dry years to more than 6 TAF in wet years.

Stream loss to groundwater (streambed recharge) typically occurs during the summer months and in early fall, during irrigation periods. Stream recharge is also dependent on the water year types and can vary between 3 TAF to 4.5 TAF.

As mentioned throughout this chapter and observed from the historical water budget, the Basin is heavily dependent on precipitation. Historically, it has fully recharged during above normal and wet years with users relying on storage during years with less precipitation. Precipitation and recharge in the Basin depend on the outer areas in the Upper Russian River watershed and tributary flow. Therefore, the Upper Russian River watershed budget is also provided to illustrate the impacts of precipitation and evapotranspiration on the Basin and the watershed (**Figure 2.75**).

Table 2.30: Ukiah Valley Groundwater Basin estimated historical water budget for each water year type based on the average of 1992-2018. Values are in acre-foot.

Water Budget Component	Critical	Dry	Below Normal	Above Normal	Wet
Groundwater Boundary Inflow	5.4	5.3	5.3	5.3	5.3
Deep Percolation/Recharge	3352.3	3777.0	3898.7	5799.3	7879.3
Stream Loss to Groundwater	3992.6	4255.4	3967.4	3414.5	3156.7
Inflow From Upper Watershed	4277.8	4349.6	4497.8	4632.1	4954.9
Municipal Pumping	1233.7	1711.5	2038.6	1752.2	2130.0
Agricultural Pumping	5000.3	4882.3	4872.2	4477.8	4363.0
Stream Gain from Groundwater	1828.7	2205.7	2358.4	3851.7	5913.3
Groundwater Ouflow from Basin	1.0	1.0	1.0	1.0	1.0

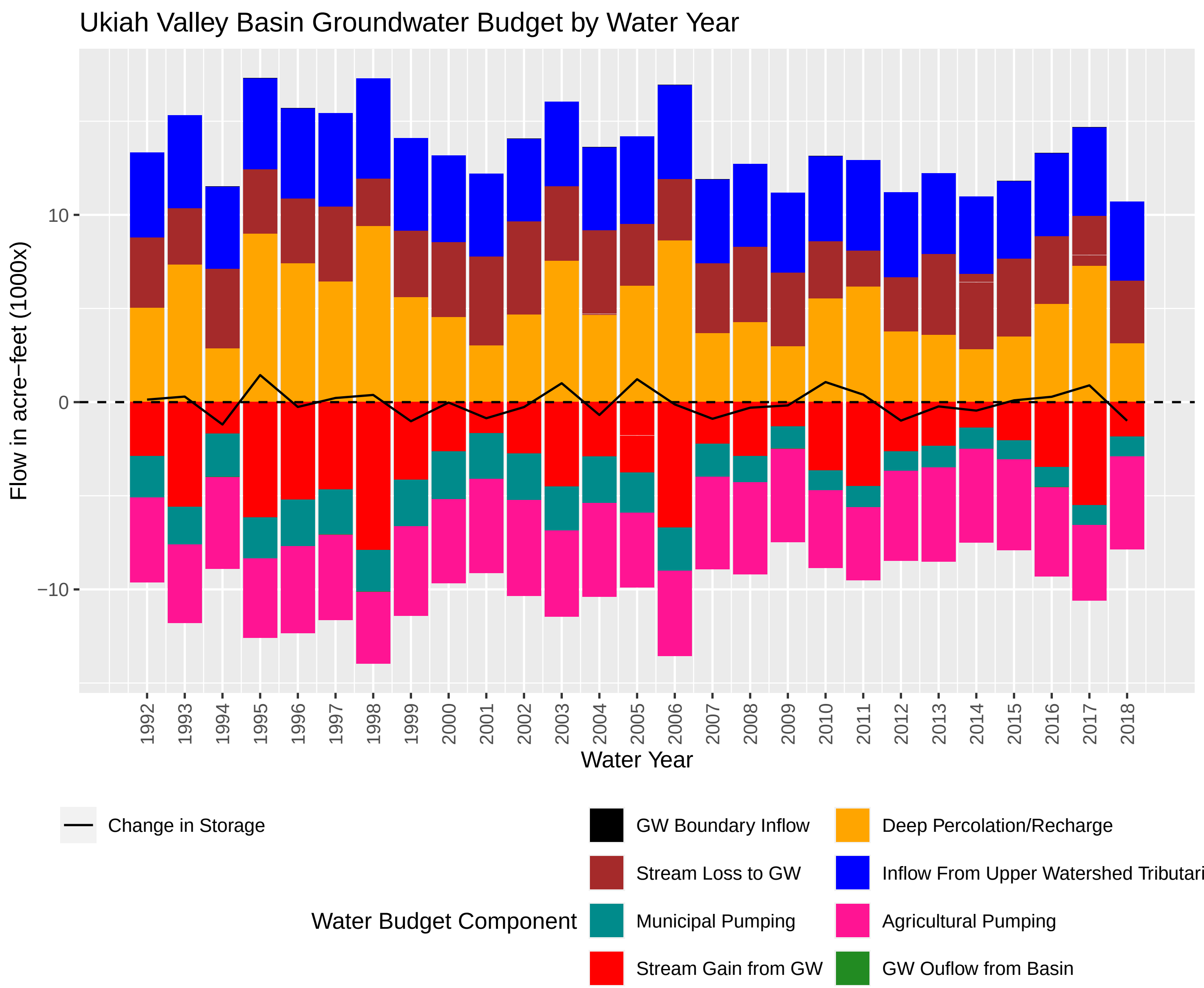

Figure 2.73: Estimated historical annual groundwater budget for the Basin averaged over 1992-2018.

