data about groundwater wells themselves (number of wells, location of wells, types of wells, and volume of groundwater pumping occurring). As two key areas of information necessary for informed decision making, detailed timelines need to be implemented on how these data gaps will be closed, funding will be obtained to close those data gaps, and necessary steps to be completed. Necessary data should be obtained and collected within the first 5 years of implementation so that the Ukiah Basin is on solid footing for preventing future undesirable results. Climate change will be exasperating the potential for undesirable impacts and having this solid data foundation in the beginning will reduce that potential.

Data gaps can be closed via the implementation of new local governance policies that can be imposed by the GSA and/or by agreement of GSA members. Some new governance policies would be the creation of metering, monitoring and reporting requirements for all new groundwater wells. To provide public assurance in health and safety of aquifer, this data should also be made publicly available.

It is also recommend the GSA continue efforts to identify and engage beneficial users representing disadvantaged communities and the environment and to incorporate the interests of these users into the calculation and update of sustainable management criteria. In order to ensure best available information about impacts to beneficial users reliant on shallow groundwater, we recommend the GSA improve local information about the location and condition of both active and abandoned groundwater wells. Local investigations would improve accuracy regarding well location, condition and water quality. We are also concerned that because well abandonment data is largely unavailable, there is potential for migration of surface contaminants to groundwater from improperly closed wells. We recommend the GSA coordinate with other local agencies to identify inactive and abandoned wells to ensure that they have been properly retired.

F. Definitions & Need for Clarity

There needs to be a section or appendix that defines how terms are being used within this GSP specifically. This will not only help with consistency in use of terms, but it will also help the lay person understand what is being said throughout this GSP.

There are frequent discussions and references to both surface waters and groundwaters. However, many of these discussions lack clarity on which type of water is actually being referenced at that particular section. This tends to create confusion when reading sections about the surface-groundwater interface which is a key component of this GSP and requires clarity. For instance, there are references to a losing river (a term of art) that then go on to say that groundwaters are feeding the river which is the opposite of a losing river. The subject of streamflow depletion in summer months and whether the river is percolating to re-fill pumped groundwater is of critical importance so the terms used must be clarified.

Another way to improve clarity is to have figures and tables set in text or at least closer to their in text references. Right now they are typically grouped a page or two away from the in text reference or sometimes even before the in text section referencing them.

G. Other

The Public Trust Doctrine imposes a related but distinct obligation to consider how groundwater management affects public trust resources, including navigable surface waters and fisheries. Groundwater hydrologically connected to navigable surface waters or surface waters supporting fisheries, and surface waters tributary to navigable surface waters or surface waters supporting fisheries, are also subject to the Public Trust Doctrine to the extent that groundwater extractions or diversions affect or may affect public trust uses (*Environmental Law Foundation v. State Water Resources Control Board* (2018), 26 Cal. App. 5th 844; *National Audubon Society v. Superior Court* (1983), 33 Cal. 3d 419).

Accordingly, groundwater plans should consider potential impacts to and appropriate protections for interconnected surface waters and their tributaries, and interconnected surface waters that support fisheries, including the level of groundwater contribution to those waters.

In the context of SGMA statutes and regulations, and Public Trust Doctrine considerations, GSA groundwater planning must carefully consider and protect environmental beneficial uses and users of groundwater including fish and wildlife and their habitats: groundwater dependent ecosystems and interconnected surface waters. Public Trust resources have not been given due consideration throughout this GSP and analysis must be done to fully do so.

Lastly, there must be due consideration for impacts and interests of those that are not part of the GSA itself so that no communities or beneficial uses are omitted. From mutual water companies, individual rural home-owners with wells, and local NGOs additional interests must be given the same consideration as agricultural interests within the Basin. Part of this needed analysis is the identification of different land uses in relation to well locations and map overlays that identify different community types. The GSP should also be cognizant of the fact that a groundwater basin does not necessarily follow the lines of a community sitting above it. As such, communities that may be impacted by this GSP are potentially being excluded.

II. Conclusion

We appreciate the opportunity to provide comment and welcome any questions that you may have.

Sincerely,

Jaime Neary
Staff Attorney
Russian Riverkeeper

Don McEnhill
Executive Director
Russian Riverkeeper

Sonoma Water

September 24, 2021

Amber Fisette, GSA Administrator
Ukiah Valley Groundwater Sustainability Agency
340 Lake Mendocino Dr.
Ukiah, CA 95482

SUBJECT: Sonoma Water staff review of the Ukiah Valley Basin Groundwater Sustainability Plan Public Review Draft

Dear Ms. Fisette,

The Sonoma County Water Agency (Sonoma Water) is a Special District created in 1949 by the California Legislature whose authorities include wholesale water supply, flood risk management & sanitation services. Sonoma Water is a wholesale water supplier to nine cities and water districts that serve more than 600,000 residents in portions of Sonoma and Marin counties. Sonoma Water manages and operates the Russian River water supply system conjunctively with the Army Corps of Engineers.

The California Department of Water Resources (DWR) has designated the Ukiah Valley basin as "medium" priority for groundwater management, necessitating the development of a Groundwater Sustainability Plan (GSP) by January 2022, as required under California's Sustainable Groundwater Management Act of 2014 (SGMA). A draft Ukiah Valley basin GSP was released for public comment by the Santa Rosa Plain Groundwater Sustainability Agency (GSA) in August, 2021.

Groundwater in the Ukiah Valley basin is hydraulically linked to surface water in the Russian River and its tributaries within the basin. Groundwater pumping in the Ukiah Valley basin has the potential to lower local groundwater levels and alter the natural groundwater/surface-water exchange in the basin, either by reducing the volume of groundwater discharge to surface water or by increasing the volume of groundwater recharge from surface water to groundwater. Sonoma Water is concerned that groundwater extraction in the Ukiah Valley basin could adversely impact surface water flows in the Russian River, and has provided comments to assist the GSA in adequately addressing those impacts. The following memo describes those comments generally.

Chapter 2: Plan Area and Basin Setting

In accordance with GSP Regulations Section 354.18, SGMA requires that the GSP to provide a water budget, which is comprehensive accounting of all water inflows and outflows from the interacting systems in the GSA basin; i.e., the land system, the surface water system, and the groundwater system. The GSP Regulations also require water budgets for three different timeframes, representing, historical conditions, current conditions, and projected decisions. An accurate and comprehensive water budget is a critical tool for understanding historical conditions in the basin, evaluating groundwater sustainability, and guiding future projects and management actions.

As is typical for many GSPs, water budgets in the Ukiah Valley basin are estimated with model simulations. Section 2.2.3 provides a summary of the water budget information for the basin and references more detailed information on the water budget and model documentation in Appendix 2-D, and data gaps and model uncertainties in Appendix 2-E. However, Appendices 2-D and 2-E are not provided along with the rest of the public review draft of the Ukiah Valley basin GSP.

Sonoma Water staff have provided specific comments outlining (1) inconsistencies between water budget components described in the text and those shown in figures and (2) questions related to current and future water budget projections, specifically regarding groundwater/surface-water interactions. Lacking additional documentation, it is currently not possible to assess the accuracy or completeness of the water budgets. We recommend that the GSA provide a comprehensive description of the water budget components as outlined in the CA Dept. of Water Resources *Handbook for Water Budget Development* (2020) and *Water Budget Best Management Practice* (2016), either within the GSP main text or in appendices so that these components can be accurately evaluated and reviewed by the public.

Chapter 3: Sustainable Management Criteria

To develop sustainable management criteria (SMCs) for the six sustainability indicators outlined in SGMA, the Ukiah Valley GSA convened a Technical Advisory Committee which has met regularly during 2020 and 2021. Sonoma Water participated in these meetings, and provided comments to help guide the selection of SMCs. During these meetings, Sonoma Water has advocated for SMCs for depletion of interconnected surface water (ISW) by groundwater pumping that are as protective as those selected for the Petaluma Valley, Santa Rosa Plain, and Sonoma Valley basins and subbasins, where Sonoma Water has led the development of GSPs.

For these three basins, the minimum threshold (MT) is set as the equivalent dry-season groundwater-level, representing the average of the three years (2014–2016) during which the most surface water depletion due to groundwater pumping was estimated during 2004–2018. The goal of the MT is to maintain estimated rates and volume of streamflow depletion below historical levels, using groundwater-level measurements as a proxy.

The Ukiah Valley basin GSP outlines an approach that also uses groundwater levels as a proxy to set sustainable management criteria for depletion of interconnected surface water during the first five years of plan implementation. For the Ukiah Valley basin GSP, the depletion of ISW MT is set “the lowest historical groundwater depth to water plus 10% of its value or 10 ft (3 m), whichever is less” (Ch. 3, lines 1822–1824). The 10% or 10 ft is presented as a “buffer” to account for uncertainties in biannual groundwater level measurements.

This methodology would set MT values below historical minimum groundwater levels. This equates to depletion of ISW by pumping that is greater than has been observed during the historical record and is not sufficiently protective of beneficial users of surface water. We advocate for more protective MT values that are as protective as those selected for the Sonoma County GSA basins, e.g., the equivalent dry-season groundwater-level, representing the average of the three years (2014–2016) during which the most depletion of ISW was estimated during the historical record. In this way, the MT value equates to less depletion than occurred during the single year with the most depletion, and is thus more protective of beneficial users of surface water.

While we recognize that accounting uncertainties related to biannual groundwater level measurement may justify a small buffer to represent the actual minimum groundwater level, the choice of 10% or 10ft is provided without any quantitative analysis to justify those buffer values. Based on a preliminary evaluation of continuous, multi-year groundwater level data and surface water depletion RMPs in Sonoma Valley GSA area, a buffer of 2.5–5% would adequately account for this uncertainty while still being sufficiently protective. We encourage the GSA to select more protective buffers that are quantitatively defined.

If you have any questions or concerns regarding this letter, please contact Don Seymour at 707-547-1925 (Donald.Seymour@scwa.ca.gov)

Sincerely,

Don Seymour

Don Seymour, P.E.
Principal Water Agency Engineer
Engineering Resource & Planning

c: Laura Foglia, Larry Walker Associates (lauraf@lwa.com)
Aaron Cuthbertson, CA Dept. of Water Resources (Aaron.Cuthbertson@water.ca.gov)
Dominic Gutierrez, CA Dept. of Water Resources (Dominic.Gutierrez@water.ca.gov)

References

California Department of Water Resources. 2020. *Handbook for Water Budget Development.* Available athttps://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater- Management/Data-and-Tools/Files/Water-Budget-Handbook.pdf

California Department of Water Resources. 2016. *Water Budget Best Management Practice.* Available at https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater- Management/Sustainable-Groundwater-Management/Best-Management-Practices-and- Guidance-Documents/Files/BMP-4-Water-Budget_ay_19.pdf

Ukiah Valley Groundwater Basin

Groundwater Sustainable Agency

Review Form

Ukiah Valley Basin Groundwater Sustainability Plan

Dear Reviewer,

Per SGMA requirements, a Groundwater Sustainability Plan (GSP) is under development for the Ukiah Valley Groundwater Basin (UVBGSP). Ukiah Valley Basin Groundwater Sustainability Agency (UVBGSA) welcomes feedback on draft sections of the GSP by the broad interests and perspectives of the public.

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UVBGSP_Public Review_[Your name]_date

Please send your comments no later than September 24, 2021.

Thanks for contributing to the draft GSP for the Ukiah Valley Groundwater Basin.

Ukiah Valley Groundwater Basin
Groundwater Sustainable Agency

Reviewer name:
Submission date:
GSP sections reviewed: **GSP Public Draft**

Line number	Suggested revision (*please delete example text below once you submit*)
Entire Doc.	All figs and tables should be placed immediately following the paragraph where they are 1st cited so reader doesn't have to hunt for them.
Entire Doc.	Regarding figs like hydrographs, label max and min values on y-axes. For hydrographs use consistent y-axis ranges and increments for easier comparison.
Entire Doc.	Additional comments and editorial suggestions are provided in the document to help improve clarity and readability, to be used at the authors' discretion.
875	General comment regarding the HCM: Please provide a summary of all sources and sinks included the HCM. These should be consistent with the quantitative estimates of sources and sinks provided in the water budget.
875	General comment regarding the HCM: Groundwater flowpaths and barriers to groundwater flow are not discussed.
925	Horizontal boundary conditions are not discussed. Please describe the assumed horizontal boundary conditions; i.e., whether they are no-flow, fixed flow, fixed head, etc. This affects water level contours.
1180	No offset of formations at Maacama fault?
1193	There are missing mapped faults in A-A' and C-C'.
1313	Storage coefficient(s) not presented or discussed.
1367	Table 12: • Check general formatting of this table. E.g., spacing spelling, superscript, etc. • Farrar misspelled • "Recent Alluvium" should be Recent quaternary alluvium? • Terrace deposit thicknesses greater than 2,000ft seems unlikely
1523	Fig. 23: Contouring does not make physical sense (see below). Contours may be improved by using model output, rather than contouring/interpolating sparse observed GWLs • Contours are not intersecting boundaries at right angles • Explain why flow in Ukiah Valley is to SW, apparently into a previously-described no-flow boundary. • Label RR and use heavier line for RR. RR should probably be gaining, do contours indicate this? • Contours intersecting tribs do not indicate whether gaining or losing.
1542	Please include discussion of vertical groundwater flow.
1597	Please include a brief discussion of the Potter Valley Project and Lake Mendocino operations.
1679	Add lack of monitoring wells in south end of basin
1695	Appendix 2E missing

Ukiah Valley Groundwater Basin

Groundwater Sustainable Agency

1934	Appendix 2F incomplete.
2055	How were constituents of concern identified?
2202	The explanation of the approach used to identify ISW is lengthy and unclear. Please revise with a more concise description that focuses on the final ISW determination, rather than the intermediate steps.
Figs 57-60	It appears that Figs. 57-59 show much of the main stem Russian River as disconnected, which is confusing because lines 2282-2284 state that this reach was reclassified as connected. Please either (1) modify the figures 57-59 to reflect the Russian River ISW determination or (2) remove figures 57-59 since they seem to reflect intermediate steps used to develop Figure 60, which appears to be the 'final' map of ISW.
2516	Appendices 2D and 2E are missing
Table 29	Description of water budget components are inconsistent with those provided in subsequent Table 31-34 and Figures 74-78. Please revise both the table and the figures so that there is consistency between each.
Table 31-34	Because it is not accurately described in Table 29, it is unclear what the term "Outflow from Russian River" describes. The volumes shown in Table 31, i.e., 4072 AF/year for a wet year (~5.6 cfs/year) are far too small to describe actual surface water outflows from the Russian River. Please clarify what each of these terms are in Table 29.
Fig. 74-77	Provide descriptions for each of these terms in Table 29
Fig. 75	
2578	Who/how were dry, wet, etc. years identified? For historical period as well as projected climates.
2577	Inconsistent simulation horizons presented for historic and current water budgets as well as projected water budgets. E.g., inconsistent between text and fig captions.
2544	Appendix 2D missing, so can't review. However, please generally describe the model in the body of the chapter. E.g., simulation horizon, temporal discretization, horizontal and vertical discretization, boundary conditions, etc. Also explain how it was calibrated.
2607	What does "…water that flows out of the Basin through the Russian River stream channel" mean? Is it hyporheic flow? GSFLOW doesn't simulate hyporheic flow, so how is this simulated?
2617	Provide a reference for IDC and explain how it works. In addition, explain why the GSFLOW Ag package wasn't used.
2690	Add additional water budget figs for the projected climate scenarios not only the baseline.
2690	Describe how reservoir operations for Lake Mendocino were incorporated into the Future Baseline and Climate Change scenarios
Table 34, 2733-2736	Large changes in "Stream Loss to Groundwater" and (to a lesser extent) "Stream Gain from Groundwater" are shown for the Future Baseline and Climate Change 2030 and 2070 scenarios relative to other water budget components. It is unclear

	what mechanism is driving these changes. Please provide a more thorough discussion of the mechanisms driving these changes.

Ukiah Valley Groundwater Basin

Groundwater Sustainable Agency

Ukiah Valley Groundwater Basin

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Review Form

Ukiah Valley Basin Groundwater Sustainability Plan

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Ukiah Valley Groundwater Basin
Groundwater Sustainable Agency

Reviewer name:
Submission date:
GSP sections reviewed: **GSP Public Draft**

Line number	Suggested revision (*please delete example text below once you submit*)
Fig. 1	Please add the well ID to each of these wells. Additionally, all figures of the monitoring network should be similarly labeled in other figures.
685-687	While we recognize that accounting uncertainties related to biannual groundwater level measurement may justify a small buffer to represent the actual minimum groundwater level, the choice of 10% or 10ft is provided without any quantitative analysis to justify those buffer values. Based on a preliminary evaluation of continuous, multi-year groundwater level data and surface water depletion RMPs in Sonoma Valley GSA area, a buffer of 2.5% or 5% would adequately account for this uncertainty while still being sufficiently protective. We encourage the GSA to select more protective buffers. At minimum, the "well-specific margin" should by identified and justified for each RMP in the text.
Fig. 2	Please add the well ID to each of these wells. Additionally, all figures of the monitoring network should be similarly labeled in other figures.
Table 3	Please identify the amount of additional buffer (i.e., percentage between 1–10% or additional ft) used for each well, along with attendant justification for each of these choices in the text.
Fig. 9	Please add the monitoring well IDs to the map
Table 7	Are the triggers Spring WLs? Please clarify.
Table 7	The MT, Triggers, and MO values for depletion of interconnected surface water for 391918N1232003W001 is inconsistent with those for groundwater levels for the same well. Lines 1820-1822 state that "… groundwater elevations will be used as a proxy, and the MT defined for chronic lowering of groundwater elevation in Aquifer I will be used as the MT for the depletion of ISW." If this is the case, then the SMCs should be consistent for both sustainability indicators.
Table 7	Please provide the approximate streambed elevation adjacent to each RMP location in the table. This way the MT, Trigger, and MO values can be assessed relative to the streambed elevation, and the gaining/losing conditions in the river can be evaluated at each RMP location
1715-1720	It is unclear what the term "lowering" refers to in the significant and unreasonable statement. Additionally, there is no mention of adverse impacts on beneficial users of surface water in the sentence containing the term "significant and unreasonable." We propose the following modification to the significant and unreasonable statement to reflect the need to avoid adverse impacts to beneficial users of surface water: "Depletion of surface water due to groundwater extraction is considered significant and unreasonable when such depletion exceeds historical depletion or

	adversely impacts the viability of groundwater dependent ecosystems (GDEs) or other beneficial users of surface water, including maintenance of in-stream flows.”
1819-1824	The first sentence in this section states that “… groundwater elevations will be used as a proxy, and the MT defined for chronic lowering of groundwater elevation in Aquifer I will be used as the MT for the depletion of ISW.” The methodology for groundwater level MTs states that “[w]herever possible, the MT is set as the average of the three lowest (Fall season) historical measurements on record for depth to groundwater taken during drought periods.” (lines 684-685). However, lines 1822-1824 state that the depletion of ISW MT is “the lowest historical groundwater depth to water …” We advocate for more the more protective methodology that uses the average of the three lowest groundwater elevations. Please clarify.
1824-1829	While we recognize that accounting uncertainties related to biannual groundwater level measurement may justify a small buffer to represent the actual minimum groundwater level, the choice of 10% or 10ft is provided without any quantitative analysis to justify those buffer values. Based on a preliminary evaluation of continuous, multi-year groundwater level data and surface water depletion RMPs in Sonoma Valley GSA area, a buffer of 2.5–5% would adequately account for this uncertainty while still being sufficiently protective. We encourage the GSA to select more protective buffers that are quantitatively defined.

Ukiah Valley Groundwater Basin
Groundwater Sustainable Agency

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Review Form
Ukiah Valley Basin Groundwater Sustainability Plan

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Ukiah Valley Groundwater Basin

Groundwater Sustainable Agency

Reviewer name:
Submission date:
GSP sections reviewed: **GSP Public Draft**

Line number	Suggested revision (*please delete example text below once you submit*)
554	Appendix 2E not available to review.
Entire Doc.	Additional comments and editorial suggestions are provided in the document to help improve clarity and readability, to be used at the authors' discretion.

Ukiah Valley Groundwater Basin

Groundwater Sustainable Agency

Ukiah Valley Groundwater Basin

Groundwater Sustainable Agency

Attachment C – Ukiah Valley Basin Groundwater Sustainability Plan Comment and Comment Response Matrix

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
City of Ukiah	COU-001	C	GE		Executive Summary	5		List of Acronyms should include MO and MT	Addressed.
City of Ukiah	COU-002	C	ED		Executive Summary	10	196	Should read 120,000-acre feet not 12,000	Addressed.
City of Ukiah	COU-003	C	PA		Executive Summary	11	224-229	This paragraph states that there is a groundwater depression "located around the City of Ukiah" that is the "most significant feature in the UVB" and "likely the greatest source of groundwater discharge in the basin". The City is aware of that data supporting this statement this may be erroneous. The City recommends reviewing the revised contour map and removing this paragraph.	Addressed.
City of Ukiah	COU-004	C	PA		Executive Summary	17	295	"Little" should be removed as no subsidence has been observed.	Addressed.
City of Ukiah	COU-005	C	PA		Executive Summary	17	312-323	This section should acknowledge ESA-listed anadromous fisheries with the GSA	Addressed.
City of Ukiah	COU-006	C	PA		Executive Summary	21	349-353	This section should acknowledge the significant recharge contributions of the City of Ukiah's and Calpella's WWTPs. Data is available in *Characterization of the Ukiah Valley Groundwater Basin, Final Report, Prepared for: City of Ukiah Maritza Flores Marquez, M.S., EIT, Samuel Sandoval Solis, Ph.D., and, Romina Díaz Gómez, Ph.D. Postdoctoral Researcher, CONICET June 2017 Pg 78.*	Please refer to Appendix 2D and MCR #5: Water budget
City of Ukiah	COU-007	B	WB		Executive Summary	22	Table 2	Water Budget should include recharge contributions noted above.	Please see MCR #5: Water Budget
City of Ukiah	COU-008	C	PA		2	16	226	The City no longer contracts with RRFC.	Addressed.
City of Ukiah	COU-009	C	PA		2	16	269	The City has a pre-1914 right, not pre-1949.	Addressed.
City of Ukiah	COU-010	C	PA		2	16	273	The City no longer contracts with RRFC.	Addressed.
City of Ukiah	COU-011	C	PA		2	32	654	This section should acknowledge the significant recharge contributions of the City of Ukiah's and Calpella's WWTPs. Data is available in *Characterization of the Ukiah Valley Groundwater Basin, Final Report, Prepared for: City of Ukiah Maritza Flores Marquez, M.S., EIT, Samuel Sandoval Solis, Ph.D., and, Romina Díaz Gómez, Ph.D. Postdoctoral Researcher, CONICET June 2017 Pg 78.*	Addressed. Please refer to Appendix 2D and MCR #5: Water budget for the information that is added with regards to this comment.
City of Ukiah	COU-012	C	PA		2	32	658	The hydrology of the percolation ponds have been studied extensively and do not "flow to the river". *See Fate and Transport if Wastewater Treatment Plant Discharge Percolation Ponds, City of Ukiah, California, Balance Hydraulics, Inc. May 2010.*	Noted and sentence was revised no to imply any judgment on the flow of percolating water.
City of Ukiah	COU-013	C	PA		2	32	665-666	The cited 2010 UWMP is dated. Please referring to *City of Ukiah Final 2020 UWMP* for current information.	2010 UWMP was used at the time of analysis. Inclusion of the 2020 will be done in the 5-year reevaluation.
City of Ukiah	COU-014	C	PA		2	96	1550-1551	Restates inaccurate information related to groundwater elevations near the City as a result of pumping.	Addressed.
City of Ukiah	COU-015	C	PA		2	97	1590-1593	Restates inaccurate information related to groundwater elevations near the City as a result of pumping.	Addressed.
City of Ukiah	COU-016	C	PA		2	115	1846-1847	Restates inaccurate information related to groundwater elevations near the City as a result of pumping.	Noted. The text here does not indicate depression due to pumping. It is pointing out observed inconsistencies in groundwater level measurements in nearby wells that may be due to production.
City of Ukiah	COU-017	C	PA		2	120	Figure 39	Based on conversation with LWA staff this figure has been revised and should be replaced.	Contours were revised as available data allowed for improvements and corrections.
City of Ukiah	COU-018	C	PA		2	121	Figure 40	Based on conversation with LWA staff this figure has been revised and should be replaced.	Contours were revised as available data allowed for improvements and corrections.
City of Ukiah	COU-019	C	PA		2	129	1929	The City, as part of its NPDES permit has monitored Groundwater WQ in the valley at a number of sites and has not observed any trends to support this statement.	Noted. The text is outlining the possibility of irrigation impacting salts and nutrients conditions and does acknowledge that those concentrations are below regulatory limits basin-wide, except for Boron.