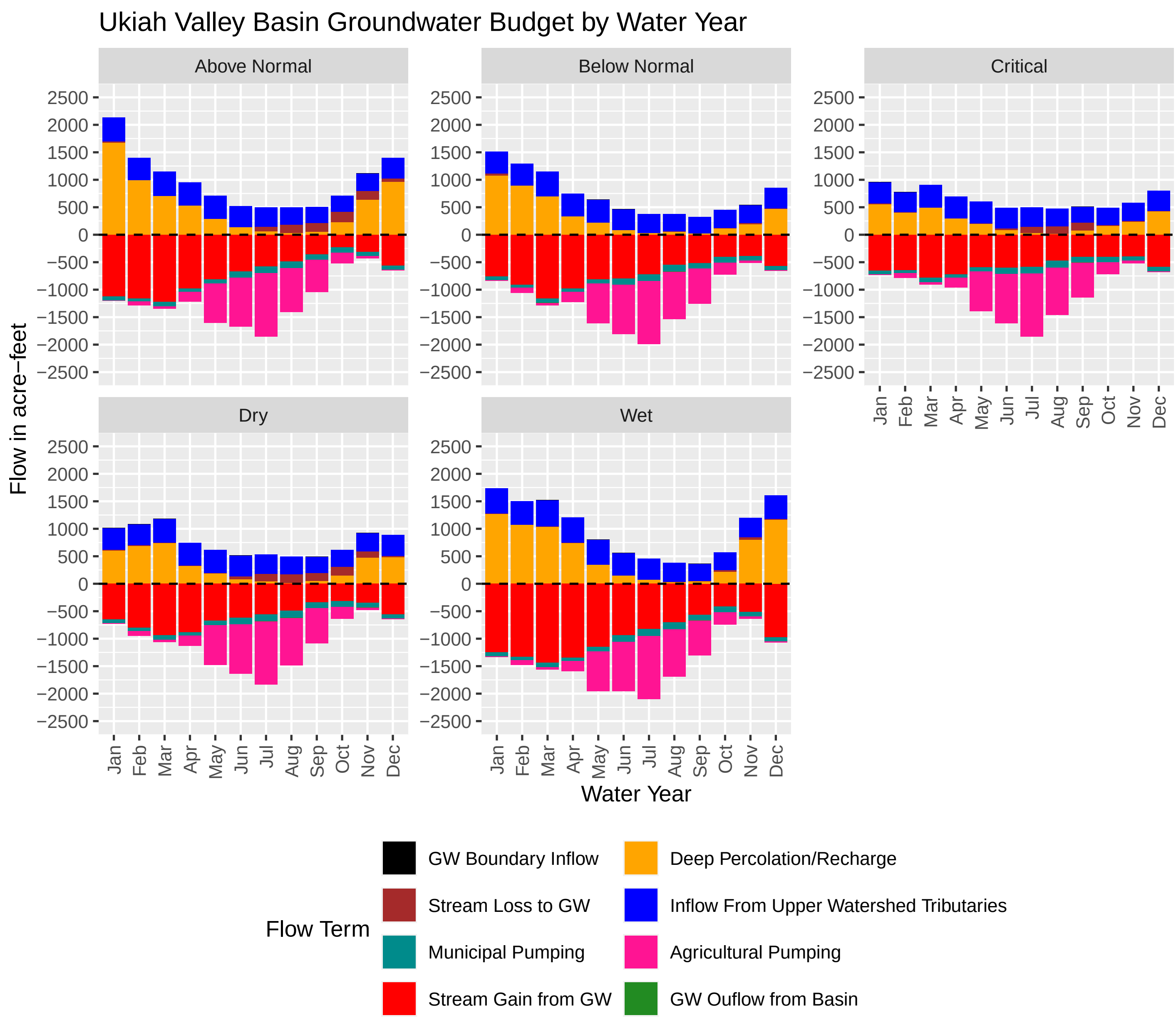

Figure 2.74: Estimated historical average monthly water budget for the groundwater Basin for each water year type. Water budget components are averaged over the same water year types in the 1992-2018 period.

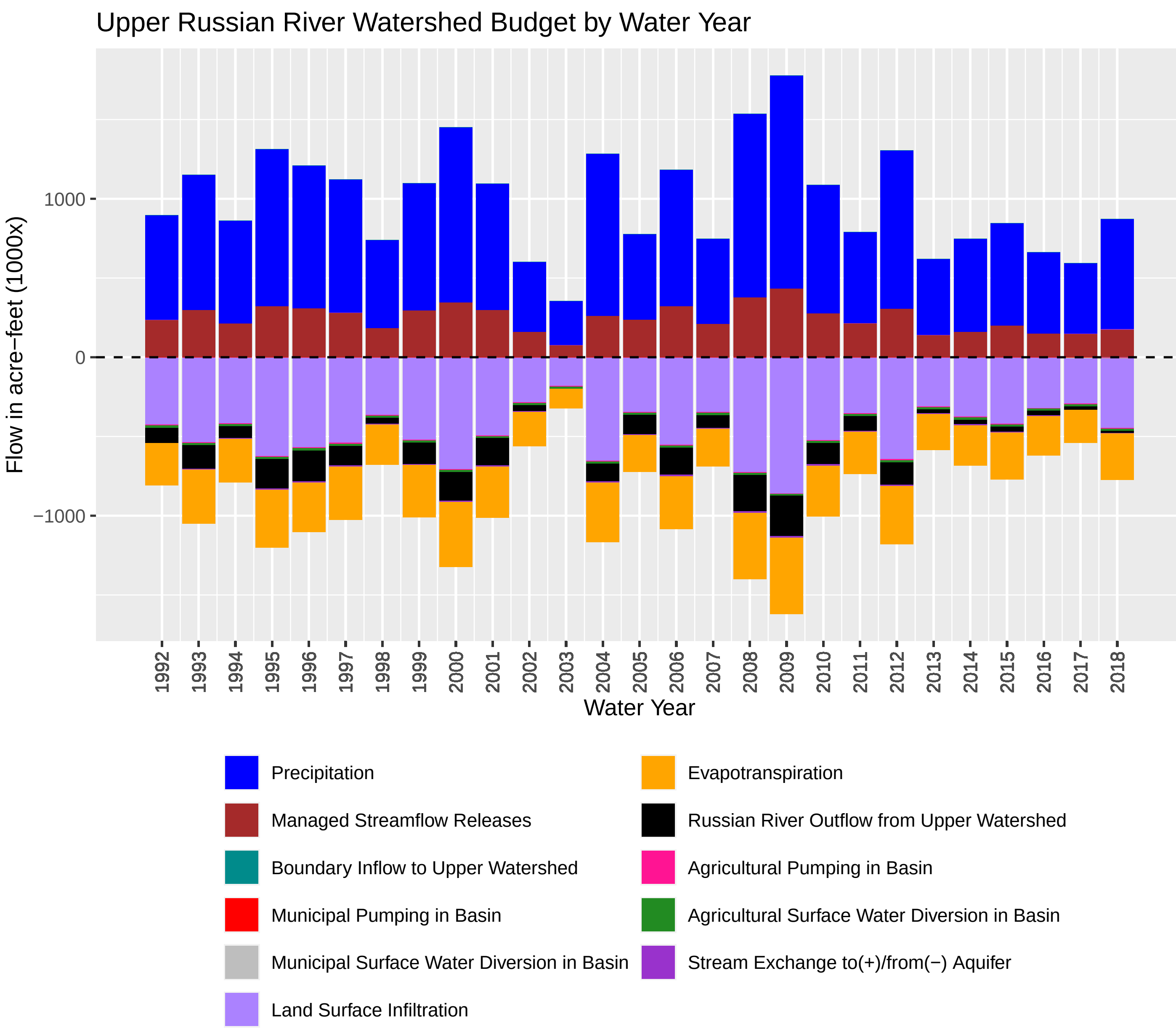

Figure 2.75: Estimated historical annual water budget for the Upper Russian River watershed.

2.2.3.4 Current Water Budget

The current water budget is provided as an indication of present conditions in the Basin using the most recent historical time series and observations. The current period for the Basin is defined as water year 2015 through water year 2018. Although this period includes an end-of-drought year and a very wet year, it reflects the best historical period available to assess conditions of the Basin considering the availability of data and other relevant information. For current conditions, municipal demands, including groundwater pumping and surface water diversions, were implemented based on the most recent data available.

Estimated annual groundwater budget for current conditions is shown in **Figure** 2.76. Due to the short length of the current period, monthly averaged water budget components are also provided in **Table** 2.31 to provide a better picture of budget components.

Current conditions follow a similar pattern as the historical period. **Figure** 2.76 shows the correlation of the budget with precipitation and water year type. Wetter years lead to more recharge and inflow from the Upper Russian River watershed tributaries and higher stream gains from the aquifers. On a monthly scale, most of the recharge happens between October to June, with the majority of recharge occurring from December to April. Groundwater and stream exchange is divided into stream losses from June to November, and stream gain during the rest of the year. This mirrors the primary irrigation season and agricultural uses in the Basin.

Table 2.31: Estimated Ukiah Valley Groundwater Basin monthly water budget averaged over 2015-2018 for current conditions. Values are in acre-foot.

Water Budget Component	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Groundwater Boundary Inflow	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.4	0.5	0.4	0.5
Deep Percolation/Recharge	1602.4	1016.4	1031.1	507.5	271.1	103.5	40.3	18.8	13.0	193.4	372.2	1084.6
Stream Loss to Groundwater	11.3	0.0	7.1	0.0	1.2	88.1	528.2	655.0	535.0	695.2	435.1	181.1
Inflow From Upper Watershed	434.2	413.8	455.1	431.5	433.5	400.1	377.1	341.9	302.4	308.4	319.2	370.8
Municipal Pumping	69.7	55.8	81.7	61.2	76.0	114.0	125.2	126.0	103.1	100.1	79.7	77.0
Agricultural Pumping	4.7	40.7	39.9	249.1	659.3	816.7	1143.0	704.3	526.0	206.9	24.6	13.7
Stream Gain from Groundwater	808.9	1050.9	1112.5	836.6	297.4	16.3	0.0	0.0	0.0	0.0	15.9	325.3
Groundwater Ouflow from Basin	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

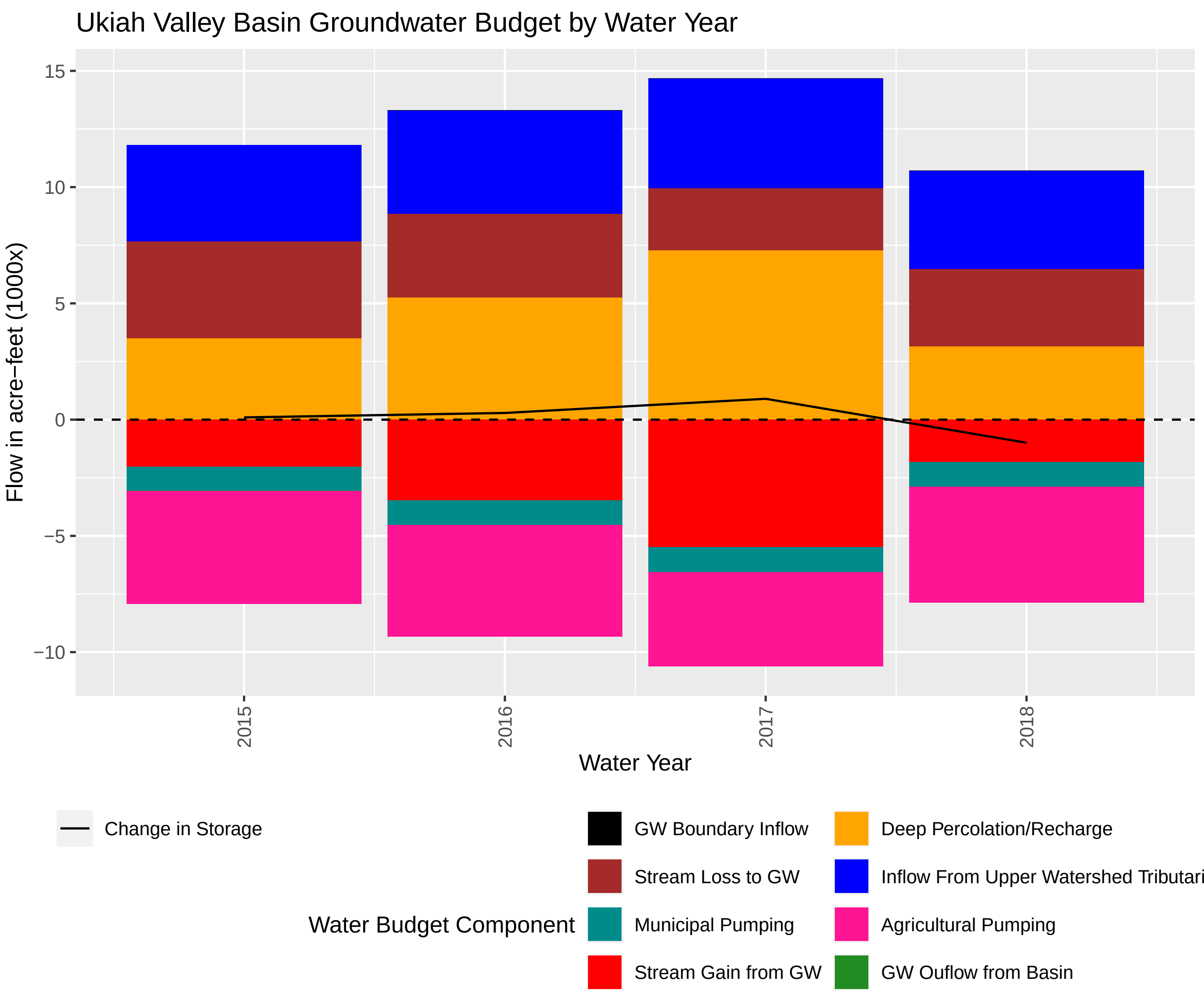

Figure 2.76: Estimated current annual groundwater budget for the Basin averaged over WY 2015-2018.

2.2.3.5 Historical and Current Water Budget Key Insights

The Basin is surrounded by an upper watershed that has highly variable natural runoff depending on precipitation and water year type. The Basin itself generates additional discharge to the stream system that exits the Basin boundary. The groundwater system receives recharge from both the stream system, especially along the upper alluvial fans of the tributaries, and from the landscape. The Russian River also provides recharge to the Basin during dry months. Groundwater within the Basin discharges into the Russian River, and into the lower sections of its tributaries.

Precipitation occurs predominantly in the winter months, from October through May. Irrigation with surface water and groundwater between April and October is used to grow grapes and pears along with smaller acreages of other fruits between April and October. Perennial crops such as cannabis and pasture also exist in the Basin in smaller acreages. Historically, agricultural and municipal demands have been variable depending on the water year type. However, the magnitude of changes in these demands is almost negligible compared to the changes in the other elements of the water budget in different water year types. Agricultural groundwater demands in the Basin have not been increasing in the recent historical period due to the change of crops from higher water demand pears to lower water demand grapes. Recent increases in the higher water demand and often prennial cannabis cultivation may impact this trend in the future. Municipal demands have been relatively stable as well in the past 10 years.

Winter rains as well as winter and spring runoff recharge the two aquifer systems between October and April. Groundwater discharge to streams along the channels drain the aquifer system during the wet season. The stream system also contributes to groundwater recharge during the irrigation season mainly through managed releases from the Coyote Valley Dam. Groundwater pumping further contributes to the natural lowering of water levels during the dry season, leading to less baseflow.

Seasonal variability of recharge is accentuated by year-to-year climate variability. Years with low precipitation lead to lower runoff from the surrounding watershed leading to less recharge from the tributaries into the alluvial fans, less recharge across the landscape of the Basin, and therefore less increase in winter groundwater storage in the aquifer system.

Any significant decrease or increase of long-term precipitation totals over the watershed will lead to commensurate lowering or raising in the average slope of the water table from the valley margins toward the Russian River stream channel and a dynamic adjustment of water levels, even under otherwise identical land use and land use management conditions. Such changes are unlikely to lead to groundwater overdraft. However, they will affect baseflow conditions, the timing of the spring recess in Russian River flows and the arrival of the first fall flush flows in the river system. Similarly, any increase or reduction in groundwater pumping will lead to a commensurate decrease or increase in groundwater discharge to the stream systems or an increase in storage and groundwater elevations. Any managed increase in recharge will also lead to similar impacts in the Basin.