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
City of Ukiah	COU-020	C	ED		2	140-145		Figure legend color scale do not match figures icons.	Addressed.
City of Ukiah	COU-021	C	ED		2	150		Figure depicts "measurements" outside range of accuracy and uses scales that artificially exaggerate observations.	Addressed.
City of Ukiah	COU-022	C	GE		2	165		Distribution, density, and range described is inaccurate.	CDFW BIOS public dataset was used to map endangered species. We acknowledge that there can be inaccuracies. These inaccuracies may be corrected through more local information and data collection.
City of Ukiah	COU-023	C	GE		2	172		Distribution, density, and range described is inaccurate.	CDFW BIOS public dataset was used to map endangered species. We acknowledge that there can be inaccuracies. These inaccuracies may be corrected through more local information and data collection.
City of Ukiah	COU-024	C	ED		3	32	882	"not a problem" should be restated to not observed.	Addressed.
City of Ukiah	COU-025	C	ED		3	53		Figure depicts "measurements" outside range of accuracy and uses scales that artificially exaggerate observations.	Addressed.
City of Ukiah	COU-026	C	PM		4	4	13-21	Section should note that currently neither actions or projects are needed to achieve sustainability as there are no indicators suggesting overdraft.	Addressed.
City of Ukiah	COU-027	C	GE		4	8	115	The cited 2015 UWMP is dated. Please referring to *City of Ukiah Final 2020 UWMP* for current information.	Noted. During the GSP development, UWMP 2010 was made available and its information was used. 2020 UWMP will be used to update the plan in the 5-year review.
City of Ukiah	COU-028	C	GE		4	9	Table 2	The correct name for the City's reuse project is the Recycled Water Project.	Addressed.
Russian Riverkeeper	RRK-001	C	IS					It is during these dry periods when users are faced with curtailments and other surface water shortages, that individuals, communities, local governments, and agriculture all turn to groundwater pumping as a replacement water source. This turn to groundwater pumping then increases the rates of depletion in the aquifer and in many areas, also causes further depletion of our local surface waters in the Russian River and its tributaries. As dry periods extend, groundwater pumping will continue with fewer and fewer opportunities for natural recharge to help replenish those losses. This results in harm to a multitude of beneficial uses like COLD habitat for our endangered salmon species and REC by further reducing depleted surface flows. The Russian River alternates between a losing and gaining river throughout the year and surface water species are heavily reliant on those gaining periods, especially in dry periods, to provide necessary cold water flows to the river. As groundwater pumping increases to accommodate for surface water losses, the Russian River will lose these key "gaining periods" that are vital to extending the health of our endangered species and the impacts could be disastrous. In turn, this means that as groundwater pumping increases and the aquifer reduces, the Russian River will likely become a "losing river" more often than not. With even less surface waters available for capture, the GSPs plan to capture surface waters to recharge the aquifers becomes even more limited. Beyond what the river recharges naturally through these "losing periods," excess surface waters available for recharge will be more limited. Though impacts may appear negligible to date, there does appear to be a downward trend and that trend is only growing to grow as our region continues to come to terms with living in a drier and hotter climate.	Noted.

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
Russian Riverkeeper	RRK-002	B	CC					The Ukiah Basin will not be the exception to these impacts and the GSP must adequately consider all of the impacts of climate change so that the groundwater basin is sustainable 20 and 50 years out. As of right now there is insufficient evidence, support, and consideration for the impacts of climate change on the Ukiah Valley Groundwater Basin.	Please see MCR #4: Climate Change
Russian Riverkeeper	RRK-003	A	PM					The GSP currently puts a very heavy emphasis on surface water supply augmentation as opposed to demand reduction. There is also very little discussion of groundwater, groundwater use, and groundwater supply itself as part of the proposed mitigation projects. While true one of the most promising approaches to increase supply is to expand groundwater recharge, climate change is likely to significantly reduce that ability compared to what might have been thought possible even five or ten years ago when SGMA was first being put together.	Please see MCR #9: Projects and Management Actions
Russian Riverkeeper	RRK-004	A	PM					When it comes to recharge, all water users will be competing for any floodwaters and rain that can be feasibly captured—likely a much smaller volume than what is expected in these plans. Then depending on what that volume turns out to be, there are also going to be physical constraints in what can actually be captured for recharge. Between existing storage limits and then transport constraints between those storage areas to the ideal recharge locations, there are some significant and costly hurdles that must be overcome. For example, it is likely that substantial regional investments in conveyance and greater efforts to coordinate the management of surface and groundwater storage infrastructure will be required in order to expand their combined impact. By time these infrastructural pieces are in place to facilitate recharge efforts, available surface waters and precipitation will have likely reduced even further away from the historical averages relied on in this GSP**. In order for the GSP to rely on recharge and supply augmentation to such a great extent, the factors and obstacles noted above must be given more consideration and details provided on how those factors will be achieved. There must also be a showing that these substantial projects will be completed on a timeline that ensures sustainability within the Basin and in compliance with SGMA. (emphasis added)**	Please see MCRs #9: Projects and Management Actions; and #10: Data Gaps and GSP Implementation. Supply augmentation PMA section was also updated to discuss the requirements and possible difficulties of its implementation.
Russian Riverkeeper	RRK-005	B	CC					In addition to the above constraints to achieving groundwater recharge, climate change is also going to increase the amount of tension among other water users within the Basin with each competing to capture any high flow events for their own storage and use. This is going to further constrain the water volume available for recharge and supply augmentation, and needs to be included in any analysis that is done. Future impacts of climate change are likely to throw off projections within this GSP and will negatively impact the GSPs ability to achieve sustainability.	Please see MCR #4: Climate Change and the response to comment #32.

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
Russian Riverkeeper	RRK-006	A	PM					Due to the increasing issues surrounding future supply replenishment, it is vital that demand reductions be fully considered and given a higher priority throughout this GSP. Demand reduction methods that need to be considered include the feasibility of land fallowing, increased urban conservation, pumping restrictions through local government policies, fees for groundwater pumping, and irrigation reductions. The timeline for implementing such measures may not need to be immediate, but the GSP needs to properly allocate time and funding to determine the feasibility and beneficial impacts of demand reduction in order for the Ukiah Basin to actually obtain long-term sustainability. Without demand reduction and knowledge of how groundwater is used, the Ukiah Basin will not obtain long-term sustainability. Analysis of demand management must occur within this initial five year period so that later decisions are well-informed.	Please see MCR #9: Projects and Management Actions
Russian Riverkeeper	RRK-007	B	MN					To date, groundwater pumping has been allowed to continue unimpeded such that the GSA does not know how many groundwater wells are active within the Basin, nor how much water is pumped, how that amount changes across the seasons, or where all the wells are even located. Without any of this data it is impossible for the GSP to tackle the demand side of things and it is a necessary and vital component to achieving lasting sustainability. Monitoring and reporting data to obtain this key information must be given priority—in both time and funding.	Please see MCRs #9: Projects and Management Actions; and #10: Data Gaps and GSP Implementation.
Russian Riverkeeper	RRK-008	A	GD					Pumping from these aquifer-stream complexes can adversely affect juvenile salmon and steelhead habitat by lowering groundwater levels and interrupting the natural flow between the aquifer and stream, which degrades water quality and diminishes streamflow. Groundwater extraction has the potential and may be compromising endangered salmon instream habitat, and must be given more attention in the form of specific details on addressing data gaps, timeline on obtaining necessary data, and funding allocated to closing this data gap.	Please see MCRs #7: Depletion of Interconnected Surface Waters; #9: Projects and Management Actions; and #10: Data Gaps and GSP Implementation.
Russian Riverkeeper	RRK-009	A	IS					The GSP currently states that additional studies are needed to confirm past modeling on the surface-groundwater interchange, but then also appears to rely on that interchange for justifying the water budget and recharge assumptions. It cannot be both ways if the GSP wants to rely on this interchange for things that benefit certain stakeholder interests, but then say more information is needed when it does not benefit those same stakeholders.	Please see MCRs #7: Depletion of Interconnected Surface Waters; and #10: Data Gaps and GSP Implementation for discussion on how data gaps and uncertainty was considered in setting sustainable management criteria for the depletion of interconnected surface water bodies and how the GSA is proposing to fill the needed data gaps. Data gaps and uncertainties in the water budget and the UVIHM overall are extensively discussed in Appendix 2D. GSA has provided water budget components that could be estimated based on measured data and discussed uncertainties, data gaps, and recommended actions for the UVIHM. The GSA considered and will continue to appropriately consider model uncertainties and data gaps as equally important factors in all aspects of its decision making, including water budget and setting sustainable management criteria.

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
Russian Riverkeeper	RRK-010	A	IS					The GSP must give further detail in how this interchange is going to be impacted by climate change and present a timeline for closing any existing data gaps. Funding for collecting this information must be made a priority and a detailed timeline should be provided.	Please see MCRs #4: Climate Change; #7: Depletion of Interconnected Surface Waters; #9: Projects and Management Actions; and #10: Data Gaps and GSP Implementation.
Russian Riverkeeper	RRK-011	A	PM					Details also need to be provided on mitigation measures and what conditions will trigger those measures, especially during dry periods with severely reduced precipitation—for instance pumping restrictions and moratoriums on new groundwater wells near interconnected surface waters when certain thresholds are exceeded in extended dry periods.	Please see MCR #9: Projects and Management Actions
Russian Riverkeeper	RRK-012	B	WR					There also needs to be analysis and consideration for how groundwater pumping may impact water rights in light of this surface groundwater interchange.	Alteration of water rights is outside the scope of SGMA. The GSA is mandated to focus on prevention and mitigation of potential future unreasonable depletion of ISWs due to groundwater pumping and will consider impacts on beneficial users, including but not limited to surface water users, in its analysis and decision-making. This was done during GSP development and will include all aspects of GSP implementation including PMAs.
Russian Riverkeeper	RRK-013	C	MN	RRK-012; CCR 23 § 354.32, CCR 23 § 354.34(b)(2), 354.38(b)				Specifically, SGMA regulations identify the need for an adequate monitoring network to help characterize the surface and groundwater interface throughout the Basin, and allow for evaluation of changes over times. [CCR 23 § 354.32]. The regulations specifically require that "The monitoring network objectives shall be implemented to ... Monitor impacts to the beneficial uses or users of groundwater" [CCR 23 § 354.34(b)(2)]. Moreover, the regulations require GSPs to identify data gaps where the network "does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency" [CCR 23 § 354.38(b)]. This monitoring network will also be key to determining what sustainable yields truly are, as it is currently possible to have overly inflated yield determinations which will only harm the Basin going forward.	Please see MCRs #8: Design and Implementation of Monitoring Networks; #9: Projects and Management Actions; and #10: Data Gaps and GSP Implementation.
Russian Riverkeeper	RRK-014	B	IS	RRK-013; CWC § 10735.2.(a)(5)(B)(ii)				Lastly, by the time of the 5-year update, the GSP should demonstrate whether "groundwater extractions result in significant depletions of interconnected surface waters" (CWC § 10735.2.(a)(5)(B)(ii)). To define significant depletions, beneficial users of surface water should be identified and considered in development of and reporting on sustainable management criteria.	Please see MCR #7: Depletion of Interconnected Surface Waters
Russian Riverkeeper	RRK-015	B	DG					There do not appear to be any clear plans for obtaining funding for PMPs, addressing data gaps, or ensuring that no undesirable results present. No timeline for applying for grants or initiating fees; no details on amounts or priority allocation for funds. Without funding and identification of priority projects to which detailed timelines can be applied, the GSP is without legs to stand on in regards to obtaining long term sustainability.	Please see MCRs #8: Design and Implementation of Monitoring Networks; and #10: Data Gaps and GSP Implementation.

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
Russian Riverkeeper	RRK-016	A	DG					There are frequent references in the GSP to data gaps, but there does not appear to be a clear path to closing those data gaps—especially in regards to the surface-groundwater interchange and data about groundwater wells themselves (number of wells, location of wells, types of wells, and volume of groundwater pumping occurring). As two key areas of information necessary for informed decision making, detailed timelines need to be implemented on how these data gaps will be closed, funding will be obtained to close those data gaps, and necessary steps to be completed. Necessary data should be obtained and collected within the first 5 years of implementation so that the Ukiah Basin is on solid footing for preventing future undesirable results. Climate change will be exasperating the potential for undesirable impacts and having this solid data foundation in the beginning will reduce that potential.	Please see MCRs #8: Design and Implementation of Monitoring Networks; #9: Projects and Management Actions; and #10: Data Gaps and GSP Implementation.
Russian Riverkeeper	RRK-017	A	DG					Data gaps can be closed via the implementation of new local governance policies that can be imposed by the GSA and/or by agreement of GSA members. Some new governance policies would be the creation of metering, monitoring and reporting requirements for all new groundwater wells. To provide public assurance in health and safety of aquifer, this data should also be made publicly available.	Please see MCRs #8: Design and Implementation of Monitoring Networks; and #10: Data Gaps and GSP Implementation.
Russian Riverkeeper	RRK-018	C	BE					It is also recommend the GSA continue efforts to identify and engage beneficial users representing disadvantaged communities and the environment and to incorporate the interests of these users into the calculation and update of sustainable management criteria.	Please see MCR #1: Communication and Engagement Plan
Russian Riverkeeper	RRK-019	B	DG					In order to ensure best available information about impacts to beneficial users reliant on shallow groundwater, we recommend the GSA improve local information about the location and condition of both active and abandoned groundwater wells. Local investigations would improve accuracy regarding well location, condition and water quality. We are also concerned that because well abandonment data is largely unavailable, there is potential for migration of surface contaminants to groundwater from improperly closed wells. We recommend the GSA coordinate with other local agencies to identify inactive and abandoned wells to ensure that they have been properly retired.	Please see MCR #9: Projects and Management Actions
Russian Riverkeeper	RRK-020	C	GE					There needs to be a section or appendix that defines how terms are being used within this GSP specifically. This will not only help with consistency in use of terms, but it will also help the lay person understand what is being said throughout this GSP. Another way to improve clarity is to have figures and tables set in text or at least closer to their in text references. Right now they are typically grouped a page or two away from the in text reference or sometimes even before the in text section referencing them.	A glossary will be added to the final GSP. Terms are defined at their first use in every chapter.
Russian Riverkeeper	RRK-021	B	GE					There are frequent discussions and references to both surface waters and groundwaters. However, many of these discussions lack clarity on which type of water is actually being referenced at that particular section. This tends to create confusion when reading sections about the surface-groundwater interface which is a key component of this GSP and requires clarity. For instance, there are references to a losing river (a term of art) that then go on to say that groundwaters are feeding the river which is the opposite of a losing river. The subject of streamflow depletion in summer months and whether the river is percolating to re-fill pumped groundwater is of critical importance so the terms used must be clarified.	Text was revised to provide more clarity

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
Russian Riverkeeper	RRK-022	C	BR					The Public Trust Doctrine imposes a related but distinct obligation to consider how groundwater management affects public trust resources, including navigable surface waters and fisheries. Groundwater hydrologically connected to navigable surface waters or surface waters supporting fisheries, and surface waters tributary to navigable surface waters or surface waters supporting fisheries, are also subject to the Public Trust Doctrine to the extent that groundwater extractions or diversions affect or may affect public trust uses (*Environmental Law Foundation v. State Water Resources Control Board* (2018), 26 Cal. App. 5th 844; *National Audubon Society v. Superior Court* (1983), 33 Cal. 3d 419). Accordingly, groundwater plans should consider potential impacts to and appropriate protections for interconnected surface waters and their tributaries, and interconnected surface waters that support fisheries, including the level of groundwater contribution to those waters.	The GSA operates under SGMA and its associated regulations. SGMA clearly outlines a staged process to full compliance with the sustainability criteria by 2042. A clear plan and adaptive management were proposed to prevent undesirable results to beneficial users of surface water caused by depletion of ISWs due to pumping. Please see MCR#7.
Russian Riverkeeper	RRK-023	C	BR					In the context of SGMA statutes and regulations, and Public Trust Doctrine considerations, GSA groundwater planning must carefully consider and protect environmental beneficial uses and users of groundwater including fish and wildlife and their habitats: groundwater dependent ecosystems and interconnected surface waters. Public Trust resources have not been given due consideration throughout this GSP and analysis must be done to fully do so.	The GSA operates under SGMA and its associated regulations. SGMA clearly outlines a staged process to full compliance with the sustainability criteria by 2042. A clear plan and adaptive management were proposed to prevent undesirable results to beneficial users of surface water caused by depletion of ISWs due to pumping. Please see MCR#7.
Russian Riverkeeper	RRK-024	A	BE					Lastly, there must be due consideration for impacts and interests of those that are not part of the GSA itself so that no communities or beneficial uses are omitted. From mutual water companies, individual rural home-owners with wells, and local NGOs additional interests must be given the same consideration as agricultural interests within the Basin. Part of this needed analysis is the identification of different land uses in relation to well locations and map overlays that identify different community types. The GSP should also be cognizant of the fact that a groundwater basin does not necessarily follow the lines of a community sitting above it. As such, communities that may be impacted by this GSP are potentially being excluded.	Please see MCR #1: Communication and Engagement Plan
Mendocino County Farm Bureau	MCFB-001	C	ED		5		94	Is water use sector mean groundwater use type such as municipal, residential, agricultural, etc?	Discussed with the commenter. Clarity provided.
Mendocino County Farm Bureau	MCFB-002	C	AL		5		95	What is considered “general location” of a well? If the data is being aggregated by use sector, is the “volume” of extraction affiliated with the “general location "such as a map quadrant?	Discussed with the commenter. Clarity provided.
Mendocino County Farm Bureau	MCFB-003	C	BC		5		101	Total water use by water source type. Is this proposing to summarize a total surface water diversion quantity within the basin? This is duplicative with the existing SWRCB water rights reporting process.	Addressed.
Mendocino County Farm Bureau	MCFB-004	C	PO		5		265-266	this sentence speaks to a communication process. Section 5.1.3.1 discusses various entities the GSA will continue to coordinate with. Is the communication process from line 265 intended to represent coordination with overlying landowners in relation to groundwater resources? If not, perhaps an additional bullet point can be added under line 264 to discuss coordination with property owners affiliated with groundwater use.	Addressed.

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
Mendocino County Farm Bureau	MCFB-005	C	PM		5		299-300	Point of clarity. Is there a limit on fee assessment increases related to SGMA GSP implementation by a GSA if the GSA is holding a sizeable general reserve?	Discussed with the commenter.
Mendocino County Farm Bureau	MCFB-006	C	PM		4		18-21	If a GSA management action leads to a change in water use timing, quantity, etc. for an agricultural operation there will most likely be a capital investment (or loss) made to react to the management action and/or related project.	Addressed.
Mendocino County Farm Bureau	MCFB-007	C	PM		4		85-87	Related to the comment on line 18-21, there could be significant costs related to compliance with the GSP for farmers and ranchers depending on various unknown variables at this time. Fallowing productive land or not using an existing well is not a choice that will be made lightly. If actions like these are suggested, there are multiple factors that the GSA will need to consider, including a way to reimburse for these losses.	Noted.
Mendocino County Farm Bureau	MCFB-008	C	AL		4		Figure 1, Box 4	How did the scenario of curtailing ag pumping come to fruition? Wouldn't more appropriate scenarios look at overall reduced pumping for all beneficial uses?	Box 4 explains how to build extreme scenarios to assess and build understanding of how PMAs can generally impact Basin conditions. It is not intended to define a PMA. Ag curtailment is not defined as a PMA in this chapter.
Mendocino County Farm Bureau	MCFB-009	C	BC		4		Table 2, P. 3	What are the current water sources for the Mendocino College and Ukiah High projects? It is helpful to know where the current water source is coming from to understand the related water reduction from the projects in Table 2.	Discussed and addressed with commenter. PMA will help add flexibility and resiliency to the water supply.
Mendocino County Farm Bureau	MCFB-010	C	PM		4		146	I don't believe there are any DWR or Bureau of Rec. projects in the basin. Is this reference needed?	Addressed.
Mendocino County Farm Bureau	MCFB-011	B	WR		4		211-213	Are there numbers associated with the portion of water rights holders that don't have reliable wells? Is this under natural conditions of curtailment action by the SWRCB in low water years?	This is a general PMA and is not necessarily related to drought or natural conditions. The intent primarily is to provide redundancy and flexibility in the water supply. No specific numbers are yet determined. But such numbers will be provided when the GSA implements the Well Inventory PMA. This comment was discussed through discussion with the commenter, as well.
Mendocino County Farm Bureau	MCFB-012	C	PM		4		258	Understanding that site location for Flood-Mar projects is part of the process, it is a good reminder that during wet years, there is an existing flood plain along the main stem Russian that is mostly in agricultural use for just that reason. There are management issues with existing conditions to work to minimize damage to vineyards, orchards or properties from flooding. Flood-Mar can be appropriate in certain location, but implementation will require substantial interaction with property owners/managers to understand the existing issues with flood damage to avoid adding additional impacts from these projects. Similar comments apply to **lines 396-403.**	Noted.
Mendocino County Farm Bureau	MCFB-013	C	PM		4		277-278	There could be situations where agreements can be made with agricultural property owners in the basin to release water into tributaries from stored water resources. There have been successful projects in Sonoma County on tributaries for instream fishery purposes, but there is most likely an added benefit of some degree of recharge.	Noted.
Mendocino County Farm Bureau	MCFB-014	C	PM		4		375	creating recharge basins in the upper main stem Russian River below Lake Mendocino would be a challenge. Is the river channel referenced here the West Fork?	PMA is generally defined and the feasibility study will define appropriate streams and segments to be considered for implementation.