2.2.3.6 Projected Water Budget

To inform long-term hydrologic planning, a future projected water budget was developed using the following method:

1. Climatic and hydrologic data and input from water years 1965 to 2018 were used to make a future baseline longer than the 50 years required under SGMA. The first few years of the period are used to allow the model to spin up and function effectively but are not incorporated into outputs. The 50-year baseline used for the water budget is equal to water years from 1969 to 2018. The future baseline projection represents a hypothetical future period in which climate conditions are the same as historical conditions.

2. Water demands including agricultural and municipal pumping and surface water diversions are considered constant and equal to that of the water year 2018. All other inputs to the model such as land use, soil types, etc are kept as their most recent value.

3. The climate-influenced variables precipitation (as rain), and potential ET were altered to represent the following two DWR designed climate change scenarios:

   - Near-future climate, representing conditions in the year 2030 (held over the entire projection timeline); and,
   - Far-future climate, representing central tendency of projected conditions in the year 2070 (held over the entire 50-year projection).

4. The UVIHM was run for the projection period for the future baseline and the two projected climate change scenarios.

The scenarios described in points 2a-2d above will be referenced as the near and far future climate scenarios, respectively. Additional details for future water budget and climate change simulations are included in **Appendix 2-D**.

The climate record for the projected timeline was constructed from model inputs for the same timeline multiplied by climate change factors provided by DWR for each scenario. These change factors are only provided up to 2011. Therefore, from 2012 to 2018 multipliers were selected based on the similarity of water year types and precipitation amounts, with the preference of selecting the most recent similar years.

Under their SGMA climate change guidance, DWR provided a dataset of change factors which each GSA can use to convert local historical weather data into 4 different climate change scenarios (DWR 2018). Change factors are geographically and temporally explicit. Geographically, a grid of 1/16-degree resolution cells covers the extent of California; for each of these cells, one change factor applies to each month, from 1911 to 2011.

The change factor concept is intended to convert all past years to a single near or far future year; for example, imagining that in a hypothetical grid cell, the 2030 (Near) scenario change factor for reference ET in March 2001 was 5 percent. This would imply that under the local results of the global climate change scenario used to inform this guidance, if March 2001 had occurred in the year 2030, there would be 5% more ET in that grid cell than historically observed.

Climate change scenarios include the Recycled Water Project since it started in 2019. Recycled water project delivers water to agricultural users along the mainstem Russian River in central and southern Ukiah Valley and provides an opportunity for conjunctive use. This helps reduce surface water diversion and groundwater pumping during the irrigation period. For climate change scenarios, it was assumed that recycled water users mainly use surface water, and the amount of recycled water delivered to them was subtracted from their most recent historical surface water diversion.

In addition, CVD releases from Lake Mendocino were not altered due to climate change. While this assumption is not scientifically accurate and climate change will impact managed water releases from the CVD and storage in Lake Mendocino, the accurate estimation of CVD releases for DWR scenarios was determined to be infeasible within the timeline available for GSP development. Therefore, acknowledging the uncertainty imposed by this assumption, the GSA found it the best feasible approach to consider climate change impacts during GSP development in its analysis and decision-making process. The GSA has outlined a PMA in **Chapter 4** of the GSP and developed a framework for the generation of future climate change scenarios and enhancement to the UVIHM. This framework is explained in more detail in **Appendix 2-D**.

The annual projected groundwater budget over the 2019-2070 future baseline period is shown in **Figure 2.77**. Budget elements are quantified in **Table 2.32** for each water year type by averaging similar water years throughout the baseline period. Similar to the historical period, the projected water budget is largely dependent on precipitation and water year type, specifically for groundwater recharge, streams and groundwater exchange, and inflow from upper watershed tributaries.

Table 2.33 shows annual groundwater budgets for all timelines and scenarios averaged over their entire respective periods. Comparison of historical, current, and future baseline periods indicates that less recharge and stream loss to groundwater on average is expected in the future, reducing the amount of inflow to the Basin. Groundwater discharge to the stream system will also be increased compared to historical and current conditions adding to the increasing difference between inflows and outflows. Similarly, Near and Far climate change scenarios show a decline in aquifer recharge and stream loss to aquifers. Although this seems to constrain the Basin in the future in average conditions, no significant trend in cumulative storage change could be established from the future baseline conditions, or climate change scenarios. In addition, the uncertainty and unpredictability of climate conditions need to be considered to interpret future baseline and climate change results cautiously since an exact repeat of the historical period may not be likely.

Table 2.32: Ukiah Valley Groundwater Basin estimated projected water budget for each water year type averaged over 2019-2070. Values are in acre-foot.

Water Budget Component	Critical	Dry	Below Normal	Above Normal	Wet
Groundwater Boundary Inflow	5.3	5.3	5.3	5.3	5.3
Deep Percolation/Recharge	3003.2	3559.1	3773.0	5902.4	6954.7
Stream Loss to Groundwater	991.0	933.3	836.7	977.2	583.6
Inflow From Upper Watershed	4230.7	4331.5	4360.9	4465.8	4830.3
Municipal Pumping	1069.5	1068.9	1069.2	1069.0	1068.8
Agricultural Pumping	4932.9	4931.8	4932.4	4835.4	4935.5
Stream Gain from Groundwater	2920.1	3527.1	3738.4	5197.7	6780.3
Groundwater Ouflow from Basin	1.0	1.0	1.0	1.0	1.0

Table 2.33: Ukiah Valley Groundwater Basin estimated historical, current, and future water budgets. Future budgets include future baseline, 2030, and 2070 climate change scenarios. Values are in acre-foot.

Water Budget Component	Historical: 1992-2018	Current: 2015-2018	Future Baseline: 2019-2070	Climate Change 2030 Scenario	Climate Change 2070 Scenario
Groundwater Boundary Inflow	5.3	5.3	5.3	5.3	5.3
Deep Percolation/Recharge	5422.8	6254.2	5123.1	1949.4	4100.1
Stream Loss to Groundwater	3660.7	3137.3	818.8	1363.7	1031.8
Inflow From Upper Watershed	4611.7	4588.0	4512.2	4404.4	4183.0
Municipal Pumping	1854.7	1069.5	1069.0	1069.0	1069.0
Agricultural Pumping	4630.0	4429.0	4914.0	4914.0	4914.0
Stream Gain from Groundwater	3632.2	4463.7	4889.5	2152.0	3758.9
Groundwater Ouflow from Basin	1.0	1.0	1.0	1.0	1.0

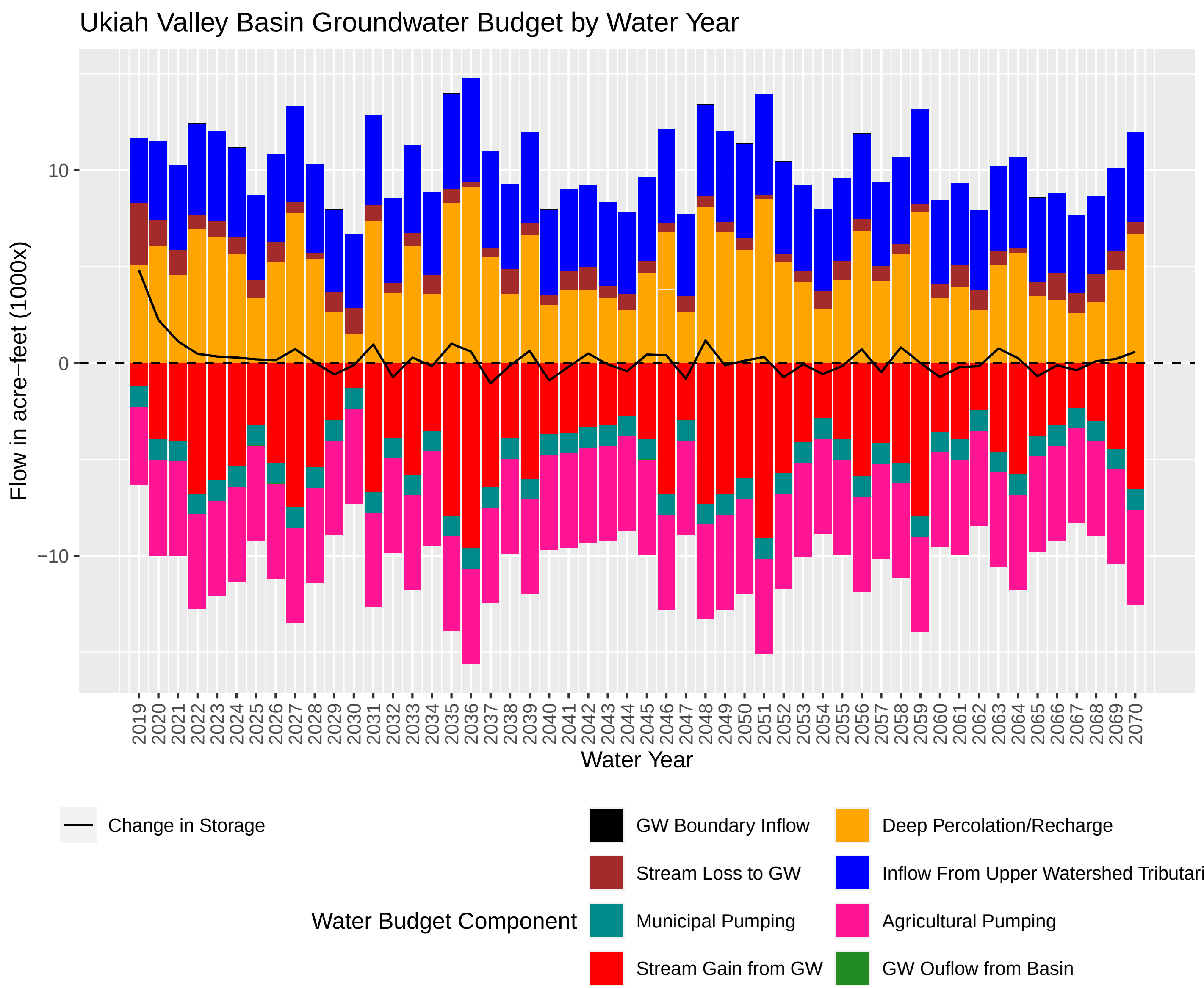

Figure 2.77: Estimated future annual groundwater budget for the Basin averaged over 2019-2070.

2.2.3.7 Projected Sustainable Yield

The sustainable yield "means the maximum quantity of water, calculated over a base period representative of long-term conditions in the Basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result." (California Water Code Section 10721). The Sustainable Groundwater Management Act explicitly makes the sustainable yield a function of long-term conditions and of the conditions causing undesirable results. The sustainable yield in the Basin is not equal to the historic 1992 to 2018 average groundwater pumping, since those conditions have not resulted in overdraft. Water levels and groundwater storage have been in a dynamic equilibrium with inflows to and outflows from the aquifer system, with no significant, discernable negative trend in water levels or groundwater storage. Also, the sustainable yield cannot be defined for the Basin as a single number that is constant over time, as future conditions may decrease or increase the amount of groundwater that can be withdrawn without causing undesirable results. For example, modeling of climate change scenarios suggested that the overall budget may become smaller through reductions in deep percolation and stream recharge. Therefore, less water and storage may be available in the long term, and continuing the same amount of pumping may not be a sustainable practice in the far future. In contrast, implementation of projects and management actions such as managed aquifer recharge that increase recharge and water availability may increase the ability to pump without causing undesirable results in the Basin. In both conditions, sustainable yield needs to be adjusted to maintain sustainable management of the Basin.

In addition, in the Basin, protecting against depletion of interconnected surface waters and impacts on GDEs warrants the addition of a spatial and possibly hydrogeological component to the sustainable yield. In other words, a single sustainable yield number may lead to different impacts if the pumping patterns differ significantly. For example, if the majority of the pumping occurs close to surface water bodies, mainly the mainstem Russian River, and from the shallower aquifers, significant and unreasonable depletion of ISWs and impacts to GDEs are more likely to be observed than when pumping is well distributed and withdrawings from deeper depths.

Exploratory pumping scenarios can be modeled by the UVIHM to project the sustainable yield of the Basin. However, considering the current availability of data and information and the uncertainty in UVIHM projections due to the unpredictability of the future conditions (climate change, land use and crop changes, population growth, etc.) and data gaps, such estimation will be more accurate upon collection of additional data in the Basin.

According to the SGMA definition, the sustainable yield for the Basin is estimated to be at least 6,500 acre-feet, based on the average groundwater pumping of the historical period. The sustainable yield of the Basin may be greater than 6,500 acre-feet with the current conditions persisting, but cannot be estimated based on the available historical record. Therefore, it is recommended that the sustainability of the Basin is not determined based on the sustainable yield, but rather based on the tracking of sustainable management criteria. During the implementation of the GSP and the future, the sustainable yield will be this number plus any additional storage or increase in water availability provided by the implementation of the PMAs. GSA has several PMAs defined in **Chapter 4** under supply augmentation and other management actions categories that may reduce groundwater withdrawal and/or increase the available storage in the Basin. These projects may increase the sustainable yield of the Basin upon implementation.

2.2.4 Management Areas

Based on SGMA requirements if management areas are defined, the quantity and density of monitoring sites in these areas shall be sufficient to evaluate conditions of the Basin setting and sustainable management criteria specific to that area. At this time, the GSA has decided not to define management areas for the UVB.

Chapter 3

Sustainable Management Criteria

List of Appendices

The Sustainable Groundwater Management Act (SGMA) requires each Groundwater Sustainability Agency (GSA) to develop a Groundwater Sustainability Plan (GSP, or Plan) that outlines definitions of “significant and unreasonable” impacts to sustainability indicators (California Water Code [CWC] § 10727(a)). Furthermore, SGMA defines Sustainable Management Criteria (SMC) as measurable steps towards a sustainability goal, which culminates in the absence of undesirable results within 20 years of Plan implementation. SGMA defines six sustainability indicators (CWC § 10721(x)), which are used to determine if “significant and unreasonable” impacts occur for beneficial users and uses of groundwater:

1. Chronic Lowering of Groundwater Levels;
2. Reduction of Groundwater Storage;
3. Seawater Intrusion;
4. Degraded Water Quality;
5. Land Subsidence;
6. Depletions of Interconnected Surface Water (ISW)

This section focuses on all sustainability indicators except for “Seawater Intrusion” which does not apply to the Basin. The avoidance of significant and unreasonable impacts to sustainability indicators is guided by SMC, which include Minimum Thresholds (MTs), Measurable Objectives (MOs), and Interim Milestones (IMs) as defined in **Section 3.1** below.