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
Mendocino County Farm Bureau	MCFB-015	C	PM		4		388	Urban stormwater runoff already travels through existing agricultural field during high flows. The urban areas on the West side of Highway 101 discharge onto the ag properties on the East side of 101. One reminder to incorporate into these concepts with stormwater management is the amount of debris and other components that are flushed onto agricultural properties from urban runoff. Looking at ways to reduce this "run-on" onto agricultural properties is important.	Noted. Predicting and planning to prevent these negative impacts will be part of the feasibility studies and pilot projects and will be done prior to full-scale implementation of all infrastructural PMAs.
Mendocino County Farm Bureau	MCFB-016	C	PM		4		428	Conservation easements come with various conservation terms or requirements. Farm Bureau does not like to see working lands taken out of production solely for a conservation purpose. Looking for ways to maintain a working landscape while concurrently achieving a conservation goal is preferred.	Noted.
Mendocino County Farm Bureau	MCFB-017	C	PM		4		455	snow shade and accumulation are not an issue in this basin	Addressed.
Mendocino County Farm Bureau	MCFB-018	C	ED		4		462-463	any chance of river disconnection during low flow years is associated with overall water demand from ALL beneficial uses and not just irrigation. The wording," lessening the chance of river disconnection during critical dry periods" should be removed. Also, urban irrigation efficiency improvement should be included in this section.	Noted and addressed.
Mendocino County Farm Bureau	MCFB-019	C	ED		4		489	what is the definition of full-season irrigation?	Addressed.
Mendocino County Farm Bureau	MCFB-020	C	PM		4		496-498	Crop rotation can be a challenge. Mendocino County does not have the machinery and infrastructure related to harvesting a lot of the winter crops that would only be dependent on natural water supply.	Noted.
Mendocino County Farm Bureau	MCFB-021	C	PM		4		499-502	Most irrigation in the basin is via under canopy sprinklers in orchards or drip in vineyards. The presence of using irrigation pivots is minimal on a small acreage of hay ground.	Noted.
Mendocino County Farm Bureau	MCFB-022	C	PM		4		507-509	Farm Bureau does not support the conversion of working lands into solar farms.	Noted.
Mendocino County Farm Bureau	MCFB-023	C	PM		4		516-540	The history of crop production in Mendocino County has revolved around "cash crops" such as hops, prunes, pears and now wine grapes. There is some degree of crop variation, but our rural location and distance from processing infrastructure is what has limited diversity. Our last prune orchard was removed when the last prune dryer in Sonoma County closed. The point is, that there may be several lower ET crops that could be grown in the county, but economically, would not be viable. Any alternative crop would also have to be machine harvestable since labor intensive crops are also not viable. Continuing to encourage the removal of water intense landscaping in urban settings, such as lawns (private and municipal), should also be included in this section.	Noted. Urban conservation efforts and its respective PMA is included in Chapter 4.
Mendocino County Farm Bureau	MCFB-024	C	DG		4		583	The SWRCB and regional water boards don't have jurisdiction over percolating ground water. Farm Bureau is concerned that under emergency orders seen in 2021, the SWRCB is looking to expand this jurisdiction. Local well owners may be willing to collaborate with the GSA, but not if there is a chance that the data provided is shared with all the other agencies listed.	Noted.

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
Mendocino County Farm Bureau	MCFB-025	C	BC		4		595-600	there are assumptions being made that all groundwater is hydrologically connected in the basin and that reducing the use of wells by increasing the use of contract water will automatically reduce an assumed loss of surface water to groundwater. This statement seems overly broad.	Noted.
Mendocino County Farm Bureau	MCFB-026	C	ED		3		136	"significant additional". The GSP will work to analyze the surface to groundwater interaction to avoid any significant streamflow depletion that is determined to be related to groundwater pumping. The word "additional" makes assumptions of current conditions that have yet to be determined. The word additional should be removed.	Addressed.
Mendocino County Farm Bureau	MCFB-027	C	PM		3		175	How are potential future economic impacts to groundwater users accounted for within a GSP?	Minimizing the impacts on the economy of the Basin is one of the main goals of PMA implementation outlined in Chapter 4 (See Section 4.1). The GSA has also defined a PMA called "Future of Basin Assessment", which would study the economic impacts of PMA implementation on the users in the Basin. Since the GSP in setting SMC in chapter 3 and implementing its monitoring network is not alternating historical practices, economic impacts on the Basin would likely occur through implementation of PMAs. The GSA believes that maintaining the sustainability of the Basin and water resources would have positive impacts on all users in the Basin.
Mendocino County Farm Bureau	MCFB-028	C	IS		3		390	"rivers cease to flow". Is this referencing the West Fork Russian River?	Both West Fork and East Fork Russian River and tributaries that are determined to be ISWs.
Mendocino County Farm Bureau	MCFB-029	C	BE		3		641-644	this section is a bit confusing. Is the term Rural Residential and Agricultural Residential? Are these non-commercial agricultural wells?	Discussed with the commenter and further clarity provided. Definition was provided.
Mendocino County Farm Bureau	MCFB-030	C	BE		3		652-653	The reference to beneficial users and water rights holders doesn't seem to fit in the description of environmental uses.	Noted and addressed.
Mendocino County Farm Bureau	MCFB-031	C	ED		3		817	specifying land trusts and resource conservation agencies does not match the other sections that just list coordination with other agencies and stakeholders. The use of other agencies is more consistent.	Addressed.
Mendocino County Farm Bureau	MCFB-032	C	IS		3		825-826	What is meant by lack of available information concerning surface water diversion data? Is this data not available in the SWRCB water rights reporting system?	Discussed with the commenter and further clarity provided in Appendices 2D and 2E.
Mendocino County Farm Bureau	MCFB-033	B	ED		3		912	is this figure in development?	Text was revised accordingly.
Mendocino County Farm Bureau	MCFB-034	C	WQ? GS?		3		977	NCRWQCB basin plan for clarification.	References was made in text previous to this mention and comment addressed
Mendocino County Farm Bureau	MCFB-035	C	BE		3		1201	What is the definition of agricultural residential?	Discussed with the commenter and further clarity provided.
Mendocino County Farm Bureau	MCFB-036	C	WQ		3		1341	are naturally occurring NOIs reported to the NCRWQCB?	Any exceedances will be reported according to requirements. However, in the case of naturally occurring COI, the investigation may be limited to see if increasing trends or unusual increases are observed that fall within the responsibility and jurisdiction of the GSA to address.
Mendocino County Farm Bureau	MCFB-037	B	SS		3		1423	It is agreed that there is not a historical documentation of subsidence, however there are active faults in the basin. Is there consideration for tectonic action in the SGMA process for land subsidence or surface/groundwater interaction?	Discussed with the commenter and further clarity provided.

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
Mendocino County Farm Bureau	MCFB-038	B	IS		3		1498	Has it been determined that the entirety of the basin is interconnected to the mainstem Russian River? What divides the sections of the basin considered main stem versus tributary? It is recommended to rephrase line 1498.	Text was revised accordingly.
Mendocino County Farm Bureau	MCFB-039	C	ED		3		1560	… will ultimately be used to quantify POTENTIAL ISW depletions…..	Addressed.
Mendocino County Farm Bureau	MCFB-040	C	DG		3		1606-1607	again, what is the lack of historical and surface water diversion referring to? Is this in addition to the SWRCB water rights reporting records?	Discussed with the commenter and further clarity provided in Appendices 2D and 2E.
Mendocino County Farm Bureau	MCFB-041	C	DG		3		1629	What are the surface water diversion data gaps?	Discussed with the commenter and further clarity provided in Appendices 2D and 2E.
Mendocino County Farm Bureau	MCFB-042	C	ED		3		1752	This line seems to be a combination of two lines. Agricultural Land Uses and Users should be moved down.	Addressed.
Mendocino County Farm Bureau	MCFB-043	C	ED		3		1756	when releases from LAKE MENDOCINO	Addressed.
Mendocino County Farm Bureau	MCFB-044	C	ED		3		Figure 10	NOTE: The Fort Jones reference is not applicable.	Addressed.
Mendocino County Farm Bureau	MCFB-045	C	ED		2		Table 4	Update director for tribal seat and name alternates	Addressed.
Mendocino County Farm Bureau	MCFB-046	C	ED		2		Table 6	Update tribal seat	Addressed.
Mendocino County Farm Bureau	MCFB-047	C	PA		2		Table 6	ag use/ private user under public water systems needs to be moved up for Levi Paulin under the TAC.	Addressed.
Mendocino County Farm Bureau	MCFB-048	C	ED		2		1498	Cannabis isn't an agricultural commodity. It is an agricultural product.	Addressed.
Mendocino County Farm Bureau	MCFB-049	C	PA		2		1597	since this section describes surface water resources, should the Potter Valley Project be mentioned perhaps on line 1608 as the water in the East Fork coming into the lake is connected to the Project? There is reference to the PVP on line 1657.	Addressed.
Mendocino County Farm Bureau	MCFB-050	C	MN		2		Table 16	The NMFS gauge on Robinson Creek may not still be operated by NMFS	Addressed.
James Sullivan	JS-001	C	DG/MN		General Comment			I appreciate the opportunity to comment upon the Draft UVGB GSP and ongoing effort the GSA is investing in the SGMA effort. I have reviewed the referenced document and have a general comment that applies to the entire GSP. The document does not emphasize enough the need for a substantial investment towards installation of strategically located surface and groundwater monitoring locations to fill data gaps. As stated within the GSP, the Ukiah Valley groundwater basin is not currently adequately monitored. The success and relevance of the GSA will depend upon early projects investigating areas needing immediate installation of additional monitoring infrastructure and acquisition of resulting monitoring results prior to implementation of many of the PMA's. More data will be necessary for implementing meaningful PMA projects to protect and improve the health of the UVB aquifer and connected hydrology.	Noted. Thank you for your comments.
James Sullivan	JS-002	C	DG/MN		3		631 - 633	At this time the statement: "Chronic well outages are not expected in Ukiah Valley due to the lack of long-term overdraft and seasonal variation in water levels." cannot be supported given the lack of adequate spatial data supporting time series groundwater recharge rates and long-term groundwater water level monitoring data. Suggest such statements be avoided within the GSP without supporting data and evidence.	Noted and addressed.

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
James Sullivan	JS-003	B	MN		3	73	1945-1962	Suggest that this is where the GSA initial energy and efforts focus upon. This section is the "KEY" to the GSA's success in management of SGMA. Without a pathway to achieve measurable objectives, and understanding the ISW's all efforts will have limited meaningful results. As stated many times within the GSP, at this time the basin is not monitored adequately. Conclusions within the GSP of the "health" of the aquifer cannot be adequately supported, promoted or stated other than without an adequate monitoring network of groundwater and surface water gauging this basin will not be adequately characterized. Promoting that the basin is healthy at this time cannot be support, and should not be promoted other than more information is necessary. This section needs stronger language and specific areas proposed to improve knowledge of groundwater and surface water conditions and the importance of the need for additional Basin monitoring. The pathway to achieve measurable objectives starts with designing and implementing an adequate monitoring network, which includes ISW's. Strongly suggest the use of "may" be used less in this vision document and the action verb of "will" be used to demonstrate the commitment the GSA in this effort. Especially the last sentence in this section…The GSA may will identify knowledge requirements, seek funding and help to implement additional studies.	Please see MCRs #7: Depletion of Interconnected Surface Waters; #8: Design and Implementation of Monitoring Networks; and #10: Data Gaps and GSP Implementation.
James Sullivan	JS-004	B	MN		4			General Comment: Without an integrated groundwater/surface water monitoring network achieving the GSP sustainability goals are abstract and easily ignored. The GSA needs to know the science before it can propose the solutions. Chapter 4 is where the GSP should have a blueprint for the GSA to act upon. Increased monitoring (both quantity and quality) should be more specific throughout the document and not as general, as presented. Adequate monitoring networks and their results will be the driver for projects to reach SGMA goals. Chapter 4 needs to expand upon monitoring generalities to establish concrete goals in establishing an adequate monitoring network as the keystone project in which each of the GMP PMA's effort will be based upon. As an example, in Section 3 part 3.4.3 Minimum Thresholds-Chronic Lowering of Groundwater Levels (lines 672 and 673), continuous groundwater monitoring is proposed to gather information on an identified data gap in the identification of high and low seasonal groundwater levels…This level of detail should be included and expanded upon in Chapter 4 as an opportunity to specify tasks.	Please see MCR #8: Design and Implementation of Monitoring Networks

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
National Marine Fisheries Service	NMFS-001	C	GD					Several waterways that overlie portions of the Ukiah Valley basin support federally threatened Central California Coast (CCC) steelhead (*Oncorhynchus mykiss*) and California Coastal (CC) Chinook salmon (*O. tshawytscha*). Surface water and groundwater are hydraulically linked in the Ukiah Valley basin, and this linkage is critically important in creating seasonal habitat for steelhead and salmon. Where the groundwater aquifer supplements streamflow, the influx of cold, clean water is critically important for maintaining water quality (e.g., temperature and dissolved oxygen) and flow volume. Pumping water from these aquifer-stream complexes has the potential to affect salmon and steelhead habitat by lowering groundwater levels and interrupting the hyporheic flow between the aquifer and stream. NMFS is concerned that groundwater extraction in the Ukiah Valley basin is currently impacting CCC steelhead and CC Chinook salmon instream habitat, and submits the following comments and recommendations to assist the GSA in adequately addressing those impacts.	Noted.
National Marine Fisheries Service	NMFS-002	B	IS		3		684	**Comment 1:** <u>Re: Chapter 3, line 684:</u> Proposing groundwater elevations representing the “average of the three lowest (fall season) historical measurements on record for depth to groundwater taken during drought periods” as streamflow depletion minimum thresholds will likely not avoid significant impacts to ESA-listed salmonids and their habitat. Basic hydraulic principles dictate that groundwater flow is proportional to the difference between groundwater elevations at different locations along a flow path. Using this basic principle, groundwater flow to a stream, or conversely seepage from a stream to the underlying aquifer, is proportional to the difference between water elevation in the stream and groundwater elevations at locations away from the stream. Minimum thresholds and measurable objectives consistent with the lowest groundwater elevations on record would likely create historically high streamflow depletion rates, resulting in instream conditions characterized by low surface flow input and high groundwater pumping that would be very likely to adversely affect ESA-listed salmonids and their critical habitat. Recommendation: The GSA should explain how the proposed measurable objective, which represents groundwater levels just a few feet higher than the minimum thresholds, are likely sustainability within 20 years. If a lack of data prevents the development of appropriate sustainable management criteria, the GSA should design and implement studies that better inform appropriate minimum thresholds and measurable objectives for streamflow depletion. In that circumstance, we again suggest the GSA follow guidance by the California Department of Fish and Wildlife that recommends conservative sustainability management criteria be established to ensure groundwater dependent ecosystem protection (CDFW 2019).	Please see MCR #7: Depletion of Interconnected Surface Waters. The recommendation was noted and considered. Section 3.4.4 of the GSP outlines how MOs are set and why the GSA believes they represent the sustainable operation of the Basin. It is worth mentioning that the Basin has not historically been subject to overdraft conditions or chronic declines in groundwater levels. Therefore, maintaining average historical groundwater levels as MOs will be sufficient to prevent undesirable results. Moreover, the GSP outlines that SMC set at representative monitoring points can be revised as needed upon collection of better data.

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
National Marine Fisheries Service	NMFS-003	A	IS		3		810	**Comment 2**: Re: Chapter 3, line 810: Comparing impact levels expected under the proposed minimum thresholds "to Fall 2015" is inappropriate for the reasons stated above (Fall 2015 coincides with the depths of California's historical drought). Furthermore, asserting that the "GSA and its technical advisory committee found that MTs are sufficiently protective of GDEs in the basin" offers little reasoned explanation as to how those minimum thresholds avoid the undesirable result of streamflow depletion (i.e., causing significant and unreasonable impacts to surface water beneficial uses). Were there specific analysis or past monitoring results that informed this determination? If so, the GSA should include this information in the draft GSP. Recommendation: We recommend the GSA adequately address the following requirement for minimum thresholds as spelled out in the SGMA regulations as follows: "The relationship between the minimum thresholds for each sustainability indicator, including an explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators." (CCR 23 §354.28(b)(2) According to DWR (2021), "it is up to GSAs to define in their GSPs the specific significant and unreasonable effects that would constitute undesirable results and to define the groundwater conditions that would produce those results in their basins." The GSA should qualitatively describe what conditions within the subbasin would constitute an undesirable result with regard to streamflow depletion, ensuring that the description accounts for beneficial uses of surface water that support ESA-listed salmon and steelhead.	Please see MCR #7: Depletion of Interconnected Surface Waters regarding the reasoning of using interim SMC based on groundwater levels for the depletion of ISWs. As noted in this MCR, streamflow depletion can be caused by many factors, including groundwater pumping. Therefore, preventing undesirable results to surface water beneficial users falls within the depletion of ISWs due to groundwater pumping sustainability indicator. The relationship between the chronic lowering of groundwater levels minimum thresholds and other sustainability indicators is discussed in Section 3.4.3.2. This section was revised to address this comment. Impacts of the minimum thresholds on beneficial users, including GDEs, drinking water wells, and ISWs, are discussed in Sections 3.4.3.1 and 3.4.2.2. Determination of sufficient protection of GDEs was made based on this analysis and the criteria set for the undesirable results. The GSA acknowledges data gaps and uncertainty in its assessments and will re-assess and update its criteria and analysis upon additional data collection. Please refer to MCR#3 for further explanation of the GSA's future actions with respect to GDE protection. Quantitative and qualitative description of undesirable results for chronic lowering of groundwater levels is provided in Section 3.4.2, and for the depletion of ISWs in Section 3.9.2.

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
National Marine Fisheries Service	NMFS-004	A	IS		3		836	**Comment 3**: Re: Chapter 3, line 836: The plan states the following: "Through discussions with the GSA Board, technical advisory committee, stakeholder groups, and the public, and considering the analysis conducted on impacts on other beneficial users and uses in the basin, it was determined that impacts on ISWs and other beneficial uses and users such as shallow domestic wells during the recent drought (2012-2016) was considerable but not unreasonable. Therefore, since groundwater level MTs are set equal or very close to the groundwater levels experienced during the recent drought, impacts on ISWs are expected not to be significant and unreasonable during the first 5 to 10 years of the implementation." Recommendation: The GSA should fully explain what reasoning and rationale was used to conclude that stream depletion impacts to surface water beneficial uses during California's historic drought were "considerable but not unreasonable." Designated beneficial uses within upper Russian River watershed include migration of aquatic organisms; spawning, reproduction, and/or early development; and cold freshwater habitat. [footnote] As noted earlier, during a historic drought, groundwater levels are likely the lowest they've ever been, meaning that streamflow depletion rates were likely the highest they've ever been. Additionally, surface water base-flows are naturally at their lowest during a drought, meaning that streamflow depletion impacts from groundwater pumping are likely accentuated as compared to other water year types. Given the above reasoning, the conclusion reached by the GSA that these acknowledged "considerable" impacts are not unreasonable strains credulity, and would benefit from further explanation. We recommend any further explanation be based upon hydrogeologic and ecological principles and reasoning, where available.	Please see MCR #7: Depletion of Interconnected Surface Waters and revised text provided in Chapter 3.

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
National Marine Fisheries Service	NMFS-005	A	IS		3		1507	**Comment 4**: Chapter 3 line 1507, Section 3.9.1 Depletion of Interconnected Surface Waters Monitoring Network: Regarding Figure 9: Depletion of interconnected surface waters monitoring network. NMFS is concerned that the monitoring network proposed may not be sufficient to detect changes in surface flow in tributary streams within the GSA. Many westside tributaries such as Orrs, Gibson, Doolin, Robinson creeks and others provide habitat for CCC steelhead. These tributaries typically dry in the low-gradient reaches of the valley floor during the spring and summer depending on the water-year. Detecting impacts from groundwater extraction to these tributary streams is extremely important because specific life-stage survival of ESA listed salmonids may be affected. Stream monitoring should have the ability to detect relatively small changes (tenths of feet) in stage elevation and flow that could impact survival of newly emerged steelhead fry from stream gravels. The fry lifestage is particularly sensitive to stages changes due to their preference to stream margins where they can become stranded or beached with small changes in stage elevation. Other potential impacts in these tributary streams are associated with reduction of migration opportunity and habitat availability for various lifestages of juvenile steelhead attempting to access the mainstem Russian River or rear in upstream areas that provide summer refuge habitat. Reduction in stage elevation or loss of surface flow from groundwater extraction could reduce the number of days/opportunity for juveniles to migrate downstream into the Russian River, or upstream into higher gradient reaches that maintain surface flows during the summer months. Extraction may also affect available wetted habitat available in specific tributary reaches that are critical for survival during the summer months. Recommendation: The monitoring of interconnected streamflow should be implemented to detect "signals" in stage and flow changes from extraction. Specific high risk tributary reaches should be monitored in the spring and summer to determine if groundwater extraction has adversely affected ESA listed species or their habitat. Improving the number of monitoring well sites and stream gauges along high risk tributary reaches is recommended.	Please see MCRs #7: Depletion of Interconnected Surface Waters; #8: Design and Implementation of Monitoring Networks; #9: Projects and Management Actions; and #10: Data Gaps and GSP Implementation.
National Marine Fisheries Service	NMFS-006	C	PM					•We suspect that groundwater recharge projects are likely to be an important action implemented as part of the effort to achieve groundwater sustainability in the Ukiah Valley basin. NMFS encourages the GSA to consider implementing recharge projects that facilitate floodplain inundation, offering multiple benefits including downstream flood attenuation, groundwater recharge, and ecosystem restoration.	Noted.
National Marine Fisheries Service	NMFS-007	C	PM					•Managed floodplain inundation can recharge floodplain aquifers, which in turn slowly release stored water back to the stream during summer months. These projects also reconnect the stream channel with floodplain habitat, which can benefit juvenile salmon, steelhead, and sturgeon by creating off-channel habitat characterized by slow water velocities, ample cover in the form of submerged vegetation, and high food availability.	Noted.
National Marine Fisheries Service	NMFS-008	C	PM					•As an added bonus, these types of multi-benefit projects likely have more diverse grant funding that can lower their cost as compared to traditional off-channel recharge projects. NMFS stands ready to work with any GSA interested in designing and implementing floodplain recharge projects.	Noted.

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
Clean Water Action et al.	NGO-001	A	BE					The identification of Disadvantaged Communities (DACs), drinking water users, and tribes is incomplete. The GSP provides basic information on DACs, including identification by name and location on a map (Figure 2-4) as determined by the California Department of Water Resources DAC Mapping Tool, description of the size of the population in each DAC (p. 2-13), and a map of tribal lands (Figure 2-2). The plan fails, however, to identify the population dependent on groundwater as their source of drinking water in these communities. Identify the sources of drinking water for DAC members, including an estimate of how many people rely on groundwater (e.g., domestic wells, state small water systems, and public water systems).	Please see MCR #2: Identification of Disadvantaged Communities and Tribes
Clean Water Action et al.	NGO-002	A	PA					The plan also fails to provide depth of domestic wells (such as minimum well depth, average well depth, or depth range) within the basin. Include a map showing domestic well locations and average well depth across the subbasin.	Appendix 3-A presents a comprehensive assessment of domestic wells in the Basin. In addition, Section 2.1.1.4 provide maps for well density by use sector. Data gaps and further need for domestic well assessment are discussed in Appendix 2-E. Please also see MCR #10: Data Gaps and GSP Implementation
Clean Water Action et al.	NGO-003	B	IS					The identification of Interconnected Surface Waters (ISWs) is insufficient, due to lack of clarity around the monitoring well data (well location and screen depth) used to map interconnected stream reaches. The GSP took initial steps for the ISW analysis by comparing interpolated groundwater elevations to streambed elevations. The GSP states (p. 2-152): “To identify river reaches that are interconnected to groundwater, assumed streambed elevations were compared to representations of groundwater elevations above mean sea level.” Further information regarding the actual data used in the analysis is not provided, however. The GSP also describes a saturated zone threshold analysis to determine interconnected reaches to account for the assumed presence of saturated zones in areas of data gaps.	Contour maps for groundwater elevations are provided for selected years in Section 2.2.1 along with well hydrographs. Basin only has a limited record of groundwater elevation measurements through the CASGEM program. Therefore, the same information were used anywhere in the GSP that groundwater level data was needed. For further information regarding data gaps please see Appendix 2-E.
Clean Water Action et al.	NGO-004	B	IS					Provide more discussion in the GSP about the groundwater elevation data and streambed elevation data used to verify interconnected reaches. Include a map of the interpolated groundwater elevations and spatial extent of groundwater monitoring wells used to produce the map. Discuss screening depth of monitoring wells and ensure they are monitoring the shallow principal aquifer.	Contour maps for groundwater elevations are provided for selected years in Section 2.2.1 along with well hydrographs. Basin only has a limited record of groundwater elevation measurements through the CASGEM program. These maps are provided in the GSP Section 2.2.1. Streambed elevation was extracted from DEMs and detailed streambed elevation data is a data gap identified in Appendix 2-E. Section 2.2.2.6 explains how streambed elevations were extracted using best available science and data.
Clean Water Action et al.	NGO-005	C	IS					Identify gaining and losing reaches on the ISW map (Figure 60).	In this Basin, gaining and losing conditions of streams change seasonally. Due to existing data gaps discussed in Appendix 2-E, gaining and losing status cannot be accurately determined based in measured data and observations currently. The UVIHM provides a simulation method to obtain such information. Preliminary results of gaining and losing streams from the UVIHM are provided in Appendix 2-D. However, due to uncertainties and data gaps, further improvement and calibration of the UVIHM is needed to obtain reliable gaining/losing simulation results.

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Clean Water Action et al.	NGO-006	B	IS/DG					On the ISW map (Figure 60), clearly label the areas with data gaps. While the GSP clearly identifies data gaps and their locations in the text, we recommend that the GSP considers any segments with data gaps as potential ISWs and clearly marks them as such on maps provided in the GSP.	Please refer to Appendix 2E for a discussion of data gaps. As explained in MCR#7, the GSA considered existing uncertainty and data gaps into its analysis and decision-making process and assumed the entire Russian River as an ISW. The GSA will also re-evaluate interconnection upon collection of additional data for the next 5-review update of the plan.
Clean Water Action et al.	NGO-007	C	GDE/MN					The identification of Groundwater Dependent Ecosystems (GDEs) is insufficient, due to lack of clarity around the monitoring well data (well location and screen depth) used to map groundwater elevations and depth to groundwater. The GSP references TNC Best Practices for using the NC Dataset (2019) as the approach used to map depth to groundwater, using the difference between land surface elevation and interpolated groundwater elevation above mean sea level. However, as mentioned above in the ISW comments, the GSP does not further describe or present monitoring well data (well location and screen depth) used to create the depth-to-groundwater maps.	Please see MCR #3: Groundwater-Dependent Ecosystems. Contour maps for depth to groundwater was added to Section 2.2.2.7. Basin only has a limited record of groundwater elevation measurements through the CASGEM program.
Clean Water Action et al.	NGO-008	A	GDE					NC dataset polygons were incorrectly removed in areas adjacent to irrigated fields due to the presence of surface water. However, this removal criteria is flawed since GDEs, in addition to groundwater, can rely on multiple water sources – including shallow groundwater receiving inputs from irrigation return flow from nearby irrigated fields – simultaneously and at different temporal/spatial scales. NC dataset polygons adjacent to irrigated land can still potentially be reliant on shallow groundwater aquifers, and therefore should not be removed solely based on their proximity to irrigated fields.	Please see MCR #3: Groundwater-Dependent Ecosystems. A comparison of mapped potential GDEs before and after the refinement was added to Section 2.2.2.7 to show the limited extent of changes made.
Clean Water Action et al.	NGO-009	A	GDE					• NC dataset polygons were incorrectly removed based on the amount of time that they access groundwater. As presented in the GSP, assumed GDEs have access to groundwater >50% of time and assumed non-GDEs have access to groundwater <50% of the time. However, NC dataset polygons should not be assumed to be disconnected if there is any connection to groundwater (regardless of temporal percentage). Many GDEs often simultaneously rely on multiple sources of water (i.e., both groundwater and surface water), or shift their reliance on different sources on an interannual or inter-seasonal basis.	Please see MCR #3: Groundwater-Dependent Ecosystems. To address the comment, GDEs that are connected at any time during the period of record are considered potential GDEs. If they are not connected at all, they are assumed as to be likely disconnected. Potential GDEs will be reassessed upon collection of data and information.
Clean Water Action et al.	NGO-010	C	GDE/MN					Include a map of the interpolated groundwater elevations and spatial extent of groundwater monitoring wells used to produce the map. Discuss screening depth of monitoring wells and ensure they are monitoring the shallow principal aquifer.	A figure was added to show depth to groundwater contours based on the data available to address this comment and the few comments above in Section 2.2.2.7. Pleas refer to Appendix 2-E for data gaps and uncertainty in groundwater levels. CASGEM well information are provided in previous sections of the GSP. Number of wells that only monitor groundwater levels in the shallow principal aquifer are limited. Contouring method followed best available data and information and used shallow wells in the Basin for GDE and ISW analysis.
Clean Water Action et al.	NGO-011	B	GDE					Use depth-to-groundwater data from multiple seasons and water year types (e.g., wet, dry, average, drought) to determine the range of depth to groundwater around NC dataset polygons and to verify whether polygons in the NC Dataset are supported by groundwater.	Please see MCR #3: Groundwater-Dependent Ecosystems

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Clean Water Action et al.	NGO-012	B	GE					● Use a baseline period (we recommend 10 years from 2005 to 2015) to characterize groundwater conditions over multiple water year types.	Please refer to Appendix 2E for a discussion of data gaps and Chapter 2 of the GSP. Measured data is not available for such periods in the Basin. The GSA will revise accordingly upon the availability of additional data.
Clean Water Action et al.	NGO-013	B	GDE/DG					● If insufficient data are available to describe groundwater conditions within or near polygons from the NC dataset, include those polygons as "Potential GDEs" in the GSP until data gaps are reconciled in the monitoring network.	Please see MCR #3: Groundwater-Dependent Ecosystems
Clean Water Action et al.	NGO-014 Pt 1	C	GDE/WB	Water Code: 23 CCR §351(al) Water Code 23 CCR §354.18				Native vegetation and managed wetlands are water use sectors that are required [footnote] to be included into the water budget. The integration of native vegetation into the water budget is insufficient.	Please see MCR #5: Water Budget
Clean Water Action et al.	NGO-014 Pt 2	B	GDE/WB					The water budget did not explicitly include the current, historical, and projected demands of native vegetation. The omission of explicit water demands for native vegetation is problematic because key environmental uses of groundwater are not being accounted for as water supply decisions are made using this budget, nor will they likely be considered in project and management actions. Managed wetlands are not mentioned in the GSP, so it is not known whether or not they are present in the basin.	Please see MCR #5: Water Budget
Clean Water Action et al.	NGO-015	B	WB					Quantify and present all water use sector demands in the historical, current, and projected water budgets with individual line items for each water use sector, including native vegetation.	Please refer to Appendix 2D Modeling appendix for water use discussion.
Clean Water Action et al.	NGO-016	B	GDE/WB					● State whether or not there are managed wetlands in the basin. If there are, ensure that their groundwater demands are included as separate line items in the historical, current, and projected water budgets.	Noted.
Clean Water Action et al.	NGO-017	C	PO					We commend the GSA for their outreach to tribal members in the basin and for including a tribal member on the Technical Advisory Committee. However,	Noted.
Clean Water Action et al.	NGO-018 Part 1	C	PO	Water Code 23 CCR 354.10(d)(3)				Stakeholder engagement during GSP development is **insufficient**. SGMA's requirement for public notice and engagement of stakeholders is not fully met by the 3 description in the Communication and Engagement Plan	Please see MCR #1: Communication and Engagement Plan
Clean Water Action et al.	NGO-018 Part 2	A	PO					● The opportunities for public involvement and engagement are described in very general terms. They include attendance at public meetings, stakeholder email list, mailings of flyers and brochures, and updates to the GSP website. ● Environmental agencies are listed as stakeholders in Table 2-6, but specific engagement and outreach methods are not described. ● The Stakeholder Outreach Plan does not include a plan for continual opportunities for engagement through the implementation phase of the GSP for DACs, domestic well owners, and environmental stakeholders. Include a more detailed and robust Communication and Engagement Plan that describes active and targeted outreach to engage DAC members, domestic well owners, and environmental stakeholders during the remainder of the GSP development process and throughout the GSP implementation phase. Refer to Attachment B for specific recommendations on how to actively engage stakeholders during all phases of the GSP process.	Please see MCR #1: Communication and Engagement Plan
Clean Water Action et al.	NGO-019	C	BE	Water Code [23 CCR §354.28(b)(4)] Water Code 23 CCR §354.28(b)(5)				The consideration of beneficial uses and users when establishing sustainable management criteria (SMC) is **insufficient**. The consideration of potential impacts on all beneficial users of groundwater in the basin are required when defining undesirable results [footnote] and establishing minimum thresholds. [footnotes]	Noted. GSA considered to best of its ability and using the best available data and science the impacts of SMC on all beneficial users and uses. In cases of data gaps and uncertainty, the GSA has proposed PMAs and monitoring activities to cover important data gaps.

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
Clean Water Action et al.	NGO-020	A	GL					For chronic lowering of groundwater levels for drinking water users, the GSP describes impacts to domestic drinking water wells when defining undesirable results, and the GSP describes how the existing minimum threshold groundwater levels are consistent with avoiding undesirable results in the basin. This discussion is provided in Appendix 3-A, Shallow Well Protection Memorandum. The GSP does not however, specifically analyze direct and indirect impacts on DACs and tribes or evaluate the cumulative or indirect impacts of proposed minimum thresholds on DACs and tribes. Describe direct and indirect impacts on DACs and tribes when describing undesirable results and defining minimum thresholds for chronic lowering of groundwater levels (in addition to describing impacts to drinking water users).	Please see MCR #2: Identification of Disadvantaged Communities and Tribes
Clean Water Action et al.	NGO-021 Part 1	B	WQ					Minimum thresholds for two constituents of concern (COCs), nitrate and specific conductivity, are set at the primary (nitrate as N) or secondary (specific conductivity) maximum contaminant levels (MCLs). However, the GSP does not set SMC for the other naturally occurring constituents in the basin (i.e., iron, manganese, boron).	The GSA describes its reasoning in Chapters 2 and 3 and believes monitoring those constituents to observe unusual trends will be a sufficient course of action due to their historical exceedances.
Clean Water Action et al.	NGO-021 Part 2	A	WQ	Water Code [23 CCR §354.34(c)(4)]				Set minimum thresholds and measurable objectives for the naturally occurring COCs in the basin (iron, manganese, boron). Ensure they align with drinking water standards [footnote].	The GSA describes its reasoning in Chapters 2 and 3 and believes monitoring those constituents to observe unusual trends will be a sufficient course of action due to their historical exceedances.
Clean Water Action et al.	NGO-022	A	WQ					For degraded water quality, the GSP only includes a very general discussion of indirect impacts to drinking water users when defining undesirable results and evaluating the cumulative or indirect impacts of proposed minimum thresholds. The GSP does not, however, mention or discuss direct and indirect impacts on DACs or tribes when defining undesirable results for degraded water quality, nor does it evaluate the cumulative or indirect impacts of proposed minimum thresholds on DACs or tribes. Describe direct and indirect impacts on drinking water users, DACs and tribes when defining undesirable results for degraded water quality. For specific guidance on how to consider these users, refer to "Guide to Protecting Water Quality Under the Sustainable Groundwater Management Act."[footnote] ● Evaluate the cumulative or indirect impacts of proposed minimum thresholds for degraded water quality on drinking water users, DACs, and	Please see MCR #2: Identification of Disadvantaged Communities and Tribes
Clean Water Action et al.	NGO-023	C	SMC					We commend the GSA for their comprehensive analysis of SMC for GDEs and ISWs. The GSP analyzes the impacts on GDEs when defining undesirable results for three sustainability indicators (i.e., chronic lowering of groundwater levels, degraded water quality, and depletions of interconnected surface waters). Furthermore, the GSP evaluates the impacts of proposed minimum thresholds on GDEs or environmental beneficial users of surface water for these sustainability indicators. The GSP considers GDEs when establishing measurable objectives and evaluates the measurable objectives based on GDE water needs.	Noted.
Clean Water Action et al.	NGO-024	B	GD					● After re-analyzing the extent of GDEs and ISWs in the basin based on our comments above, re-evaluate the SMC to ensure they are protective of GDEs and surface water users in the basin.	Please see MCR #3: Groundwater-Dependent Ecosystems

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Clean Water Action et al.	NGO-025 Part 1	A	CC	Water Code [23 CCR §354.18(e)]				The integration of climate change into the projected water budget is **insufficient**. The GSP does incorporate climate change into the projected water budget using DWR change factors for 2030 and 2070. However, the GSP did not consider multiple climate scenarios (e.g., the 2070 extremely wet and extremely dry climate scenarios) in the projected water budget. The GSP should clearly and transparently incorporate the extremely wet and dry scenarios provided by DWR into projected water budgets or select more appropriate extreme scenarios for their basins. While these extreme scenarios may have a lower likelihood of occurring, their consequences could be significant, therefore they should be included in groundwater	Please see MCR #4: Climate Change
Clean Water Action et al.	NGO-025 Part 2	A	CC					Integrate climate change, including extremely wet and dry scenarios, into all elements of the projected water budget to form the basis for development of sustainable management criteria and projects and management actions.	Please see MCR #4: Climate Change
Clean Water Action et al.	NGO-026	A	WB					The GSP includes climate change into precipitation, evapotranspiration, and surface water flow terms of the projected water budget. However, the GSP does not calculate a sustainable yield based on the projected water budget with climate change incorporated. Calculate sustainable yield based on the projected water budget with climate change incorporated.	Please see MCR #4: Climate Change; and, #6: Sustainable Yield
Clean Water Action et al.	NGO-027	B	WB					If the water budgets are incomplete, including the omission of extremely wet and dry scenarios, and sustainable yield is not calculated based on climate change projections, then there is increased uncertainty in virtually every subsequent calculation used to plan for projects, derive measurable objectives, and set minimum thresholds. Plans that do not adequately include climate change projections may underestimate future impacts on vulnerable beneficial users of groundwater such as ecosystems, DACs, domestic well owners, and tribes. Incorporate climate change scenarios into projects and management actions.	Please see MCR #4: Climate Change
Clean Water Action et al.	NGO-028 Part 1	A	MN/DG	Water Code [23 CCR §354.34(b)(2)]				The consideration of beneficial users when establishing monitoring networks is **insufficient**, due to lack of clarity around the Representative Monitoring Points (RMPs) in the monitoring network that represent water quality conditions and shallow groundwater elevations around DACs, domestic wells, tribes, and GDEs. These beneficial users of groundwater may remain unprotected by the GSP without adequate monitoring and identification of data gaps in the shallow aquifer. The Plan therefore fails to meet SGMA's requirements for the monitoring network10.	Please see MCR #2: Identification of Disadvantaged Communities and Tribes ; and, #8: Design and Implementation of Monitoring Networks
Clean Water Action et al.	NGO-028 Part 2	B	MN/DG					Provide maps that overlay monitoring well locations with the locations of DACs, domestic wells, tribes, and GDEs to clearly identify potentially impacted areas. Increase the number of representative monitoring points (RMPs) across the subbasin for all groundwater condition indicators. Prioritize proximity to GDEs and drinking water users when identifying new RMPs.	Maps of DACs and SDACs, GDEs, domestic wells, and monitoring networks are provided in appropriate sections of the GSP and explained. GDEs are impacted mainly by groundwater levels near the river and the tributaries and Aquifer I conditions. DAC and SDACs as explained in MCR# 2 and shown on maps in Section 2.1.1.1 cover an overwhelming are of the Basin and have been considered in all analysis and decision-making processes. Comment noted for future RMPs. As more data becomes available and more new wells become appropriate selections as RMPs, GSA will update its monitoring network and RMP selections.

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
Clean Water Action et al.	NGO-029	B	MN/DG					The GSP states (p. 3-11): "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." Thus the GSP recognizes the importance of filling data gaps, however does not provide specific plans, well locations shown on a map, or a timeline to fill the data gaps. Without a map of proposed new monitoring well locations, a determination cannot be made regarding the adequacy of the monitoring network for sustainability indicators going forward into the GSP implementation phase. Provide specific plans to fill data gaps in the monitoring network. Evaluate how the gathered data will be used to identify and map GDEs and ISWs, and identify DACs and shallow domestic well users that are vulnerable to undesirable results.	Please see MCRs #8: Design and Implementation of Monitoring Networks; #9: Projects and Management Actions; and #10: Data Gaps and GSP Implementation.
Clean Water Action et al.	NGO-030	B	MN					Determine what biological monitoring can be used to assess the potential for significant and unreasonable impacts to GDEs or ISWs due to groundwater conditions in the subbasin.	Please refer to monitoring activities PMA in Chapter 4 for added details with regards to GDE satellite imagery assessments.
Clean Water Action et al.	NGO-031	C	PM					The consideration of beneficial users when developing projects and management actions is **insufficient**, due to the failure to completely identify benefits or impacts of identified projects and management actions to beneficial users of groundwater such as DACs, drinking water users, and tribes. We commend the GSA for including habitat and stream restoration projects in the GSP (described in Sections 4.1 and 4.3.2.2). The GSP discusses the manner in which these projects will benefit ecosystems, but does not discuss the manner in which DACs, drinking water users, and tribes may be benefitted or impacted by identified projects and management actions. Therefore, potential project and management actions may not protect these beneficial users. Groundwater sustainability under SGMA is defined not just by sustainable yield, but by the avoidance of undesirable results for all beneficial users.	Please see MCR #2: Identification of Disadvantaged Communities and Tribes
Clean Water Action et al.	NGO-032	B	PM/DW					• For DACs and domestic well owners, include discussion of a drinking water well impact mitigation program to proactively monitor and protect drinking water wells through GSP implementation. Refer to Attachment B for specific recommendations on how to implement a drinking water well mitigation program.	Well inventory and well rehabilitation PMAs combined with Appendix 3A analysis address this comment. The GSA will implement those PMAs upon the availability of funds and determination of needs.
Clean Water Action et al.	NGO-033	B	PM/WQ					• For DACs, domestic well owners, and tribes, include a discussion of whether potential impacts to water quality from projects and management actions could occur and how the GSA plans to mitigate such impacts.	Potential impacts to water quality resulting from PMAs was addressed in Chapter 3 and in the "degraded water quality sustainable management criteria flowchart". The proposed course of action is comprehensive and includes any impact on DACs and tribes.
Clean Water Action et al.	NGO-034	C	PM					• Recharge ponds, reservoirs and facilities for managed stormwater recharge can be designed as multiple-benefit projects to include elements that act functionally as wetlands and provide a benefit for wildlife and aquatic species. For guidance on how to integrate multi-benefit recharge projects into your GSP, refer to the "Multi-Benefit Recharge Project Methodology Guidance Document"[footnote}.	Noted.
Clean Water Action et al.	NGO-035	B	PM/CC					• Develop management actions that incorporate climate and water delivery uncertainties to address future water demand and prevent future undesirable results.	Please see MCR #9: Projects and Management Actions

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
Sonoma County Water Agency	SCWA-001	A	IS					Sonoma Water is concerned that groundwater extraction in the Ukiah Valley basin could adversely impact surface water flows in the Russian River, and has provided comments to assist the GSA in adequately addressing those impacts.	Noted.
Sonoma County Water Agency	SCWA-002	C	GE	gsp regs 354.18				Appendices 2-D and 2-E are not provided along with the rest of the public review draft of the Ukiah Valley basin GSP.	Thank you for your comment. These appendices were in production and are now added.
Sonoma County Water Agency	SCWA-003	C	ED					Sonoma Water staff have provided specific comments outlining inconsistencies between water budget components described in the text and those shown in figures	Noted.
Sonoma County Water Agency	SCWA-004	C	GE					Sonoma Water staff have provided specific comments outlining questions related to current and future water budget projections, specifically regarding groundwater/surface-water interactions	Noted.
Sonoma County Water Agency	SCWA-005	B	WB					Lacking additional documentation, it is currently not possible to assess the accuracy or completeness of the water budgets. We recommend that the GSA provide a comprehensive description of the water budget components as outlined in the CA Dept. of Water Resources Handbook for Water Budget Development (2020) and Water Budget Best Management Practice (2016), either within the GSP main text or in appendices so that these components can be accurately evaluated and reviewed by the public.	Please see MCR #5: Water Budget and Appendix 2D.
Sonoma County Water Agency	SCWA-006	A	SMC/IS					We advocate for more protective MT values that are as protective as those selected for the Sonoma County GSA basins, e.g., the equivalent dry-seasongroundwater-level, representing the average of the three years (2014–2016) during which the most depletion of ISW was estimated during the historical record. In this way, the MT value equates to less depletion than occurred during the single year with the most depletion, and is thus more protective of beneficial users of surface water.	Please see MCR #7: Depletion of Interconnected Surface Waters
Sonoma County Water Agency	SCWA-007	A	SMC/IS					While we recognize that accounting uncertainties related to biannual groundwater level measurement may justify a small buffer to represent the actual minimum groundwater level, the choice of 10% or 10ft is provided without any quantitative analysis to justify those buffer values. Based on a preliminary evaluation of continuous, multi-year groundwater level data and surface water depletion RMPs in Sonoma Valley GSA area, a buffer of 2.5–5% would adequately account for this uncertainty while still being sufficiently protective. We encourage the GSA to select more protective buffers that are quantitatively defined.	Please see MCR #7: Depletion of Interconnected Surface Waters
Sonoma County Water Agency	SCWA-008	C	ED		2	Entire Doc.		All figs and tables should be placed immediately following the paragraph where they are 1st cited so reader doesn't have to hunt for them.	Noted.
Sonoma County Water Agency	SCWA-009	C	ED		2	Entire Doc.		Regarding figs like hydrographs, label max and min values on y-axes. For hydrographs use consistent y-axis ranges and increments for easier comparison.	Noted and addressed as instances were possible.
Sonoma County Water Agency	SCWA-010	C	GE		2	Entire Doc.		Additional comments and editorial suggestions are provided in the document to help improve clarity and readability, to be used at the authors' discretion.	Noted and addressed as seem needed. Thank you for providing detailed comments.