SMC are thus management goalposts that inform discrete actions to be taken over the management and implementation horizon and provide a quantitative means to evaluate progress towards the sustainability goal. The scientifically-informed SMC presented herein have been designed to protect beneficial uses and users of groundwater in the Basin against significant and unreasonable impacts that may be caused by unsustainable groundwater management, and reflect the values expressed in stakeholder-driven discussions. The specific beneficial uses and users this Plan emphasizes include domestic, agricultural, and public wells, groundwater dependent ecosystems (GDE), and interconnected surface waters (ISW) that support sensitive aquatic habitats and species. Detailed technical memoranda for impacts on GDEs and domestic wells are provided as appendices to this section and impacts on ISW is thoroughly discussed in **Sections 3.4.3 and 3.9.3**. Within this section, an overview of these uses and users and the specific, quantitative criteria that demonstrate the avoidance of significant and unreasonable impacts to these users is presented and explained.

The SMC for groundwater levels, storage, and interconnected surface water have been co-developed within an integrated approach to promote ease and efficiency of monitoring and interpretation. As more information is collected, and understanding of the Basin improves over time, certain SMC may change, for instance, during five-year Plan updates the criteria for ISW will be revised. However, at the time of Plan submission, the SMC in this section reflect the best available science applied to the sustainable management of groundwater in the Basin. These SMC will ensure the Basin operates in a steady condition over the implementation horizon, and achieves and then maintains the sustainability goal beyond the implementation period ending in 2042.

3.1 Introduction to Sustainable Management Criteria and Definition of Terms

The terms defined below are used throughout this chapter.

Sustainability Goal: The overarching goal for the Basin with respect to managing groundwater conditions to ensure the absence of undesirable results.

Sustainability Indicators (SI): Six indicators defined under SGMA: chronic lowering of groundwater levels, reduction of groundwater storage, seawater intrusion, degraded groundwater quality, land subsidence, and depletion of interconnected surface water. These indicators describe groundwater-related conditions in the Basin and are used to determine the occurrence of undesirable results (23 CCR 354.28(b)(1)-(6)).

Sustainable Management Criteria (SMC): Minimum thresholds, measurable objectives, and undesirable results, consistent with the sustainability goal, that must be defined for each sustainability indicator.

Undesirable Results: Conditions, defined under SGMA as:

"… one or more of the following effects caused by groundwater conditions occurring throughout a basin:
1. Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon.
2. Significant and unreasonable reduction of groundwater storage.
3. Significant and unreasonable seawater intrusion.
4. Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.
5. Significant and unreasonable land subsidence that substantially interferes with surface land uses.
6. Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water." (Wat. Code § 10721(x)(1)-(6))

Minimum Thresholds (MT): a quantitative value representative of groundwater conditions at a site (or sites), that, if exceeded, may cause an undesirable result. The term "maximum threshold" (MaxT) is the equivalent value for sustainable management criteria with a defined maximum limit (e.g., groundwater quality).

Measurable Objectives (MO): specific and quantifiable goals that are defined to reflect the desired groundwater conditions in the Basin and achieve the sustainability goal within 20 years. Measurable objectives are defined in relation to the six undesirable results and use the same metrics as minimum thresholds.

Interim Milestones: periodic goals (defined every five years, at minimum), that are used to measure progress toward measurable objectives and the sustainability goal.

Representative Monitoring Points (RMP): for each sustainability indicator, a subset of the entire monitoring network where minimum thresholds, measurable objectives, and milestones are measured and evaluated.

Projects and Management Actions (PMAs): creation or modification of a physical structure / infrastructure (project) and creation of policies, procedures, regulations, or management actions that are implemented to achieve Basin sustainability.

3.2 Sustainability Goal

The overall sustainability goal of groundwater management in the Basin is to maintain groundwater resources in ways that best support the continued and long-term health of the people, the environment, and the economy in Ukiah Valley, for generations to come. This includes managing groundwater conditions for each of the applicable sustainability indicators in the Basin so that:

- Groundwater elevations and groundwater storage do not significantly decline below their historically measured range, protect groundwater uses in the Basin, protect groundwater dependent ecosystems, and avoid significant streamflow depletion due to groundwater pumping.
- Groundwater quality is suitable for the beneficial uses in the Basin and is not significantly or unreasonably degraded.
- Significant and unreasonable land subsidence is prevented in the Basin. Infrastructure and agricultural production in Ukiah Valley remain safe from permanent subsidence of land surface elevations.
- Significant and undesirable streamflow depletions due to groundwater pumping are avoided through projects and management actions consistent with existing regulatory requirements.
- The GSA's groundwater management is efficiently and effectively integrated with other watershed and land use planning activities through collaborations and partnerships with local, state, and federal agencies, private landowners, and other organizations, to achieve the broader watershed goal of sufficient surface water flows that sustain healthy ecosystem functions.

The sustainability goal will be achieved by rigorous assessment of potential impacts to domestic, urban, agricultural, industrial, and environmental beneficial users, and scientifically-informed management that avoids significant and unreasonable impacts to beneficial uses and users of groundwater. Significant and unreasonable impacts to beneficial uses and users of groundwater are quantitatively and qualitatively defined in each respective subsection below. This Plan acknowledges that climate change, unplanned growth, and complex watershed coordination challenge sustainable groundwater management. Thus, this Plan advances solutions to these challenges via:

- SMC rigorously tested on data and modeling of historical and projected groundwater use, analyzed specifically with respect to the most sensitive groundwater users (vulnerable wells, GDEs, and ISW) and designed to avoid significant and unreasonable impacts to these users;
- improved monitoring and scientific studies across the Basin to refine models and address data gaps; and,
- substantial inter-agency coordination on conjunctive use projects and management actions already underway (**Chapter 4**) that are estimated to increase net basin storage over the implementation period and that will support sustainable pumping, bolster well reliability, improve GDE water access, and maintain critical surface water flows.

3.3 Monitoring Networks

The monitoring networks described here support data collection to monitor the chronic lowering of groundwater levels, reduction of groundwater in storage, degradation of water quality, land subsidence, and depletion of interconnected surface water sustainability indicators. The monitoring networks for each sustainability indicator are critical to demonstrating the Basin's sustainability over time. No monitoring network is identified for the seawater intrusion sustainability indicator as it is not applicable to the Basin.

Per 23 CCR Section 354.34, monitoring networks should be designed to:

- Demonstrate progress towards achieving measurable objectives described in the Plan;
- Monitor impacts to the beneficial uses or users of groundwater;
- Monitor changes in groundwater conditions relative to measurable objectives and minimum or maximum thresholds; and,
- Quantify annual changes in water budget components.

Monitoring networks are required to have sufficient spatial density and temporal resolution to evaluate the effects and effectiveness of plan implementation and represent seasonal, short-term, and long-term trends in groundwater conditions and related surface conditions. Short-term is considered here to be a time span of 1 to 5 years, and long-term is considered to be 5 to 20 years. The spatial densities and frequency of data measurement are specific to monitoring objectives, the parameter to be measured, degree of groundwater use, and Basin conditions, among other factors.

Network Enrollment and Expansion

For the first 5 years of GSP implementation, the basin will rely on two main monitoring networks to demonstrate sustainability: groundwater level and groundwater quality network. After the 5 year update, the Ukiah Valley Integrated Hydrological Model (UVIHM) will be added as a monitoring option for streamflow depletion. The monitoring network defined in this preliminary phase relies entirely on groundwater wells for all the indicators, with the exception of subsidence. Some wells will be monitored for water level, some for water quality, some will be monitored for both. Prior to enrolling wells into the GSA's monitoring network, wells are evaluated using the selection criteria listed below, to determine their suitability. The selection criteria for potential wells to be added to the monitoring network include the following:

- Well location;
- Monitoring history;
- Well information including construction details; and,
- Well access.