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
Sonoma County Water Agency	SCWA-011	B	HCM		2		875	General comment regarding the HCM: Please provide a summary of all sources and sinks included the HCM. These should be consistent with the quantitative estimates of sources and sinks provided in the water budget.	In the HCM, Section 2.2.1.5, a discussion of recharge and discharge areas is provided as required in the SGMA regulations. There is also a description of groundwater recharge and discharge from the principal aquifers (which should address the comment of sources and sinks) within the Principal Aquifers discussion and Surface Water discussion (Sections 2.2.1.4 and 2.2.1.6, respectively). The HCM provided a more narrative description of sources and sinks, identifying them for future discussion and quantification in the subsequent chapters. For a quantitative list of sources and sinks, along with assumptions made, that information is provided in Section 2.2.3 Water budget and Appendix 2D. This information will be updated through GSP implementation as there is greater clarity and additional data collection. The HCM, along with the water budget discussion, should meet the intent of your comment by providing details on sources and sinks in the Basin.
Sonoma County Water Agency	SCWA-012	B	HCM		2		875	General comment regarding the HCM: Groundwater flowpaths and barriers to groundwater flow are not discussed.	From the current best available information, there was little to no discussion of groundwater barriers to flow. The Maacama fault was identified in a previous study as serving as a likely barrier to groundwater flow, due to the expected vertical offset in geologic formations, but there is yet to be data to support this claim. Discussion of the Maacama fault as a barrier to flow is discussed in Section 2.2.1.3 of the HCM, in the discussion of faults and folds. Groundwater flow paths are discussed in Section 2.2.1.5 of the HCM
Sonoma County Water Agency	SCWA-013	B	BC		2		925	Horizontal boundary conditions are not discussed. Please describe the assumed horizontal boundary conditions; i.e., whether they are no-flow, fixed flow, fixed head, etc. This affects water level contours.	For the purposes of the HCM, we did not go into detail on these boundary conditions but do provide a narrative and graphical description of groundwater flow within the Basin per the SGMA regulations and HCM BMPs. There is also a discussion of bedrock boundaries in the geologic setting. The more detailed and quantitative discussion for these boundary conditions should be described in the groundwater modeling discussion and in Chapter 2.2.3 Water Budget.
Sonoma County Water Agency	SCWA-014	C	BC		2		1180	No offset of formations at Maacama fault?	Previous studies do mention vertical offset of geologic material as caused by the Maacama fault. Currently, the available geologic data is not of sufficient details to determine or map any offset. As future monitoring wells are installed, there will be greater geologic detail and clarity on the effects of the Maacama fault.
Sonoma County Water Agency	SCWA-015	C	ED		2		1193	There are missing mapped faults in A-A' and C-C'.	This is accurate and faults were added to the cross sections.

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
Sonoma County Water Agency	SCWA-016	C	ED		2		1313	Storage coefficient(s) not presented or discussed.	Data regarding the hydraulic properties of the principal aquifers were limited and much of the analysis done in the previous HCM by LACO focused on pumping tests from Well Completion Logs. These are not conducive for determining a storage coefficient. Groundwater modeling efforts used these initial pumping tests data points, conductivities assigned by the textural model, and hydraulic properties described in Table 11 (including conductivity values and specific yield). It is acknowledged as a data gap that further efforts are needed to define the hydraulic properties of the Basin, including the storage coefficient of the principal aquifers. For information regarding how storage coefficients were set in modeling the Basin hydrology, please refer to the modeling discussion.
Sonoma County Water Agency	SCWA-017	C	ED		2		1367	Table 12: •Check general formatting of this table. E.g., spacing spelling, superscript, etc. •Farrar misspelled •"Recent Alluvium" should be Recent quaternary alluvium? •Terrace deposit thicknesses greater than 2,000ft seems unlikely	Noted and addressed as needed.
Sonoma County Water Agency	SCWA-018	B	BC		2		1523	Fig. 23: Contouring does not make physical sense (see below). Contours may be improved by using model output, rather than contouring/interpolating sparse observed GWLs •Contours are not intersecting boundaries at right angles •Explain why flow in Ukiah Valley is to SW, apparently into a previously-described no-flow boundary. •Label RR and use heavier line for RR. RR should probably be gaining, do contours indicate this? •Contours intersecting tribs do not indicate whether gaining or losing.	The comment was noted and acknowledged. The use of model simulations will be implemented as additional data and information become available, and the UVIHM is improved and re-calibrated. Although imperfect at boundaries due to limited data, current contours are sufficient to obtain a fundamental understanding of Basin conditions.
Sonoma County Water Agency	SCWA-019	B	BC		2		1542	Please include discussion of vertical groundwater flow.	Vertical groundwater gradients are further discussed in Section 2.2.1. This will be further analyzed with the construction of nested, multilevel wells.
Sonoma County Water Agency	SCWA-020	B	PA		2		1597	Please include a brief discussion of the Potter Valley Project and Lake Mendocino operations.	A more detailed discussion of the water systems operations is included in Appendix 2D. The citation is included in the text.
Sonoma County Water Agency	SCWA-021	C	PA		2		1679-1694	Add lack of monitoring wells in south end of basin	A comprehensive discussion of data gaps, including lack of monitoring wells in the Basin is provided in Appendix 2E. In-text reference is provided.
Sonoma County Water Agency	SCWA-022	C	ED		2		1695	Appendix 2E missing	Noted.
Sonoma County Water Agency	SCWA-023	C	ED		2		1934	Appendix 2F incomplete.	Noted.
Sonoma County Water Agency	SCWA-024	B	BC/WQ		2		2055	How were constituents of concern identified?	Please refer to Appendix 2F.
Sonoma County Water Agency	SCWA-025	A	IS		2		2202-2232	The explanation of the approach used to identify ISW is lengthy and unclear. Please revise with a more concise description that focuses on the final ISW determination, rather than the intermediate steps.	Comments was addressed through some revisions to the text. Since final ISW determination is more inclusive to consider uncertainties and data gaps, it is important to show intermediatory steps and actual analysis results.

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
Sonoma County Water Agency	SCWA-026	C	IS		2	Figs 57-60		It appears that Figs. 57-59 show much of the main stem Russian River as disconnected, which is confusing because lines 2282-2284 state that this reach was reclassified as connected. Please either (1) modify the figures 57-59 to reflect the Russian River ISW determination or (2) remove figures 57-59 since they seem to reflect intermediate steps used to develop Figure 60, which appears to be the 'final' map of ISW.	Figures 57-59 show analysis steps and results based on available data. As backloaded in the text and also in Appendix 2E, there are considerable data gaps and uncertainty in this analyses. To consider these sources of uncertainty, the GSA decided to take a conservative approach and considered the entire mainstem as connected as revise when better data is available. Accordingly, it is needed that these figures and analysis methods remain in place to facilitate the understanding of GSA's decision making.
Sonoma County Water Agency	SCWA-027	C	ED		2		2713	Appendices 2D and 2E are missing	Noted.
Sonoma County Water Agency	SCWA-028	C	WB		2	Table 29		Description of water budget components are inconsistent with those provided in subsequent Table 31-34 and Figures 74-78. Please revise both the table and the figures so that there is consistency between each.	Addressed.
Sonoma County Water Agency	SCWA-029	C	BC		2	Table 31-34		Because it is not accurately described in Table 29, it is unclear what the term "Outflow from Russian River" describes. The volumes shown in Table 31, i.e., 4072 AF/year for a wet year (~5.6 cfs/year) are far too small to describe actual surface water outflows from the Russian River. Please clarify what each of these terms are in Table 29.	Addressed.
Sonoma County Water Agency	SCWA-030	B	ED		2	Fig. 74-77		Provide descriptions for each of these terms in Table 29	Addressed.
Sonoma County Water Agency	SCWA-031	C			2	Fig. 75		[There was no comment]	No comment to address
Sonoma County Water Agency	SCWA-032	C	WB/CC		2		2578	Who/how were dry, wet, etc. years identified? For historical period as well as projected climates.	Water year types were determined based on DWR's classification. Future baseline uses historical climate and therefore, water year types are considered the same. Citation was provided to DWR published water year types.
Sonoma County Water Agency	SCWA-033	C	WB		2		2577	Inconsistent simulation horizons presented for historic and current water budgets as well as projected water budgets. E.g., inconsistent between text and fig captions.	Addressed.
Sonoma County Water Agency	SCWA-034	B	WB		2		2544	Appendix 2D missing, so can't review. However, please generally describe the model in the body of the chapter. E.g., simulation horizon, temporal discretization, horizontal and vertical discretization, boundary conditions, etc. Also explain how it was calibrated.	Please refer to Appendix 2D that was added.
Sonoma County Water Agency	SCWA-035	C	WB		2		2607	What does "…water that flows out of the Basin through the Russian River stream channel" mean? Is it hyporheic flow? GSFLOW doesn't simulate hyporheic flow, so how is this simulated?	Addressed and corrected.
Sonoma County Water Agency	SCWA-036	C	WB		2		2617	Provide a reference for IDC and explain how it works. In addition, explain why the GSFLOW Ag package wasn't used.	Please see Appendix 2D.
Sonoma County Water Agency	SCWA-037	B	WB/CC		2		2690-2710	Add additional water budget figs for the projected climate scenarios not only the baseline.	Please refer to Appendix 2D that was added.
Sonoma County Water Agency	SCWA-038	B	WB/CC		2		2690-2710	Describe how reservoir operations for Lake Mendocino were incorporated into the Future Baseline and Climate Change scenarios	Please refer to Appendix 2D that was added.
Sonoma County Water Agency	SCWA-039	B	WB/CC		2	Table 34, 2733-2736		Large changes in "Stream Loss to Groundwater" and (to a lesser extent) "Stream Gain from Groundwater" are shown for the Future Baseline and Climate Change 2030 and 2070 scenarios relative to other water budget components. It is unclear what mechanism is driving these changes. Please provide a more thorough discussion of the mechanisms driving these changes.	Text was revised to provide additional information.
Sonoma County Water Agency	SCWA-040	C	ED		3		1550	Appendix 2E not available to review.	Noted.
Sonoma County Water Agency	SCWA-041	C	GE		3	Entire Doc.		Additional comments and editorial suggestions are provided in the document to help improve clarity and readability, to be used at the authors' discretion.	Noted.

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
Sonoma County Water Agency	SCWA-042	B	MN		3	Fig. 1		Please add the well ID to each of these wells. Additionally, all figures of the monitoring network should be similarly labeled in other figures.	To maintain clarity in the map, well IDs were or added. However, a table was included with information about monitoring wells including Well IDs.
Sonoma County Water Agency	SCWA-043	A	IS		3		677-680	While we recognize that accounting uncertainties related to biannual groundwater level measurement may justify a small buffer to represent the actual minimum groundwater level, the choice of 10% or 10ft is provided without any quantitative analysis to justify those buffer values. Based on a preliminary evaluation of continuous, multi-year groundwater level data and surface water depletion RMPs in Sonoma Valley GSA area, a buffer of 2.5% or 5% would adequately account for this uncertainty while still being sufficiently protective. We encourage the GSA to select more protective buffers. At minimum, the "well-specific margin" should by identified and justified for each RMP in the text.	Please see MCR #7: Depletion of Interconnected Surface Waters. Upon collection of additional data, the GSA will re-evaluate and update RMP-specific SMC set.
Sonoma County Water Agency	SCWA-044	B	MN		3	Fig. 2		Please add the well ID to each of these wells. Additionally, all figures of the monitoring network should be similarly labeled in other figures.	Well IDs were added.
Sonoma County Water Agency	SCWA-045	B	MN		3	Table 3		Please identify the amount of additional buffer (i.e., percentage between 1–10% or additional ft) used for each well, along with attendant justification for each of these choices in the text.	Justification is provided in the text
Sonoma County Water Agency	SCWA-046	C	MN		3	Fig. 9		Please add the monitoring well IDs to the map	Well IDs were added.
Sonoma County Water Agency	SCWA-047	B	IS		3	Table 7		Are the triggers Spring WLs? Please clarify.	Yes, it was addressed in the text.
Sonoma County Water Agency	SCWA-048	A	IS		3	Table 7		The MT, Triggers, and MO values for depletion of interconnected surface water for 391918N1232003W001 is inconsistent with those for groundwater levels for the same well. Lines 1820-1822 state that "… groundwater elevations will be used as a proxy, and the MT defined for chronic lowering of groundwater elevation in Aquifer I will be used as the MT for the depletion of ISW." If this is the case, then the SMCs should be consistent for both sustainability indicators.	Addressed.
Sonoma County Water Agency	SCWA-049	C	SMC		3	Table 7		Please provide the approximate streambed elevation adjacent to each RMP location in the table. This way the MT, Trigger, and MO values can be assessed relative to the streambed elevation, and the gaining/losing conditions in the river can be evaluated at each RMP location	Approximate streambed elevation will be monitored and added during the implementation phase. River profile and streambed depth is a data gap for the Basin and providing approximate values based on DEMs is not desirable.
Sonoma County Water Agency	SCWA-050	A	SMC/IS		3		1715-1720	It is unclear what the term "lowering" refers to in the significant and unreasonable statement. Additionally, there is no mention of adverse impacts on beneficial users of surface water in the sentence containing the term "significant and unreasonable." We propose the following modification to the significant and unreasonable statement to reflect the need to avoid adverse impacts to beneficial users of surface water: "Depletion of surface water due to groundwater extraction is considered significant and unreasonable when such depletion exceeds historical depletion or adversely impacts the viability of groundwater dependent ecosystems (GDEs) or other beneficial users of surface water, including maintenance of in-stream flows."	Recommendation is accepted and implemented with minor revisions.

Author	CIN	Group	Sub-Category	Code/ Regulation	Chapter	Page	Line	Comment	Response / Recommended Action
Sonoma County Water Agency	SCWA-051	A	SMC/IS		3		1819-1824	The first sentence in this section states that "… groundwater elevations will be used as a proxy, and the MT defined for chronic lowering of groundwater elevation in Aquifer I will be used as the MT for the depletion of ISW." The methodology for groundwater level MTs states that "[w]herever possible, the MT is set as the average of the three lowest (Fall season) historical measurements on record for depth to groundwater taken during drought periods." (lines 684-685). However, lines 1822-1824 state that the depletion of ISW MT is "the lowest historical groundwater depth to water …" We advocate for more the more protective methodology that uses the average of the three lowest groundwater elevations. Please clarify.	The paragraph was revised and the comment was addressed. The intention for this SMC was to follow the groundwater elevation SMC methodology. However, wells located in Aquifer I do not have long historical records, and all fall into the second category of MTs, which is the lowest historical elevation in the short record of data. However, the text was updated to allow the GSA to update the SMC if additional data is collected and a sufficient historical record is achieved.
Sonoma County Water Agency	SCWA-052	A	IS		3		1824-1829	While we recognize that accounting uncertainties related to biannual groundwater level measurement may justify a small buffer to represent the actual minimum groundwater level, the choice of 10% or 10ft is provided without any quantitative analysis to justify those buffer values. Based on a preliminary evaluation of continuous, multi-year groundwater level data and surface water depletion RMPs in Sonoma Valley GSA area, a buffer of 2.5–5% would adequately account for this uncertainty while still being sufficiently protective. We encourage the GSA to select more protective buffers that are quantitatively defined.	Please see MCR #7: Depletion of Interconnected Surface Waters. Upon collection of additional data, the GSA will re-evaluate and update RMP-specific SMC set.
Mike Webster (MCRCD)		C	HCM		2	98	1626-1627	USGS gage 11461000 is still operated by USGS and can be found at https://waterdata.usgs.gov/ca/nwis/current/?type=flow USGS gage 11462000 is now operated by an ACOE contractor. Data can be found at the California Data Exchange, CDEC, http://cdec.water.ca.gov/cdecstation/ , station ID: CDM.	Addressed.

MCR #	Subcategory	Response
1	Communication and Engagement Plan	The GSA understands the need for continued active and targeted outreach and education efforts during GSP implementation. These efforts must include all beneficial users of the Basin, including but not limited to DACs, tribes, NGOs, and environmental, agricultural, and municipal users. Therefore, GSA acknowledges the comments on this section of the GSP and has begun updating and improving its C&E plan as of November 2021. This update is unlikely to finish by the required submittal date of the GSP. Therefore, GSP will be submitted with additional information added about the commitment to update the C&E plan in the first year of the GSP implementation and continue the outreach and education efforts throughout the implementation of the GSP.
2	Identification of Disadvantaged Communities and Tribes	GSP Section 2.1.1 includes a description of DACs and tribes identified as the Basin's beneficial users. The GSA has a voting tribal representative on its Board and a tribal representative at its technical committee. Tribal member selection and election are explained in the GSA JPA and ByLaws, appendices 1-B and 1-C of the GSP. Through coordination with these tribal representatives, identification of the tribes in the Basin was improved to the extent possible and with the information available. The GSA has made targeted outreach and education, including meetings and presentations, during the GSP development. These meetings and efforts are summarized in Chapter 1 of the GSP. According to the DWR's DAC mapping tool, the majority of the communities within the Basin are designated as either DACs or SDACs. Mapping and information about DACs and SDACs in the Basin are provided in Section 2.1.1 of the GSP. Therefore, any impacts to the general public, including domestic, agricultural, and municipal users in the Basin, reflect impacts on DACs and SDACs. The GSA has been conscious of this fact throughout the GSP development. Relevant sections of the GSP were updated to acknowledge this fact with more clarity.
3	Groundwater-Dependent Ecosystems	Identification of groundwater-dependent ecosystems (GDEs) is outlined in Section 2.2.2.7 of the GSP. The GSA used the methodology proposed by The Nature Conservancy. The location of communities and/or dominant species within the Basin requires local confirmation and an element of fine-tuning the Natural Communities Commonly Associated with Groundwater Dataset (NC Dataset) reflecting the location, extent, and attributes of assumed potential "vegetation" and "wetland" communities. This was done in the GSP development process by the GSA technical committee. The potential GDE maps were refined based on publicly available data such as land use and crop maps, and local input. Groundwater levels in the Basin are generally at their highest point during the spring season. This commonly coincides with the growing season of potential "vegetation" GDEs. Therefore, the GSA defined a conservative criterion to identify assumed GDEs by assessing if potential GDEs are connected to groundwater through their assumed rooting zone depths during the spring seasons. The GSA used 2015-2020 as baseline years because groundwater level data is available for the Basin during this period. The GSP was updated to explain this with more clarity. The goal of the GSP is to protect existing GDEs. Assumed GDEs are therefore sufficiently protected when groundwater level and depletion of interconnected surface waters (ISWs) sustainable management criteria (SMC) are set to preserve historical water level conditions. The GSA acknowledges the existing data gaps regarding GDE location, extent, and attributes as well as groundwater level data. This has been highlighted in Appendix 2E of the GSP and Section 2.2.2.7. Therefore, the GSA has modified the GDE analysis and added an additional category called "potential GDEs" based on the commenters' recommendations. This category includes the mapped potential GDEs that do not satisfy the connection criterion explained above. The GSA will re-assess these GDEs upon collecting more information and update the GSP for its 5-year review accordingly. This is to better address and consider existing data gaps and uncertainty in GSP development. Impacts to GDEs for setting sustainable management criteria and other facets of the GSP are still defined based on the assumed GDEs but will be revised accordingly upon re-assessment of potential GDEs for the next review. Moreover, the GSA developed an additional PMA to implement GDE monitoring on an as-needed basis using satellite imagery and vegetation indices. GSP Chapter 4 is modified to include this PMA. The GSA looks forward to working with stakeholders and other agencies to fill these data gaps of local habitat in the Basin for the next GSP review and acknowledges the importance of a coordinated effort to fully understand
4	Climate Change	The GSA acknowledges the importance of assessing the impacts of climate change in all aspects of the GSP and providing adaptability to efficiently and effectively mitigate such effects. The significance of these changes has been made ever so clearer during the recent drought in Mendocino County. The GSA has simulated the two central tendency scenarios suggested by the DWR to assess climate change impacts on Basin's sustainability. This approach is consistent with several submitted critical basin GSPs. These simulations are discussed in Section 2.2.3 of the GSP as wells as Appendix 2D. These scenarios and their impacts on groundwater levels and water budget were extensively discussed at GSA Board and its technical committee meetings and were considered in setting sustainable management criteria and planning the future of the Basin. However, the GSA is aware that these two scenarios may not represent the full spectrum of impacts and uncertainty that climate change may impose on the Basin. Due to DWR methodology, it is difficult to assess the impacts of climate change on precipitation patterns, including changes to timing and intensity of precipitation events. It is also important to consider the increasing lengths and severity of droughts and dry years, which this methodology may not represent due to repeating the historical hydrology. The GSA also acknowledges data gaps and existing uncertainty in its Ukiah Valley integrated hydrological model (UVIHM), as outlined in Appendix 2D. While the model was developed based on the best available science and data and provided a sufficient understanding of Basin conditions, further improvements are needed to conduct climate change studies and simulate future scenarios. GSA has sought to coordinate with local and regional stakeholders in generating and conducting climate change scenarios to include the largest spectrum of expected changes possible. Through these coordinations, the GSA has developed a framework in communication with Sonoma Water to conduct watershed-wide consistent climate change simulations for the Basin. This will help the GSA include the changes to reservoir operation and surface water availability in the Basin through the Potter Valley Project and Coyote Valley Dam. Surface water availability can have significant impacts on the Basin and need to be incorporated into future scenarios. Sonoma Water has implemented climate change scenarios based on downscaled GCM data for the groundwater basins that it manages. Following its approach will help the GSA address climate change impacts as a watershed-wide and regional effort. This framework is explained in more detail in Appendix 2D. Conducting such extensive studies needed major enhancements to the UVIHM and significant cooperation from Sonoma Water that could not fit within the scope of the GSP development. Therefore, a PMA is added to Chapter 4 of the GSP to outline the path forward for conducting climate change studies and future scenarios.
5	Water Budget	The GSA used the Ukiah Valley Integrated Hydrological Model (UVIHM) to produce water budgets. Water budgets are summarized in Section 2.2.3 of the GSP and in more detail in Appendix 2D. UVIHM was developed using the best available science and data. Water use and recharge practices in the basin have been implemented in the model as accurately as possible, depending on the available data and the GSP development scope and time limitations. Input data to the UVIHM, including water use, are discussed in detail in Appendix 2D. Native vegetation water demand is simulated by the UVIHM and is included in the water budget. UVIHM PRMS considers the land cover of the watershed to calculate evapotranspiration demands. This demand includes what native vegetation uses as its water demand. In order to better clarify these demands, crop use maps were added to Appendix 2D to show the root zone budget for native and riparian vegetation. These budgets are calculated by UVIHM IDC. No additional demands were transferred to UVIHM GSFLOW for native and riparian vegetation since it would duplicate this specific water use accounting. The GSA acknowledges that to better estimate native and riparian vegetation needs, additional data regarding the vegetation type and their typical water use is required. However, it finds the calculation method incorporated in the PRMS to be sufficient for simulation of Basin conditions. The GSA will update and enhance the UVIHM as more data becomes available, including additional native and riparian vegetation data. It is worth noting that the UVIHM will be updated and re-calibrated upon collection of additional data and for the GSP's 5-year review. Water budgets will be accordingly updated upon recalibration of the model.

MCR #	Subcategory	Response
6	Sustainable Yield	The starting value of the sustainable yield is focused on the historic average of groundwater pumping, translating into looking at the future averages of annual groundwater pumping rather than specific years. The GSP is being more conservative in defining the sustainability of the basin according to the different sustainable management criteria than a single sustainable yield number. Prescribing a fixed sustainable yield is technically incorrect and practically insufficient to achieve long-term sustainability. The GSA acknowledges the importance of assessing the impacts of climate change in all aspects of the GSP and providing adaptability to mitigate such effects efficiently and effectively. Furthermore, the GSA acknowledges the impacts of possible changes to the water system in the Basin due to the future of the Potter Valley Project and sees the need to assess the combined effects of such changes with climate change. As outlined in Master Comment Response #4 for climate change, GSA included a climate change PMA to conduct further studies and future scenarios to assess the impacts of climate change. Upon completion of such studies, the sustainable yield will be updated as necessary to reflect the impacts of climate change. The GSA believes that the management framework developed for the Basin, considering that it is not in overdraft conditions, is sufficiently protective and adaptive and further re-evaluation are possible and necessary to keep the Basin sustainable (see also MCR #4: Climate Change).
7	Depletion of Interconnected Surface Waters	The best available data and information were used to identify interconnected surface waters (ISWs). The GSA acknowledges the existing data gaps impacting this determination, as discussed in Appendix 2E, and incorporates this uncertainty into its decision by considering the entire Russian River mainstem as likely connected, although its assessments showed a few segments to be seasonally disconnected. In addition, the GSA changed the identification of tributaries that its analysis showed to be disconnected to "likely disconnected" and will reassess its determination upon collection of additional data for the 5-year GSP update. The GSP uses adaptive management to address the uncertainty surrounding the depletion of ISWs sustainable management criteria (SMC). The initial ISW depletion SMC, set based on sparse (in both time and space) GW elevations, aims to protect ISW depletions during the first five years. These initial SMC are set in coordination with the Sonoma Water and are consistent with SMCs set in other Basins, and GSPs developed within the Russian River watershed. The GSA assessed the impacts to beneficial uses and users of groundwater and surface water to the best of its ability and used the best available data and information to develop the SMC methodology for groundwater levels (See section 3.4). The GSP identifies a reliable methodology to be pursued upon collection of additional data and for the 5-year review of the GSP: the depletion of ISW SMC will be reviewed based on the model generated depletion volumes (this is the metric suggested by DWR in the regulation), streamflow, and continuous groundwater level data collected at implemented monitoring transects. A detailed explanation of the initial SMC and the future pathway to revise the SMC is provided in Section 3.9 of the GSP. Currently, the GSP lacks sufficient data to calculate the depletion of ISWs due to groundwater pumping using the model. The current version of the UVIHM lacks adequate surface water and groundwater monitoring data near the river to be reliably calibrated. Due to these data gaps and inherent uncertainties, the GSA did not develop interim milestones for the depletion of ISWs either. Interim milestones will be developed during the first five-year of the implementation period upon the availability of additional data and enhancement and calibration of the UVIHM. While measurable objectives are provided based on groundwater elevations, they should be considered as temporary proxies and will be revised accordingly to be based on the depletion of ISWs due to groundwater pumping. The GSA acknowledges the data gaps in the identification and depletion of ISWs in Section 2.2.2.6, outlines how to address them in Appendix 2E, and discusses the implementation plan in Chapter 5. The GSA will immediately begin to address the identified data gaps and update and re-calibrate the UVIHM during implementation. The depletion of ISWs SMC will be revisited during the next 5-year GSP update.
8	Design and Implementation of Monitoring Networks	The GSA identified and prioritized its data gaps in Appendix 2E and developed a PMA in Chapter 4 to implement and enhance monitoring activities. The GSA acknowledges that measuring streamflow from Russian River tributaries may be helpful to the management of the Basin. Therefore, it has installed streamflow gages on Forsythe Creek and West Fork Russian River in Redwood Valley during GSP development. The GSA will pursue additional funding through available grants and coordination with other stakeholders to install streamflow gages on other prioritized tributaries. The GSA also supports additional representative monitoring points (RMPs) to be added for groundwater levels and depletion of ISWs SMCs. Due to the short history of groundwater level data in the Basin and the limited number of wells for reliable monitoring, the GSA could not increase the number of RMPs per principal aquifers. However, the GSA has installed new monitoring wells in the Basin during the GSP development through DWR technical support services grant and instrumented them with continuous monitoring devices. Information was added to Section 3.4.1 of the GSP to incorporate newly drilled wells as RMPs upon establishing sufficient baseline data for the 5-year update of the GSP. Proper implementation details for covering these data gaps were added to Chapter 5 of the GSP. The GSA is committed to data collection and providing a better understanding of the Basin conditions and believes that it is needed for sustainable management of the Basin. As outlined in Chapters 4 and 5 of the GSP and Appendix 2E, the GSA will pursue additional funding through available grants to increase the spatial and temporal frequency of its monitoring network and data collection as possible.
9	Projects and Management Actions	The GSP Chapter 4 was updated to include additional PMAs with respect to data gaps and data collection, climate change impact studies, demand management and groundwater conservation. Well inventory PMA and well rehabilitation program were expanded to provide clarity on its implementation. Further details with respect to PMA implementation and possible funding sources were added to Chapter 4. Needed PMAs that the GSA will implement are added to Chapter 5, and their implementation schedule is provided. GSAs commitment to apply for applicable grants was highlighted in Chapter 5.
10	Data Gaps and GSP Implementation	Implementation Plan and Chapter 5 of the GSP were updated to provide better clarity in funding sources, implementing PMAs, and covering data gaps. Data gaps are identified and explained in Appendix 2E and prioritized based on their influence in understanding the conditions of the Basin and its management. GSA laid out a plan in Chapter 5 to cover the prioritized data gaps and outlined its commitment to pursue additional funding and grants to cover data gaps. Additional PMAs are also added to Chapter 4 to address specific gaps such as climate change studies, well inventory, and drinking water well protection.

Appendix 1-E DWR GSP Elements Guide

Article 5. **Plan Contents for Sample Basin** — **GSP Document References**

				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
§ 354.			**Introduction to Plan Contents**					
			This Article describes the required contents of Plans submitted to the Department for evaluation, including administrative information, a description of the basin setting, sustainable management criteria, description of the monitoring network, and projects and management actions.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
SubArticle 1.			**Administrative Information**					
§ 354.2.			**Introduction to Administrative Information**					
			This Subarticle describes information in the Plan relating to administrative and other general information about the Agency that has adopted the Plan and the area covered by the Plan.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.4.			**General Information**					
			Each Plan shall include the following general information:					
(a)			An executive summary written in plain language that provides an overview of the Plan and description of groundwater conditions in the basin.	18:50	ES-1:ES-5	1:6	1:4	
(b)			A list of references and technical studies relied upon by the Agency in developing the Plan. Each Agency shall provide to the Department electronic copies of reports and other documents and materials cited as references that are not generally available to the public.	406:408	6			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10733.2 and 10733.4, Water Code.					
§ 354.6.			**Agency Information**					
			When submitting an adopted Plan to the Department, the Agency shall include a copy of the information provided pursuant to Water Code Section 10723.8, with any updates, if necessary, along with the following information:					
(a)			The name and mailing address of the Agency.	55	1.3.2			
(b)			The organization and management structure of the Agency, identifying persons with management authority for implementation of the Plan.	92:94	2.1.5.1:2.1.5.4		2.3:2.4	
(c)			The name and contact information, including the phone number, mailing address and electronic mail address, of the plan manager.	59	1.3.2			
(d)			The legal authority of the Agency, with specific reference to citations setting forth the duties, powers, and responsibilities of the Agency, demonstrating that the Agency has the legal authority to implement the Plan.	59, 438:454	1.3.4			Appendices 1-B and 1-C
(e)			An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.	57:59,401:402	1.3.5, 5.2		5.2	
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.8, 10727.2, and 10733.2, Water Code.					
§ 354.8.			**Description of Plan Area**					
			Each Plan shall include a description of the geographic areas covered, including the following information:					
(a)			One or more maps of the basin that depict the following, as applicable:					

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(1)		The area covered by the Plan, delineating areas managed by the Agency as an exclusive Agency and any areas for which the Agency is not an exclusive Agency, and the name and location of any adjacent basins.	64:65	2.1.1	2.1:2.2		
	(2)		Adjudicated areas, other Agencies within the basin, and areas covered by an Alternative.	74	2.1.1.2			
	(3)		Jurisdictional boundaries of federal or state land (including the identity of the agency with jurisdiction over that land), tribal land, cities, counties, agencies with water management responsibilities, and areas covered by relevant general plans.	67:73	2.1.1.1	2.3:2.5		
	(4)		Existing land use designations and the identification of water use sector and water source type.	74:77,1037:1193	2.1.1.3	2.6:2.7	2.1,2.2	Apendix 2-D
	(5)		The density of wells per square mile, by dasymetric or similar mapping techniques, showing the general distribution of agricultural, industrial, and domestic water supply wells in the basin, including de minimis extractors, and the location and extent of communities dependent upon groundwater, utilizing data provided by the Department, as specified in Section 353.2, or the best available information.	77:79	2.1.1.4	2.8:2.9		
(b)			A written description of the Plan area, including a summary of the jurisdictional areas and other features depicted on the map.	64:79	2.1.1	2.1:2.9	2.1,2.2	
(c)			Identification of existing water resource monitoring and management programs, and description of any such programs the Agency plans to incorporate in its monitoring network or in development of its Plan. The Agency may coordinate with existing water resource monitoring and management programs to incorporate and adopt that program as part of the Plan.	80:85	2.1.2			
(d)			A description of how existing water resource monitoring or management programs may limit operational flexibility in the basin, and how the Plan has been developed to adapt to those limits.	85	2.1.2.4			
(e)			A description of conjunctive use programs in the basin.	88	2.1.4.5			
(f)			A plain language description of the land use elements or topic categories of applicable general plans that includes the following:					
	(1)		A summary of general plans and other land use plans governing the basin.	82:83	2.1.3.1, 2.1.3.2			
	(2)		A general description of how implementation of existing land use plans may change water demands within the basin or affect the ability of the Agency to achieve sustainable groundwater management over the planning and implementation horizon, and how the Plan addresses those potential effects	82:83	2.1.3.1, 2.1.3.2			
	(3)		A general description of how implementation of the Plan may affect the water supply assumptions of relevant land use plans over the planning and implementation horizon.	82:83	2.1.3.1, 2.1.3.2			
	(4)		A summary of the process for permitting new or replacement wells in the basin, including adopted standards in local well ordinances, zoning codes, and policies contained in adopted land use plans.	83	2.1.3.3			
	(5)		To the extent known, the Agency may include information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management.	82:83	2.1.3.1			

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(g)			A description of any of the additional Plan elements included in Water Code Section 10727.4 that the Agency determines to be appropriate.	84:85	2.1.4			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10720.3, 10727.2, 10727.4, 10733, and 10733.2, Water Code.					
§ 354.10.			**Notice and Communication**					
			Each Plan shall include a summary of information relating to notification and communication by the Agency 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.	95:104	2.1.5.6:2.1.5.9		2.5,2.6	
(b)			A list of public meetings at which the Plan was discussed or considered by the Agency.	99:105	2.1.5.8-10	2.10	2.6	
(c)			Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.	61	1.4.1			Appendix 1-D includes explanation of commenting process, all the comments received, and responses provided.
(d)			A communication section of the Plan that includes the following:					
	(1)		An explanation of the Agency’s decision-making process.	94, 413:438	2.1.5.4			Appendix 1-A
	(2)		Identification of opportunities for public engagement and a discussion of how public input and response will be used.	94:104	2.1.5.5:2.1.5.9		2.6	
	(3)		A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of the population within the basin.	95:104	2.1.5.6:2.1.5.9		2.5, 2.6	Communication and engagement plan is being updated by the GSA for the first annual report and expands the current communication plan to the implementation period in more detail.
	(4)		The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.	98:104	2.1.5.7:2.1.5.9		2.6	
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.8, 10728.4, and 10733.2, Water Code					
SubArticle 2.			**Basin Setting**					
§ 354.12.			**Introduction to Basin Setting**					
			This Subarticle describes the information about the physical setting and characteristics of the basin and current conditions of the basin that shall be part of each Plan, including the identification of data gaps and levels of uncertainty, which comprise the basin setting that serves as the basis for defining and assessing reasonable sustainable management criteria and projects and management actions. Information provided pursuant to this Subarticle shall be prepared by or under the direction of a professional geologist or professional engineer.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.14.			**Hydrogeologic Conceptual Model**					

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(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.	106:164,614:969,995:1310	2.2.1	2.11:2.28	2.7:2.18	Appendices 2-A, 2-C, 2-D, and 2-E
(b)			The hydrogeologic conceptual model shall be summarized in a written description that includes the following:					
	(1)		The regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency.	109:112	2.2.1.1	2.11:2.12		
	(2)		Lateral basin boundaries, including major geologic features that significantly affect groundwater flow.	109:112,120	2.2.1.1,2.2.1.3	2.11:2.12		
	(3)		The definable bottom of the basin.	111	2.2.1.1			
	(4)		Principal aquifers and aquitards, including the following information:					
		(A)	Formation names, if defined.	115:122	2.2.1.3	2.14-2.17		
		(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.	132:145	132:145	132:145	132:145	
		(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.	132:145	2.2.1.4	2.21:2.22	2.10:2.13	
		(D)	General water quality of the principal aquifers, which may be based on information derived from existing technical studies or regulatory programs.	142:143	2.2.1.4	2.22	2.13	
		(E)	Identification of the primary use or uses of each aquifer, such as domestic, irrigation, or municipal water supply.	132:145, 614:969	2.2.1.4			Appendix 2-A
	(5)		Identification of data gaps and uncertainty within the hydrogeologic conceptual model	164,1193:1310	2.2.1.7			Appendix 2-E
(c)			The hydrogeologic conceptual model shall be represented graphically by at least two scaled cross-sections that display the information required by this section and are sufficient to depict major stratigraphic and structural features in the basin.	115:131, 614:969	2.2.1.3	2.16:2.20	2.8:2.9	Appendix 2-A
(d)			Physical characteristics of the basin shall be represented on one or more maps that depict the following:					
	(1)		Topographic information derived from the U.S. Geological Survey or another reliable source.	105:106	2.2.1.1	2.11		
	(2)		Surficial geology derived from a qualified map including the locations of cross-sections required by this Section.	107:115, 614:969	2.2.1.1	2.13		Appendix 2-A
	(3)		Soil characteristics as described by the appropriate Natural Resources Conservation Service soil survey or other applicable studies.	113:115,1037:1193	2.2.1.2	2.13:2.14		Appendix 2-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.	113:114, 146:152,1037:1193	2.2.1.2, 2.2.1.5	2.13, 2.23		Appendix 2-D
	(5)		Surface water bodies that are significant to the management of the basin.	153:163,1037:1193	2.2.1.6	2.28:2.32	2.15:218	Appendix 2-D
	(6)		The source and point of delivery for imported water supplies.	153:163,1037:1193	2.2.1.6	2.28:2.32	2.15:218	Appendix 2-D

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2, 10733, and 10733.2, Water Code.					
§ 354.16.			**Groundwater Conditions**					
			Each Plan shall provide a description of current and historical groundwater conditions in the basin, including data from January 1, 2015, to current conditions, based on the best available information that includes the following:					
(a)			Groundwater elevation data demonstrating flow directions, lateral and vertical gradients, and regional pumping patterns, including:					
	(1)		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.	178:179	2.2.2.1	2.35:2.36		
	(2)		Hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients between principal aquifers.	173:183	2.2.2.1	2.31:2.33, 2.37:2.39	2.19	
(b)			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.	184:185	2.2.2.2	2.40		
(c)			Seawater intrusion conditions in the basin, including maps and cross-sections of the seawater intrusion front for each principal aquifer.	186	2.2.2.3			Seawater intrusion is not applicable in the basin.
(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.	186:208	2.2.2.4	2.41:2.51	2.20	
(e)			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.	207:208	2.2.2.5	2.56		
(f)			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.	211:217	2.2.2.6	2.53:2.56		
(g)			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.	218:244	2.2.2.7	2.57:2.70	2.21:2.27	
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.2, 10727.4, and 10733.2, Water Code.					
§ 354.18.			**Water Budget**					
(a)			Each Plan shall include a water budget for the basin that provides an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the basin, including historical, current and projected water budget conditions, and the change in the volume of water stored. Water budget information shall be reported in tabular and graphical form.	243:271,1037:1193	2.2.3			Appendix 2-D Ukiah Valley Integrated Hydrologic Model Report includes information on surface water budgets, including model calibration, results, and sensitivity runs.
(b)			The water budget shall quantify the following, either through direct measurements or estimates based on data:					
	(1)		Total surface water entering and leaving a basin by water source type.	243:271	2.2.3			

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(2)		Inflow to the groundwater system by water source type, including subsurface groundwater inflow and infiltration of precipitation, applied water, and surface water systems, such as lakes, streams, rivers, canals, springs and conveyance systems.	243:271	2.2.3			
	(3)		Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow.	243:271	2.2.3			
	(4)		The change in the annual volume of groundwater in storage between seasonal high conditions.	243:271	2.2.3			
	(5)		If overdraft conditions occur, as defined in Bulletin 118, the water budget shall include a quantification of overdraft over a period of years during which water year and water supply conditions approximate average conditions.	243:271	2.2.3			
	(6)		The water year type associated with the annual supply, demand, and change in groundwater stored.	253:261	2.2.3.3	2.76:2.79	2.30	
	(7)		An estimate of sustainable yield for the basin.	270	2.2.3.7			
(c)			Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:					
	(1)		Current water budget information shall quantify current inflows and outflows for the basin using the most recent hydrology, water supply, water demand, and land use information.	263:265,1037:1193	2.2.3.4	2.76	2.31	Appendix 2-D
	(2)		Historical water budget information shall be used to evaluate availability or reliability of past surface water supply deliveries and aquifer response to water supply and demand trends relative to water year type. The historical water budget shall include the following:					
		(A)	A quantitative evaluation of the availability or reliability of historical surface water supply deliveries as a function of the historical planned versus actual annual surface water deliveries, by surface water source and water year type, and based on the most recent ten years of surface water supply information.	255:266,1037:1193	2.2.3.3:2.2.3.5	2.72:2.76	2.30:2.31	Appendix 2-D
		(B)	A quantitative assessment of the historical water budget, starting with the most recently available information and extending back a minimum of 10 years, or as is sufficient to calibrate and reduce the uncertainty of the tools and methods used to estimate and project future water budget information and future aquifer response to proposed sustainable groundwater management practices over the planning and implementation horizon.	255:266,1037:1193	2.2.3.3:2.2.3.5	2.72:2.76	2.30:2.31	Appendix 2-D
		(C)	A description of how historical conditions concerning hydrology, water demand, and surface water supply availability or reliability have impacted the ability of the Agency to operate the basin within sustainable yield. Basin hydrology may be characterized and evaluated using water year type.	255:266,1037:1193	2.2.3.3:2.2.3.5	2.72:2.76	2.30:2.31	Appendix 2-D
	(3)		Projected water budgets shall be used to estimate future baseline conditions of supply, demand, and aquifer response to Plan implementation, and to identify the uncertainties of these projected water budget components. The projected water budget shall utilize the following methodologies and assumptions to estimate future baseline conditions concerning hydrology, water demand and surface water supply availability or reliability over the planning and implementation horizon:					