Well Location

The location and design of a well network are important to ensure adequate spatial distribution, coverage, and well density. Objectives for network design include sufficient coverage and density of wells to capture hydraulic gradients and overall groundwater in storage. Additionally, wells important for the measurement of groundwater level and groundwater quality must be included in areas within or adjacent to planned GSP projects and management actions and locally defined areas where existing operations are found to pose a significant risk of affecting groundwater levels or quality. Statistical methods will be used to aid in extrapolating measurements from a limited number of monitoring sites to groundwater conditions in the entire Basin.

Monitoring History

Wells with a long monitoring record provide valuable historical groundwater level or water quality data and enable the assessment of long-term trends. Such wells were preferentially selected for a network over wells with limited monitoring data.

Well Information

In addition to well location, information about the construction of the well, including the well depth and screened interval(s) is necessary to provide context for the measurement taken at the well, such as which water bearing formation is being sampled. Well information is critical for an effective well network, so the groundwater aquifer can be efficiently monitored. For wells that are candidates for being added to the well network, the GSA will continue to verify well information with well logging.

Well Access/Agency Support

In order to be a functional component of the monitoring network, the ability to gain access to the well to collect samples at the required frequency is critical.

Wells in existing monitoring programs, particularly for water quality, are located near populated areas, leaving sections of the remainder of the Basin without monitoring data. The planned additional wells for inclusion in a network are intended to provide data representative of different land uses, activities, and geologic units to improve upon the existing spatial coverage in the Basin. Any wells added to the monitoring network will be evaluated using the criteria listed above to ensure well suitability. A more detailed evaluation of the required spatial density and monitoring frequency of the individual sustainability indicator monitoring network(s) will be conducted to determine appropriate attributes so that the monitoring network is representative of Basin conditions and enables evaluations of seasonal, short-term, and long-term trends.

The monitoring networks will continue to be developed throughout GSP implementation. Individual sustainability indicator monitoring networks will be modified throughout GSP implementation, as necessary, to address monitoring objectives and support any PMAs. Expansion of individual sustainability indicator monitoring networks that rely on wells will involve identification of additional existing wells in the Basin that could be included in the monitoring network once evaluated, using the selection criteria, and approved for inclusion in the network. Evaluations of the monitoring network will be conducted at least every five years to determine whether additional wells are required to achieve sufficient spatial density, whether wells are representative of the Basin conditions, and whether wells provide monitoring in key areas identified by stakeholders. If additional sites are required to ensure sufficient spatial density, then existing wells may be identified or new wells may be constructed at select locations, as required. The monitoring frequency and timing that enable evaluation of seasonal, short-term, and long-term trends will also be assessed throughout GSP implementation. Where it is necessary, the GSA will coordinate with existing programs to develop an agreement for data collection responsibilities, monitoring protocols, and data reporting and sharing. For existing monitoring programs implemented by agencies, monitoring would be conducted by agency program staff or their contractors. For groundwater elevation monitoring, a subset of wells included in the California Statewide Groundwater Elevation Monitoring (CASGEM) Program for Mendocino County is selected and migrated to the GSP monitoring network administered by the GSA. For water quality monitoring, samples will be analyzed at contracted analytical laboratories. To prevent bias associated with date of sample collection, all samples should be collected on approximately the same date (i.e., +/- 30 days of each other) each year.

3.3.1 Reporting Monitoring Data to the Department (Reg § 354.40)

Monitoring data will be stored in a data management system and a copy of the monitoring data will be included in each annual report submitted electronically to DWR.

3.3.2 Monitoring Networks within the Basin

Existing and newly installed monitoring wells in the Basin will be used to collect and evaluate monitoring data, to define SMC, and to demonstrate the future sustainability of the Basin. Based on the Basin's historical and existing conditions discussed in **Chapter 2**, groundwater levels, groundwater storage, groundwater quality, land subsidence, and interconnected surface water are the main sustainability indicators that must be monitored and controlled to achieve sustainability.

Wells are selected for inclusion in each monitoring network based on their location, length of historical data records, and well construction information. Well location is important to assure sufficient spatial coverage within the Basin. The length and quality (continuity of measurements over time) of measurements are then evaluated to assure adequate temporal coverage. Due to major data gaps in the Basin, the length of historical data has become a secondary factor. Information about well depths, as well as the top and bottom perforation levels at each well, was extracted from well completion reports or database records to identify whether the well is monitoring the shallow, the deep, or both aquifers. However, not all well completion reports or well construction information were available for the wells identified as suitable in the Basin.

A description of the existing and planned spatial density and data collection frequency is included for each monitoring network. Detailed descriptions, assessments, and plans for improvement of the monitoring network are provided for each sustainability indicator under its corresponding section. An overview of the monitoring network established for each sustainability indicator is provided in **Table 3.1**.

Table 3.1: Summary of monitoring networks, metrics, and number of sites for sustainability indicators.

Sustainability Indicator[1]	Metric	Number of Sites in Current Network
Chronic Lowering of Groundwater Levels	Groundwater level	32[2]
Reduction of Groundwater Storage	Volume of water per year, computed from water level changes	Uses chronic lowering of groundwater levels network
Groundwater Quality	Concentration of selected water quality parameters	17
Land subsidence	DWR's vertical displacement estimates derived from Interferometric Synthetic Aperture Radar (InSAR) data[3]	Spatially continuous
Stream depletion due to groundwater pumping	Adaptive evaluation of depletion amounts using groundwater levels in the initial phase and available continuous groundwater level measurements, streamflow gages, and measured/modeled interaction of groundwater and surface water systems upon re-evaluation. Evaluation approach will be adopted as more measured data is collected and model estimates improve through filling data gaps.	At three transect sections of the Basin for the mainstem Russian River, integrated into respective RMPs, including 14 wells and three streamgages. Four additional streamgages are included to monitor streamflow for future revisions (Seven Streamflow gages in Total).

[1] This table only includes monitoring networks used to measure sustainability indicators. It does not include additional monitoring necessary to monitor the various water budget components of the Basin (such as precipitation, etc.), described in Chapter 2, or to monitor the impacts of implementation of projects and management actions, which are described in Chapter 4.

[2] Two existing wells and two TSS funded wells are nested wells monitoring the three geologic formations

[3] Land surface elevation changes are monitored through satellite remote sensing.

In summary, four monitoring networks are formally defined, including monitoring points used for more than one indicator: a water level monitoring network, a water quality monitoring network, a streamflow depletion monitoring network, and a land subsidence monitoring system. The first three monitoring networks are independent but potentially utilize some of the same wells. The fourth network utilizes satellite remote sensing. The streamflow depletion monitoring network utilizes an adaptive approach, and it will mostly rely on wells for the first implementation phase, to then be expanded to include wells, streamflow gauges, and the UVIHM estimates for the 5 year GSP update and beyond. Groundwater storage is monitored using the same wells included in the groundwater elevation monitoring network. Detailed descriptions, assessments, and plans for future improvement of the well monitoring networks and protocols for data collection and monitoring are addressed for each sustainability indicator in its corresponding section. A complete list of all groundwater monitoring wells included in these four monitoring networks are shown in **Table 3.2**.

Table 3.2: List of monitoring wells included in the groundwater elevation, groundwater quality, and depletion of interconnected surface waters monitoring networks.