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
		(A)	Projected hydrology shall utilize 50 years of historical precipitation, evapotranspiration, and streamflow information as the baseline condition for estimating future hydrology. The projected hydrology information shall also be applied as the baseline condition used to evaluate future scenarios of hydrologic uncertainty associated with projections of climate change and sea level rise.	267:270,1037:1193	2.2.3.6	2.77	2.32:2.33	Appendix 2-D
		(B)	Projected water demand shall utilize the most recent land use, evapotranspiration, and crop coefficient information as the baseline condition for estimating future water demand. The projected water demand information shall also be applied as the baseline condition used to evaluate future scenarios of water demand uncertainty associated with projected changes in local land use planning, population growth, and climate.	267:270,1037:1193	2.2.3.6	2.77	2.32:2.33	Appendix 2-D
		(C)	Projected surface water supply shall utilize the most recent water supply information as the baseline condition for estimating future surface water supply. The projected surface water supply shall also be applied as the baseline condition used to evaluate future scenarios of surface water supply availability and reliability as a function of the historical surface water supply identified in Section 354.18(c)(2)(A), and the projected changes in local land use planning, population growth, and climate.	267:270,1037:1193	2.2.3.6	2.77	2.32:2.33	Appendix 2-D
(d)			The Agency shall utilize the following information provided, as available, by the Department pursuant to Section 353.2, or other data of comparable quality, to develop the water budget:					
	(1)		Historical water budget information for mean annual temperature, mean annual precipitation, water year type, and land use.	245:254,1037:1193	2.2.3.1:2.2.3.2	2.72	2.28:2.29	Appendix 2-D
	(2)		Current water budget information for temperature, water year type, evapotranspiration, and land use.	245:254, 263:265,1037:1193	2.2.3.1, 2.2.3.4		2.28:2.29	Appendix 2-D
	(3)		Projected water budget information for population, population growth, climate change, and sea level rise.	245:254, 267:270,1037:1193	2.2.3.1, 2.2.3.6		2.28:2.29	Appendix 2-D
(e)			Each Plan shall rely on the best available information and best available science to quantify the water budget for the basin in order to provide an understanding of historical and projected hydrology, water demand, water supply, land use, population, climate change, sea level rise, groundwater and surface water interaction, and subsurface groundwater flow. If a numerical groundwater and surface water model is not used to quantify and evaluate the projected water budget conditions and the potential impacts to beneficial uses and users of groundwater, the Plan shall identify and describe an equally effective method, tool, or analytical model to evaluate projected water budget conditions.	245:254,1037:1193	2.2.3.1:2.2.3.2	2.72	2.28:2.29	Appendix 2-D
(f)			The Department shall provide the California Central Valley Groundwater-Surface Water Simulation Model (C2VSIM) and the Integrated Water Flow Model (IWFM) for use by Agencies in developing the water budget. Each Agency may choose to use a different groundwater and surface water model, pursuant to Section 352.4.	245,1037:1193	2.2.3.1			Appendix 2-D Ukiah Valley Integrated Hydrologic Model Report includes information on model selection.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10721, 10723.2, 10727.2, 10727.6, 10729, and 10733.2, Water Code.					

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§ 354.20.			**Management Areas**					
(a)			Each Agency may define one or more management areas within a basin if the Agency has determined that creation of management areas will facilitate implementation of the Plan. Management areas may define different minimum thresholds and be operated to different measurable objectives than the basin at large, provided that undesirable results are defined consistently throughout the basin.	272	2.2.4			At this time, the GSA has decided not to define management areas for the Basin.
(b)			A basin that includes one or more management areas shall describe the following in the Plan:					
	(1)		The reason for the creation of each management area.	N/A				At this time, the GSA has decided not to define management areas for the Basin.
	(2)		The minimum thresholds and measurable objectives established for each management area, and an explanation of the rationale for selecting those values, if different from the basin at large.	N/A				At this time, the GSA has decided not to define management areas for the Basin.
	(3)		The level of monitoring and analysis appropriate for each management area.	N/A				At this time, the GSA has decided not to define management areas for the Basin.
	(4)		An explanation of how the management area can operate under different minimum thresholds and measurable objectives without causing undesirable results outside the management area, if applicable.	N/A				At this time, the GSA has decided not to define management areas for the Basin.
(c)			If a Plan includes one or more management areas, the Plan shall include descriptions, maps, and other information required by this Subarticle sufficient to describe conditions in those areas.	N/A				At this time, the GSA has decided not to define management areas for the Basin.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10733.2 and 10733.4, Water Code.					
SubArticle 3.			**Sustainable Management Criteria**					
§ 354.22.			**Introduction to Sustainable Management Criteria**					
			This Subarticle describes criteria by which an Agency defines conditions in its Plan that constitute sustainable groundwater management for the basin, including the process by which the Agency shall characterize undesirable results, and establish minimum thresholds and measurable objectives for each applicable sustainability indicator.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.24.			**Sustainability Goal**					
			Each Agency shall establish in its Plan a sustainability goal for the basin that culminates in the absence of undesirable results within 20 years of the applicable statutory deadline. The Plan shall include a description of the sustainability goal, including information from the basin setting used to establish the sustainability goal, a discussion of the measures that will be implemented to ensure that the basin will be operated within its sustainable yield, and an explanation of how the sustainability goal is likely to be achieved within 20 years of Plan implementation and is likely to be maintained through the planning and implementation horizon.	277	3.2			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10721, 10727, 10727.2, 10733.2, and 10733.8, Water Code.					

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
§ 354.26.			**Undesirable Results**					
(a)			Each Agency shall describe in its Plan the processes and criteria relied upon to define undesirable results applicable to the basin. Undesirable results occur when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the basin.	297:300, 311, 320, 332, 343:346	3.4.2, 3.5.1, 3.7.2, 3.8.2, 3.9.2			
(b)			The description of undesirable results shall include the following:					
	(1)		The cause of groundwater conditions occurring throughout the basin that would lead to or has led to undesirable results based on information described in the basin setting, and other data or models as appropriate.	298:299, 311:312, 320:321,344	3.4.2.1, 3.5.1.1, 3.7.2.1, 3.9.2.1			
	(2)		The criteria used to define when and where the effects of the groundwater conditions cause undesirable results for each applicable sustainability indicator. The criteria shall be based on a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the basin.	297:300, 311, 320, 332, 343:346	3.4.2, 3.5.1, 3.7.2, 3.8.2, 3.9.2			
	(3)		Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results.	298:299, 312, 321, 332, 344:345	3.4.2.2, 3.5.1.2, 3.7.2.2, 3.8.2.1, 3.9.2.2			
(c)			The Agency may need to evaluate multiple minimum thresholds to determine whether an undesirable result is occurring in the basin. The determination that undesirable results are occurring may depend upon measurements from multiple monitoring sites, rather than a single monitoring site.	297:300, 311, 320, 332, 343:346	3.4.2, 3.5.1, 3.7.2, 3.8.2, 3.9.2			
(d)			An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators.	313	3.6			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10721, 10723.2, 10727.2, 10733.2, and 10733.8, Water Code.					
§ 354.28.			**Minimum Thresholds**					
(a)			Each Agency in its Plan shall establish minimum thresholds that quantify groundwater conditions for each applicable sustainability indicator at each monitoring site or representative monitoring site established pursuant to Section 354.36. The numeric value used to define minimum thresholds shall represent a point in the basin that, if exceeded, may cause undesirable results as described in Section 354.26.	299:308, 312, 322:324, 322:333,346:350	3.4.3, 3.5.3,3.7.3, 3.8.3			
(b)			The description of minimum thresholds shall include the following:					
	(1)		The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting.	302:308, 312, 323:325, 333, 347:350,1248:1270	3.4.3.1, 3.5.2 3.7.4,3.8.4.1, 3.9.4			Appendix 3-A

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				Page Numbers of Plan	**Or Section Numbers**	**Or Figure Numbers**	**Or Table Numbers**	**Notes**
	(2)		The relationship between the minimum thresholds for each sustainability indicator, including an explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.	302:308, 312, 325,333,350	3.4.3.1: 3.4.3.2, 3.5.2.1, 3.7.4.1,3.8.4.1,3.9.4.1			
	(3)		How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.	N/A				No adjacent medium or high priority basins
	(4)		How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.	302:308, 312, 323:325, 333, 347:350, 1248:1270	3.4.3.1, 3.5.2 3.7.4,3.8.4.1, 3.9.4			Appendix 3-A
	(5)		How state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the Agency shall explain the nature of and basis for the difference.	323:324	3.7.4			
	(6)		How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4.	294:296,323:324	3.4.1.3,3.7.1.1			
(c)			Minimum thresholds for each sustainability indicator shall be defined as follows:					
	(1)		Chronic Lowering of Groundwater Levels. The minimum threshold for chronic lowering of groundwater levels shall be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results. Minimum thresholds for chronic lowering of groundwater levels shall be supported by the following:					
		(A)	The rate of groundwater elevation decline based on historical trends, water year type, and projected water use in the basin.	299:308,1248:1270	3.4.3			Appendix 3-A
		(B)	Potential effects on other sustainability indicators.	308	3.4.3.2			
	(2)		Reduction of Groundwater Storage. The minimum threshold for reduction of groundwater storage shall be a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results. Minimum thresholds for reduction of groundwater storage shall be supported by the sustainable yield of the basin, calculated based on historical trends, water year type, and projected water use in the basin.	312	3.5.2			Since the Basin is not in overdraft conditions and due to data gaps and model uncertainty, groundwater elevations were used as proxy.
	(3)		Seawater Intrusion. The minimum threshold for seawater intrusion shall be defined by a chloride concentration isocontour for each principal aquifer where seawater intrusion may lead to undesirable results. Minimum thresholds for seawater intrusion shall be supported by the following:					
		(A)	Maps and cross-sections of the chloride concentration isocontour that defines the minimum threshold and measurable objective for each principal aquifer.	N/A				Seawater intrusion is not applicable in the subbasin
		(B)	A description of how the seawater intrusion minimum threshold considers the effects of current and projected sea levels.	N/A				Seawater intrusion is not applicable in the subbasin

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				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(4)		Degraded Water Quality. The minimum threshold for degraded water quality shall be the degradation of water quality, including the migration of contaminant plumes that impair water supplies or other indicator of water quality as determined by the Agency that may lead to undesirable results. The minimum threshold shall be based on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin. In setting minimum thresholds for degraded water quality, the Agency shall consider local, state, and federal water quality standards applicable to the basin.	322:324	3.7.3:3.7.4			
	(5)		Land Subsidence. The minimum threshold for land subsidence shall be the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results. Minimum thresholds for land subsidence shall be supported by the following:					
		(A)	Identification of land uses and property interests that have been affected or are likely to be affected by land subsidence in the basin, including an explanation of how the Agency has determined and considered those uses and interests, and the Agency's rationale for establishing minimum thresholds in light of those effects.	326:331	3.8			
		(B)	Maps and graphs showing the extent and rate of land subsidence in the basin that defines the minimum threshold and measurable objectives.	326:331	3.8	3.8		
	(6)		Depletions of Interconnected Surface Water. The minimum threshold for depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results. The minimum threshold established for depletions of interconnected surface water shall be supported by the following:					
		(A)	The location, quantity, and timing of depletions of interconnected surface water.	335:341	3.9.1			Proxy groundwater elevations used.
		(B)	A description of the groundwater and surface water model used to quantify surface water depletion. If a numerical groundwater and surface water model is not used to quantify surface water depletion, the Plan shall identify and describe an equally effective method, tool, or analytical model to accomplish the requirements of this Paragraph.	335:341,344:346,1037:1193	3.9.1,3.9.4	3.10		Appendix 2-D
(d)			An Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence.	335:341,346	3.9.1,3.9.3			
(e)			An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish minimum thresholds related to those sustainability indicators.	313	3.6			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.2, 10733, 10733.2, and 10733.8, Water Code.					
§ 354.30.			**Measurable Objectives**					

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(a)			Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin within 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.	308:311, 312, 325:328,333:334,350:351	3.4.4:3.4.5, 3.5.3, 3.7.5,3.8.5:3.8.6,3.9.5:3.9.6			
(b)			Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.	308:311, 312, 325:328,333:334,350:351	3.4.4:3.4.5, 3.5.3, 3.7.5,3.8.5:3.8.6,3.9.5:3.9.6			
(c)			Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.	308:311, 312, 325:328,333:334,350:351	3.4.4:3.4.5, 3.5.3, 3.7.5,3.8.5:3.8.6,3.9.5:3.9.6			
(d)			An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence.	308:311, 312, 333:334,350:351	3.4.4:3.4.5, 3.5.3, 3.8.6,3.9.5:3.9.6			
(e)			Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon.	308:311, 312, 325:328,333:334,350:351	3.4.4:3.4.5, 3.5.3, 3.7.5,3.8.5:3.8.6,3.9.5:3.9.6			
(f)			Each Plan may include measurable objectives and interim milestones for additional Plan elements described in Water Code Section 10727.4 where the Agency determines such measures are appropriate for sustainable groundwater management in the basin.	N/A				no additional plan elements
(g)			An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for a finding of inadequacy of the Plan.	N/A				GSP established the concept of watershed goal for the depletion of interconnected surface waters sustainable management criteria that will be determined during the next updates to the GSP and upon collection of more data and information.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2, 10727.4, and 10733.2, Water Code.					
SubArticle 4.			**Monitoring Networks**					
§ 354.32.			**Introduction to Monitoring Networks**					
			This Subarticle describes the monitoring network that shall be developed for each basin, including monitoring objectives, monitoring protocols, and data reporting requirements. The monitoring network shall promote the collection of data of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the basin and evaluate changing conditions that occur through implementation of the Plan.					
			Note: Authority cited: Section 10733.2, Water Code.					

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			Reference: Section 10733.2, Water Code.					
§ 354.34.			**Monitoring Network**					
(a)			Each Agency shall develop a monitoring network capable of collecting sufficient data to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions, and yield representative information about groundwater conditions as necessary to evaluate Plan implementation.	277:278	3.3			
(b)			Each Plan shall include a description of the monitoring network objectives for the basin, including an explanation of how the network will be developed and implemented to monitor groundwater and related surface conditions, and the interconnection of surface water and groundwater, with sufficient temporal frequency and spatial density to evaluate the affects and effectiveness of Plan implementation. The monitoring network objectives shall be implemented to accomplish the following:					
	(1)		Demonstrate progress toward achieving measurable objectives described in the Plan.	277:278	3.3			
	(2)		Monitor impacts to the beneficial uses or users of groundwater.	277:278	3.3			
	(3)		Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.	277:278	3.3			
	(4)		Quantify annual changes in water budget components.	N/A				data collected by monitoring network is used to update the integrated surface water - groundwater model that is used to derive the water budgets
(c)			Each monitoring network shall be designed to accomplish the following for each sustainability indicator:					
	(1)		Chronic Lowering of Groundwater Levels. Demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features by the following methods:					
		(A)	A sufficient density of monitoring wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.	277:278,289:296	3.3.2, 3.4.1	3.1	3.2:3.3	
		(B)	Static groundwater elevation measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.	277:278,289:296	3.3.2, 3.4.1	3.1	3.2:3.3	
	(2)		Reduction of Groundwater Storage. Provide an estimate of the change in annual groundwater in storage.	286,311	3.3.2,3.5			Groundwater levels are selected as the proxy for groundwater storage. Change in storage estimated as part of the water budget.
	(3)		Seawater Intrusion. Monitor seawater intrusion using chloride concentrations, or other measurements convertible to chloride concentrations, so that the current and projected rate and extent of seawater intrusion for each applicable principal aquifer may be calculated.	N/A				Not applicable to basin.
	(4)		Degraded Water Quality. Collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues.	286:288,314:319	3.3.2,3.7.1.1, 3.7.1.2	3.5	3.6:3.7	

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	(5)		Land Subsidence. Identify the rate and extent of land subsidence, which may be measured by extensometers, surveying, remote sensing technology, or other appropriate method.	288,329:332	3.3.2,3.8.1.1	3.8		
	(6)		Depletions of Interconnected Surface Water. Monitor surface water and groundwater, where interconnected surface water conditions exist, to characterize the spatial and temporal exchanges between surface water and groundwater, and to calibrate and apply the tools and methods necessary to calculate depletions of surface water caused by groundwater extractions. The monitoring network shall be able to characterize the following:					
		(A)	Flow conditions including surface water discharge, surface water head, and baseflow contribution.	279:281, 335:343	3.3.2, 3.9.1	3.9	3.1, 3.9:3.10	
		(B)	Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.	279:281, 335:343	3.3.2, 3.9.1			
		(C)	Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.	279:281, 335:343	3.3.2, 3.9.1			
		(D)	Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.	279:281, 335:343	3.3.2, 3.9.1			
(d)			The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.	279:281, 335:343	3.3.2, 3.9.1	3.9	3.1, 3.9:3.10	No management areas are defined.
(e)			A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.	279:281, 335:343	3.3.2, 3.9.1	3.9	3.1, 3.9:3.10	
(f)			The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors:					
	(1)		Amount of current and projected groundwater use.	280:287,1037:1193	3.3.2			Appendix 2-D
	(2)		Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.	280:287	3.3.2			
	(3)		Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal.	280:287	3.3.2			
	(4)		Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.	280:287,1193:1310	3.3.2			Appendix 2-E
(g)			Each Plan shall describe the following information about the monitoring network:					
	(1)		Scientific rationale for the monitoring site selection process.	289:296, 314:319, 326:327, 335:343	3.4.1, 3.7.1, 3.8.1, 3.9.1			

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				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(2)		Consistency with data and reporting standards described in Section 352.4. If a site is not consistent with those standards, the Plan shall explain the necessity of the site to the monitoring network, and how any variation from the standards will not affect the usefulness of the results obtained.	N/A				data and reporting standards are consistent with Section 352.4.
	(3)		For each sustainability indicator, the quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site or representative monitoring sites established pursuant to Section 354.36.	299:311,312, 322:328, 332:334, 346:351	3.4.3:3.4.4, 3.5.2:3.5.3, 3.7.3:3.7.4, 3.8.3:3.8.4, 3.9.3:3.9.4	3.2,3.6	3.4	
(h)			The location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used.	280:285,289:292, 314:317, 329:330,335:339	3.3.2,3.4.1.1, 3.7.1.1, 3.8.1.1,3.9.1	3.3, 3.6:3.7,3.9	3.1-3.2, 3.5, 3.8,3.9:3.10	
(i)			The monitoring protocols developed by each Agency shall include a description of technical standards, data collection methods, and other procedures or protocols pursuant to Water Code Section 10727.2(f) for monitoring sites or other data collection facilities to ensure that the monitoring network utilizes comparable data and methodologies.	294:296, 318:319	3.4.1.3, 3.7.1.3			
(j)			An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish a monitoring network related to those sustainability indicators.	313	3.6			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.2, 10727.4, 10728, 10733, 10733.2, and 10733.8, Water Code					
§ 354.36.			**Representative Monitoring**					
			Each Agency may designate a subset of monitoring sites as representative of conditions in the basin or an area of the basin, as follows:					
(a)			Representative monitoring sites may be designated by the Agency as the point at which sustainability indicators are monitored, and for which quantitative values for minimum thresholds, measurable objectives, and interim milestones are defined.	280:285,289:292, 314:317, 329:330,335:339	3.3.2,3.4.1.1, 3.7.1.1, 3.8.1.1,3.9.1			
(b)			(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following:					
	(1)		Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.	311:312, 335:341	3.5, 3.9.1			
	(2)		Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.	308:311,312,350:351	3.4.4,3.5.3, 3.9.5	3.4	3.2	

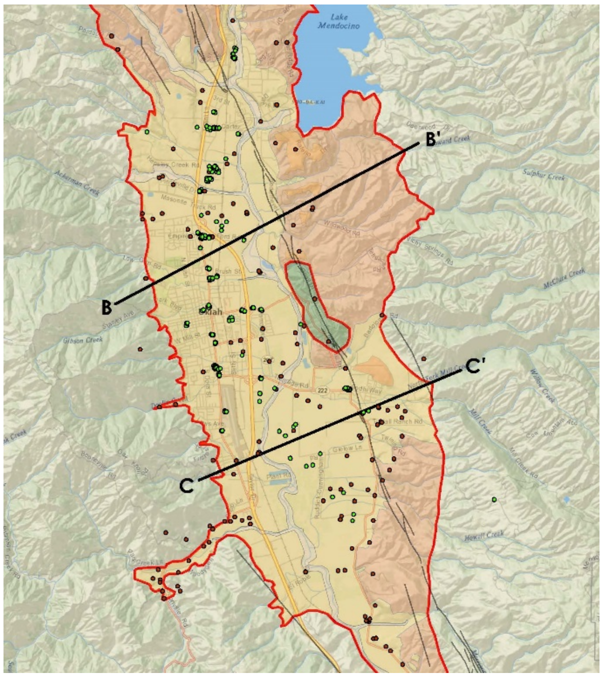
Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(c)			The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.	276:286	3.3			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2 and 10733.2, Water Code					
§ 354.38.			**Assessment and Improvement of Monitoring Network**					
(a)			Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.	294, 318,331, 341:343	3.4.1.2, 3.7.1.2, 3.8.1.2, 3.9.1.1			
(b)			Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.	294, 318,331, 341:343,1193:1310	3.4.1.2, 3.7.1.2, 3.8.1.2, 3.9.1.1			Appendix 2-E
(c)			If the monitoring network contains data gaps, the Plan shall include a description of the following:					
	(1)		The location and reason for data gaps in the monitoring network.	294, 318,331, 341:343,1193:1310	3.4.1.2, 3.7.1.2, 3.8.1.2, 3.9.1.1			Appendix 2-E
	(2)		Local issues and circumstances that limit or prevent monitoring.	N/A				none identified
(d)			Each Agency shall describe steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.	291, 315:316, 338:340, 384:385,1193:1310	3.4.1.2, 3.7.1.2, 3.8.1.2, 3.9.1.1, 4.3.4.1			Appendix 2-E
(e)			Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:					
	(1)		Minimum threshold exceedances.	291, 315:316, 338:340, 384:385	3.4.1.2, 3.7.1.2, 3.8.1.2, 3.9.1.1, 4.3.4.1			
	(2)		Highly variable spatial or temporal conditions.	N/A				not expected
	(3)		Adverse impacts to beneficial uses and users of groundwater.	302:307	3.4.3.1			
	(4)		The potential to adversely affect the ability of an adjacent basin to implement its Plan or impede achievement of sustainability goals in an adjacent basin.	N/A				not applicable to basin
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.2, 10728.2, 10733, 10733.2, and 10733.8, Water Code					
§ 354.40.			**Reporting Monitoring Data to the Department**					