Site Code/Well ID	Principal Aquifer	GW Elevation Monitoring Frequency	GW Quality Constituents Monitored	ISW Monitoring Frequency
2300507-001	Aquifer II	-	Fe,Mn,Nitrate,SC,B	-
2300605-001	Aquifer I	-	Fe,Mn,Nitrate,SC,B	-
2300605-003	Aquifer I	-	Nitrate,SC	-
2310002-001	Aquifer II	-	Fe,Mn,Nitrate,SC,B	-
2310002-002	Aquifer II	-	Fe,Mn,Nitrate,SC,B	-
2310002-005	Aquifer I	-	Fe,Mn,Nitrate,SC,B	-
2310002-009	Aquifer I	-	Fe,Mn,Nitrate,SC,B	-
2310003-004	Aquifer II	-	Fe,Mn,Nitrate,SC,B	-
2310003-028	Aquifer II	-	Nitrate,SC	-
2310003-029	Aquifer II	-	Nitrate,SC	-
2310005-001	Aquifer II	-	Fe,Mn,Nitrate,SC,B	-
2310005-004	Aquifer II	-	Fe,Mn,Nitrate,SC,B	-
2310006-009	Aquifer II	-	Fe,Mn,Nitrate,SC,B	-
390664N1231491W001	Aquifer I	CASGEM Frequency	-	-
391096N1231677W001	Aquifer II	CASGEM Frequency	-	-
391174N1231836W001	Aquifer II	CASGEM Frequency	-	-
391225N1231852W001	Aquifer I	Monthly	-	Monthly
391246N1231827W001	Aquifer I	CASGEM Frequency	-	-
391285N1231607W001	Aquifer II	Monthly	-	Monthly
391322N1231929W001	Aquifer I	CASGEM Frequency	-	-
391411N1231983W002	Aquifer II	CASGEM Frequency	-	-
391586N1232003W002	Aquifer II	CASGEM Frequency	-	-
391730N1232108W001	Aquifer II	CASGEM Frequency	-	-
391860N1232039W001	Aquifer II	CASGEM Frequency	-	-
391918N1232003W001	Aquifer I	Monthly	-	Monthly
391918N1232003W002	Aquifer II	Monthly	-	-

Table 3.2: List of monitoring wells included in the groundwater elevation, groundwater quality, and depletion of interconnected surface waters monitoring networks. *(continued)*

Site Code/Well ID	Principal Aquifer	GW Elevation Monitoring Frequency	GW Quality Constituents Monitored	ISW Monitoring Frequency
391918N1232003W003	Aquifer II	Monthly	-	-
391918N1232003W004	Aquifer II	Monthly	-	-
392358N1232020W001	Aquifer II	CASGEM Frequency	-	-
392455N1231977W001	Aquifer II	CASGEM Frequency	-	-
392455N1231977W002	Aquifer II	CASGEM Frequency	-	-
392455N1231977W003	Aquifer II	CASGEM Frequency	-	-
392572N1231906W001	Aquifer II	CASGEM Frequency	-	-
392962N1232047W001	Aquifer II	CASGEM Frequency	-	-
Ukiah WWTP-MW1	Aquifer I	Monthly	-	Monthly
UVBGSA-01a	Aquifer I	Continuous	Fe,Mn,Nitrate,SC,B	Continuous
UVBGSA-01b	Aquifer II	Continuous	-	Continuous
UVBGSA-01c	Aquifer II	Continuous	-	Continuous
UVBGSA-02	Aquifer I	Continuous	-	Continuous
UVBGSA-05	Aquifer I	Continuous	Fe,Mn,B	Continuous
UVBGSA-06a	Aquifer I	Continuous	-	Continuous
UVBGSA-06b	Aquifer I	Continuous	Fe,Mn,Nitrate,SC,B	Continuous
UVBGSA-06c	Aquifer II	Continuous	-	Continuous
UVBGSA-06d	Aquifer II	Continuous	-	Continuous
UVBGSA-07	Aquifer I	Continuous	Fe,Mn,Nitrate,SC,B	Continuous

* GW: Groundwater; ISW: Interconnected Surface Waters

† CASGEM Frequency means monitorng at least twice per year during high and low groundwater elevation seasons. The GSA may elect to increase this frequency, as needed.

‡ Monthly frequencies are assigned to wells that are scheduled to be instrumented with continous measurement devices but have not yet been instrumented. The GSA will continue its monthly monitoring until continous measurement devices are installed.

§ Nitrate is sampled annually while all other constituents are sampled once every three years. The GSA may elect to increase sampling frequencies on as-needed basis.

Groundwater Elevation Monitoring Network

The Basin has two principal aquifers and a data gap exists for the the monitoring of the upper principal aquifer (Aquifer I) where the number of wells is not sufficient to spatially cover the extent of the aquifer. The monitoring network is designed to span these two aquifers and provide adequate vertical coverage for as many wells as possible. Importantly, monitoring well density is appropriate to extrapolate seasonal groundwater elevation maps to support the shallow well protection analysis, GDE impact analysis, and to monitor seasonal changes in hydraulic gradients that indicate changes in ISW depletion. Implementation actions are proposed to cover data gaps that still exist within the network and improvements that may help such assessments.

There are currently 45 CASGEM[1] (see **Section 2.2.2.1** for details) wells monitored within the Basin. These wells are normally sampled twice a year, once in fall and once in spring. Except for the four wells monitored historically by DWR, measurement of groundwater levels for all the other wells started in 2014 or later. This results in a short historical coverage for the basin and a temporal groundwater level measurement data gap. As described in **Section 3.4.1**, a subset of CASGEM monitoring wells is included in the groundwater elevation monitoring network if they satisfied regulatory requirements regarding their construction information, the aquifer they monitor, and their accessibility. Well completion reports were not available for several of these CASGEM wells. As a result, the availability of construction information criterion was relaxed to help the GSA design and implement a more comprehensive and representative monitoring network using the existing wells. Implementation actions are proposed to fill the construction information data gap through video logs.

The selected subset of the CASGEM Program wells for the basin will be migrated accordingly to the GSP monitoring network and administered by the GSA upon submission of the GSP. Mendocino County CASGEM Program will be eliminated for the Basin when this migration is completed. The GSA has received Technical Support Services (TSS) grants from DWR to drill five additional wells. The TSS grant-funded wells will also be included in the groundwater elevation monitoring network. In addition, a subset of existing CASGEM wells has been selected to be instrumented with continuous measurement devices and combined with TSS-funded wells to form transects along the river. These wells will be automatically included in the groundwater elevation monitoring network and interconnected surface water monitoring network similar to the TSS-funded wells.

Monitoring frequency is important to characterize groundwater and surface water dynamics. All wells will collect at least biannual measurements in Spring (mid-March) and Fall (mid-October) in line with DWR Best Management Practices (CA-DWR, 2017). The subset of wells instrumented with continuous measurement devices and TSS-funded wells will be monitored continuously to provide a better understanding of surface water and groundwater interaction.

Groundwater Storage Monitoring Network

Groundwater level is used as a proxy for groundwater storage (**Section 3.5**). Thus, the groundwater storage monitoring network is identical to the network for groundwater level. Observations obtained for the groundwater level monitoring network will directly inform integrated surface and groundwater modeling in the Basin as model calibration targets.

Groundwater Quality Monitoring Network

To determine groundwater quality trends for water quality indicators, the GSA will collect sufficient

[1] The number of wells monitored for CASGEM program has been variable. The maximum number of wells monitored through 2019 for any year has been 45 wells.