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
			Monitoring data shall be stored in the data management system developed pursuant to Section 352.6. A copy of the monitoring data shall be included in the Annual Report and submitted electronically on forms provided by the Department.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10728, 10728.2, 10733.2, and 10733.8, Water Code.					
SubArticle 5.			**Projects and Management Actions**					
§ 354.42.			**Introduction to Projects and Management Actions**					
			This Subarticle describes the criteria for projects and management actions to be included in a Plan to meet the sustainability goal for the basin in a manner that can be maintained over the planning and implementation horizon.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.44.			**Projects and Management Actions**					
(a)			Each Plan shall include a description of the projects and management actions the Agency has determined will achieve the sustainability goal for the basin, including projects and management actions to respond to changing conditions in the basin.	349:383	4.1:4.3	4.1	4.1:4.2	
(b)			Each Plan shall include a description of the projects and management actions that include the following:					
	(1)		A list of projects and management actions proposed in the Plan with a description of the measurable objective that is expected to benefit from the project or management action. The list shall include projects and management actions that may be utilized to meet interim milestones, the exceedance of minimum thresholds, or where undesirable results have occurred or are imminent. The Plan shall include the following:					
		(A)	A description of the circumstances under which projects or management actions shall be implemented, the criteria that would trigger implementation and termination of projects or management actions, and the process by which the Agency shall determine that conditions requiring the implementation of particular projects or management actions have occurred.	353:356	4.1	4.1		
		(B)	The process by which the Agency shall provide notice to the public and other agencies that the implementation of projects or management actions is being considered or has been implemented, including a description of the actions to be taken.	353:387	4.1:4.3			refer to text under subheadings "Legal Authority and Public Noticing" under each PMA
	(2)		If overdraft conditions are identified through the analysis required by Section 354.18, the Plan shall describe projects or management actions, including a quantification of demand reduction or other methods, for the mitigation of overdraft.	N/A				Overdraft conditions were not identified
	(3)		A summary of the permitting and regulatory process required for each project and management action.	353:387	4.1:4.3			refer to text under subheadings "Permitting and Regulatory Requirements" under each PMA
	(4)		The status of each project and management action, including a time-table for expected initiation and completion, and the accrual of expected benefits.	353:387	4.1:4.3		4.1:4.2	

Article 5.			Plan Contents for Sample Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(5)		An explanation of the benefits that are expected to be realized from the project or management action, and how those benefits will be evaluated.	353:387	4.1:4.3			refer to text under subheadings "Measurable Objectives Expected to Benefit" under each PMA
	(6)		An explanation of how the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included.	353:387	4.1:4.3			refer to text under subheadings "Condition for Implementation" under each PMA
	(7)		A description of the legal authority required for each project and management action, and the basis for that authority within the Agency.	353:387	4.1:4.3			refer to text under subheadings "Legal Authority and Public Noticing" under each PMA
	(8)		A description of the estimated cost for each project and management action and a description of how the Agency plans to meet those costs.	353:387	4.1:4.3			refer to text under subheadings "Estimated Costs and Funding Plan" under each PMA
	(9)		A description of the management of groundwater extractions and recharge to ensure that chronic lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels or storage during other periods.	353:387	4.1:4.3			
(c)			Projects and management actions shall be supported by best available information and best available science.	353:387	4.1:4.3	4.1	4.1:4.2	
(d)			An Agency shall take into account the level of uncertainty associated with the basin setting when developing projects or management actions.	353:387	4.1:4.3			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2, 10727.4, and 10733.2, Water Code.					

Appendix 2-A LACO Initial Hydrogeologic Conceptual Model

Initial Groundwater Sustainability Plan
Hydrogeologic Conceptual Model



Ukiah Valley Groundwater Basin
Mendocino County, California
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Prepared for:
Mendocino County Water Agency

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1.0 INTRODUCTION

A Hydrogeologic Conceptual Model (HCM) for the Ukiah Valley Groundwater Basin (UVGB) is presented. The HCM has been prepared to meet the requirements listed in the Emergency Sustainable Groundwater Management Act (SGMA) Regulations Chapter 1.5, Article 5, Subarticle 2: § 354.14 (DWR, 2014). Funding for an Initial Groundwater Sustainability Plan (IGSP) was provided by the California Department of Water Resources (DWR) to the Mendocino County Water Agency (MCWA). Per SGMA, the regulations for the HCM are as follows:

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.*

b) *The Hydrogeologic Conceptual Model shall be summarized in a written description that includes the following:*
   1) *The regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency.*
   2) *Lateral basin boundaries, including major geologic features that significantly affect groundwater flow.*
   3) *The definable bottom of the basin.*
   4) *Principal aquifers and aquitards, including the following information:*
      A) *Formation names, if defined.*
      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.*
      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.*
      D) *General water quality of the principal aquifers, which may be based on information derived from existing technical studies or regulatory programs.*
      E) *Identification of the primary use or uses of each aquifer, such as domestic, irrigation, or municipal water supply.*
   5) *Identification of data gaps and uncertainty within the Hydrogeologic Conceptual Model.*

c) *The Hydrogeologic Conceptual Model shall be represented graphically by at least two scaled cross sections that display the information required by this section and are sufficient to depict major stratigraphic and structural features in the basin (Figures 3, 4, and 5).*

d) *Physical characteristics of the basin shall be represented on one or more maps that depict the following:*
   1) *Topographic information derived from the U.S. Geological Survey or another reliable source (Figure 1).*
   2) *Surficial geology derived from a qualified map including the locations of cross sections required by this Section (Figure 2).*
   3) *Soil characteristics as described by the appropriate Natural Resources Conservation Service soil survey or other applicable studies (Figure 6).*
   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 (Figure 7).*
   5) *Surface water bodies that are significant to the management of the basin (Figure 8).*
      The source and point of delivery for imported water supplies (Figure 9).

1.1 Purpose

The purpose of the HCM is to meet the regulatory requirements mandated by SGMA, to characterize the extent and geometry of water-bearing subsurface geologic formations, and estimate the hydrogeologic properties (e.g. storativity, transmissivity, and hydraulic conductivity) of the UVGB. This HCM is the foundation for a MODFLOW-2005 model that supplements a Draft Water Budget Study prepared by LACO Associates in December, 2017.

1.2 Geographic Setting

The UVGB underlies the Ukiah Valley and Redwood Valley, located in Mendocino County, California. The elevation of the Ukiah Valley ranges from approximately 550 feet in the south to approximately 850 feet in the north component of Redwood Valley. The mountains to the east and west range from approximately 1,500 feet in elevation to 3,000 feet in elevation. The ground surface slopes downward from north to south at an average of 0.35% over the 20 miles of length. Redwood Valley has a maximum west-to-east width of three miles and Ukiah Valley has a maximum west-to-east width of 3 miles at the town of Talmage. A vicinity and USGS-derived topography map is provided as Figure 1.

1.3 Hydrogeologic Conceptual Model Development

The HCM was based on previous studies pertaining to geology, hydrogeology, groundwater quality, groundwater consumption, well completion reports (WCRs), gravimeter survey data, and groundwater elevation measurements. A consolidated description of hydrogeologic formations, principal aquifers and aquitards, and water quality is presented in Sections 6 and 8. Hydrogeologic properties and hydrogeologic formation geometries were estimated based on the WCRs and previous studies. Three-dimensional digital elevation models (DEMs) for geologic formation boundaries were generated to develop for a MODFLOW-NWT model as a part of the UVGB Draft Water Budget Study prepared by LACO Associates in December, 2017, and were also utilized in developing the cross sections presented in Figures 3, 4, and 5.

1.4 Significant Assumptions

The following assumptions were made during development of the model:

- Transmissivity values derived from WCRs assume the water level stabilized during the drawdown test.
- The accuracy of well locations and lithology encountered on WCRs is assumed to be accurate.
- Depth to the Franciscan formation based on gravimeter survey data is assumed to be accurate.

2.0 PREVIOUS STUDIES AND DATA COLLECTION

This section documents the compilation of existing data was from a literature review. Selected sources provide information for key datasets of the hydrogeologic formations, including: lateral and vertical compositional changes of the aquifer and confining beds; the thickness of the aquifer, magnitude and direction of horizontal and vertical hydraulic gradients, the water quality, and current information on the estimated water demand.

2.1 Literature Review

The DWR illustrates surface water hydrology, groundwater hydrology, and geology for the Ukiah Valley in their *Recommended Water Well Construction and Sealing Standards Paper for Mendocino County*. The report describes the alluvial deposits as ranging in thickness from a few inches to over 100 feet. Stream-channel deposits were expected to range in thickness from a few inches to up to 40 feet. Terrace deposits were estimated to range from a few feet to over 200 feet thick, and underlie alluvium layers throughout the valley. Tertiary to Quaternary aged sediment deposits were described as 1,000 feet thick, and outcropping near the east side of the Ukiah Valley, west of Calpella and near Coyote Valley. Large quantities of clay and silt limit groundwater yields in the Tertiary to Quaternary aged sediments (DWR, 1958).

Charles Jennings and Rudolph Strand published a map of the Ukiah Valley geology in the Geologic Map of California-Ukiah Sheet. The geologic map depicts the Ukiah Valley as consisting primarily of quaternary-aged alluvial deposits, surrounded by mountains mapped as the Franciscan Formation (KJf) and Undivided Cretaceous marine deposits (K). The KJf borders the Ukiah Valley basin to the north, northwest, east, and southeast, and the (K) to the southwest. Quaternary alluvium (Qal) occupies the center of the valley along the Russian River. Quaternary non-marine terrace deposits (Qt) and Plio-Pleistocene non-marine formations (Qp) flank the Quaternary alluvium on mountainous slopes and are bordered by the Franciscan and Cretaceous formations. McNab Creek valley fill is mapped as Pleistocene non-marine formation (Qc), which is bordered by the Cretaceous formation (Jennings, 1960).

G.T. Cardwell described the occurrence, availability, and quality of groundwater throughout the Russian River watershed and developed geologic maps for valleys in Mendocino County in Geological Survey Water-Supply Paper 1548. The UVGB was considered the largest groundwater basin in the Russian River watershed. Geologic formations within the UVGB described in Cardwell's study included undifferentiated Franciscan and Knoxville formations (KJu), continental deposits (QTc), younger Terrace deposits (Qty), terrace deposits (Qt), older terrace deposits (QTo), dissected alluvium (Qdal), Quaternary alluvium (Qal) and river-channel deposits (Qrc). Franciscan and Knoxville formations were described to yield water slowly from wells depending on the degree of fracturing. The continental deposits (QTc) were described as 1,500 feet thick near Coyote Valley dam site based on the U.S. Army Corps Survey report for flood control and allied purposes on the Russian River. Cardwell proposed that the continental deposits may be as thick as 2,000 feet in some areas in the UVGB. Specific capacities of wells in the continental deposits were described as less than one gallon per minute per foot of drawdown. Some wells in the continental deposits were described to yield up to 50 gallons per minute. Alluvial terrace deposits (Qt) were described to be derived from the Franciscan formation and have thicknesses of approximately 200 feet. Wells in the terrace deposits were described to yield between 5 and 63 gallons per minute. Dissected alluvium (Qdal) in McNab Creek Valley was described to be at least 60 feet thick. Alluvium and river channel deposits (Qal) and (Qrc) were described to have thicknesses ranging from 50 to 282 feet and specific yields exceeding 100 gallons per minute per foot of drawdown were reported. Water levels were described to be between a few feet to twenty feet below the ground surface in the alluvial units. Seasonal hydraulic head fluctuations were described to be 15 feet. Groundwater storage in the alluvium and terrace deposits was described to be between 75,000 and 100,000 acre-feet (Cardwell 1965), (Appendix 1).

In Farrar's report, *Ground-Water Resources in Mendocino County*, groundwater conditions were described for Ukiah Valley, Little Lake Valley, Laytonville Valley, Leggett, and nearby mountainous regions. Groundwater availability was classified into four categories based on well yields and hydrogeologic characteristics. Type I formations were classified as yielding 100 to 1,000 gallons per minute, Type II formations yield less than 10 gallons per minute, Type III formations yielding only a few gallons per minute, and Type IV formations were described as having very poor groundwater availability. The groundwater storage was estimated to be 90,000 acre-feet in the upper 100 feet of Type I formations based on an area of 20 square miles and a specific yield of 8 percent. Water bearing formations included continental basin deposits (Type III), continental terrace deposits (Type III), Holocene alluvium (Type I), terrace deposits (Type II), and the Franciscan formation (Type IV) (Farrar, 1986). (Appendix 2).

In 2004, the DWR reported on the UVGB as an update to *California's Groundwater Bulletin 118* (the 2004 DWR Report) describing basin boundaries and hydrology, hydrogeologic information, public supply wells, well characteristics, active monitoring data, and basin management information. Hydrogeology was reported as recent alluvium, Pleistocene terrace deposits, Pliocene/Pleistocene alluvium, and dissected alluvium. Groundwater storage was estimated for various formations based the G.T. Cardwell and Farrar studies. The alluvium and younger terrace deposits are expected to have a storage capacity of 75,000 acre-feet to 100,000 acre-feet, river-channel deposits storage values are estimated at 35,000 acre-feet, and in the older alluvium and terrace deposits on the upper elevations of the margins of the valley approximately 45,000 acre-feet. The older continental deposits were expected to hold 324,000 acre-feet in storage, but were described as having low usability due to low permeability. Groundwater overdraft is expected in localized regions during the summer, but long-term groundwater data demonstrates that overdraft is not an issue based on the quick recharge of the groundwater basin during the rainy season (DWR 2004), (Appendix 3).

Marty Larsen and Harvey Kelsey published a geologic map of the Ukiah Valley that discretized the groundwater basin into 15 unique geologic units. Formations included quaternary alluvium (Qal), five strath terraces (Qt1, Qt2, Qt3, Qt4, and Qt5), Ukiah Basin deposits as described by Cardwell in 1965 as the Continental basin deposits (QTub), three alluvial deposits in isolated valleys (QalVS underlying Vichy Springs, QalMcN underlying McNab Ranch, and QalCR underlying Crawford Ranch), landslides (Qls), colluvium (Qc), and two variations of the Franciscan formation, KJf and KJft (Franciscan with no alluvium cover). Strath terraces are perched above the Franciscan formation on the western and eastern slopes uphill from the Russian River. Younger Qt1 and Qt2 strath formations are located in closer proximity to the Russian River, and the older strath terrace formations Qt4, and Qt5 occupy the higher elevation slopes near the interface with the Franciscan formation. The Larsen and Kelsey map differs from the 1960 map by Jennings where the Cretaceous bedrock to the south and west side of the UVGB is replaced with the Franciscan formation. Quaternary alluvium and Quaternary terrace deposit thicknesses range from 15 to 30 feet. The continental basin deposits (QTub), which underlie the Quaternary terrace and alluvial deposits, have an average thickness of 500 feet and a maximum thickness of 750 feet. These deposits pinch out as they approach the mountains (Larsen and Kelsey, 2005).

The Mendocino County Water Agency (MCWA) described the hydrogeology of the UVGB in their Water Supply Assessment for the Ukiah Area Plan. The hydrogeologic formation descriptions were based on the 2004 DWR report. Water-bearing formations included: alluvium (Qal) ranging from 80 feet to 140 feet thick, quaternary terrace (QT) with a thickness of 240 feet, and a Plio-Pleistocene terrace (QP) ranging from 170 feet to 610 feet thick (MCWA 2010), (Appendix 4).

The Russian River Independent Science Review Panel (ISRP) report described the thickness of the continental basin deposits to be 2,000 feet thick in the center of Ukiah Valley. The continental basin deposits were described to be constructed over a time range from 0.45 million years ago (ma) to 4 ma. Groundwater in Redwood Valley was described to flow from the mountains towards Forsythe Creek and the West Fork of the Russian River and subsequently down the valley to the south. A collaborative groundwater monitoring program was recommended to evaluate surface water-groundwater interaction and supplement the groundwater monitoring network that will be utilized by the Groundwater Sustainability Agency to develop the Groundwater Sustainability Plan for the UVGB (ISRP, 2016), (Appendix 5).

2.2 Ongoing Hydrogeologic Data Collection Programs

Data was compiled from ongoing hydrogeologic data collection programs to characterize surface water-groundwater interaction in the UVGB. Surface water data came from streamflow gauges and groundwater data came from well logs and groundwater level measurements.

2.2.1 Surface Water Data Collection Programs

Currently, there are ten streamflow gauges in the UVGB. The United States Geological Survey (USGS) has three streamflow gauges within the UVGB boundary. These streamflow gauges are located on the Russian River, south of Talmage, and on the forks of the Russian River upstream of the confluence near Coyote Dam. There are USGS gauges outside of the UVGB upstream of Lake Mendocino, and near Hopland that are not within the UVGB boundary. USGS data has been collected since the early 1900s. The National Oceanic and Atmospheric Administration (NOAA) collects data from National Marine Fisheries Service (NMFS) gauges on the west branch of the Russian River, York Creek, Robinson Creek, and McNab Creek. California Land Stewardship Institute (CLSI) has three gauges on McNab Creek.

The Russian River meanders for 33 miles through the UVGB. The sum of the lengths of the tributaries to the Russian River within the UVGB boundary is 123 miles. Some streams run seasonally, and in some cases streamflow percolates into the subsurface once it reaches the recent alluvium of the Russian River. Russian River flows are controlled by the Sonoma County Water Agency (SCWA) for water supply storage, and the United States Army Corps of Engineers (USACE) for flood protection at Coyote Dam (Coyote Dam created Lake Mendocino in 1959). Lake Mendocino has a maximum capacity of 118,000 acre-feet with a water supply capacity of 70,000 acre-feet (SCWA 2016). The Russian River drains 362 square miles by the time flows reach USGS Gauge 11462500 RUSSIAN R NR HOPLAND CA, which is roughly 800 feet south of the UVGB boundary. Since 1940, the average flow rate of the Russian River is 678 cubic feet per second.

According to the Russian River Independent Science Review Panel (ISRP), a panel composed of eight members and one chairman in an effort to establish a scientific basis for the future of the Russian River, the Russian River Channel Improvement project by the USACE during the 1950's and 1960's caused entrenchment of the Russian River, decreasing the elevation of the river's surface and increasing the erosion potential. The construction decreased the width of the floodplain and created a trapezoidal channel through the Ukiah Valley. The ISRP explains that channel entrenchment decreases groundwater elevations that consequently cause tributary flows to go subsurface due to a greater hydraulic gradient between the Russian River stage and the tributary stage after the toe of slope between the bedrock and the alluvium geology (ISRP, 2016).

Contributions to the Russian River north of Redwood Valley consist of flows from Rocky Creek and approximately twenty minor tributaries according to the USGS hydrography dataset (USGS 2016). Forsythe Creek collects flows from approximately 44 square miles in the watershed along Highway 101 towards Willits and the sub-watershed directly to the south. The Russian River picks up flows from seven minor tributaries as it winds through Calpella along the west bank of Lake Mendocino and receives an additional 11 square

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miles of runoff from York Creek prior to the confluence with the Russian River East Branch flowing from Coyote Dam. One NFMS gauge was installed on York Creek in the alluvial plain before the confluence with the West Branch of the Russian River. Two USGS gauges, 11462000 EF RUSSIAN R NR UKIAH CA and 11461000 RUSSIAN R NR UKIAH CA, were installed on each of the Russian River forks prior to their confluence to the main-stem Russian River. South of the confluence, the Russian River receives flow contributions from Hensley Creek, Howard Creek, Ackerman Creek, Sulphur Creek, Orrs Creek, and two minor tributaries prior to flowing adjacent to the city of Ukiah. York Creek is the only tributary that currently has a streamflow gauge in the central Ukiah Valley reach of the Russian River. Ackerman Creek drains approximately 16 square miles of watershed and Orrs Creek drains roughly 8 square miles.

Streams in the region north of Talmage have less than five square miles of contributing watershed area. The tributaries contributing from the hills of the eastern component of the valley into the Talmage area drain the steep topography of Cow Mountain and Red Mountain. The eastern tributaries include McClure Creek, Mill Creek, Howell Creek, Morrison Creek, and six unnamed tributaries that are expected to receive contributing flows from less than five square miles.

Robinson Creek drains over 20 square miles of watershed west of Talmage and parallels two minor tributaries south of Talmage near El Roble. One NFMS streamflow gauge was installed on Robinson Creek roughly one-half mile into the alluvial valley from the mountain-valley toe-of-slope. The final main contributing tributary, McNab Creek, is located in the southern component of the UVGB near Hopland. Three CLSI gauges and one NMFS gauge were installed on McNab Creek. McNab Creek contributes runoff from approximately 12 square miles to the Russian River.

2.2.2 Groundwater Monitoring Data Collection Programs

Currently, 39 wells are included in the California State Groundwater Elevation Monitoring (CASGEM) system. Areas of low CASGEM well density were identified for development of new monitoring wells and existing wells that can be integrated into the CASGEM network are identified based on DWR WCRs provided to the MCWA. In addition to the CASGEM wells, four wells are managed by the DWR, and over 436 wells have data in the GeoTracker system from 1999 to 2016 (GeoTracker, 2016).

71 groundwater monitoring wells are currently active for environmental remediation projects according to the GeoTracker website (SWRCB, 2016). Three additional monitoring wells are currently being monitored biannually by the DWR, and one is offline as of 2011. Hydraulic head data is usually acquired in March, April, or May and in October or November.

The MCWA began their involvement in groundwater resources in 1993 by contracting with the USGS to conduct groundwater monitoring in Redwood Valley as part of a groundwater resources reconnaissance project and to identify a possible location for a surface reservoir for the valley. The MCWA started collaborating with the Mendocino City Community Services District (MCCSD) and Redwood Valley Community Water District (RVCWD) after the passage of SBX 7.6. No groundwater basins within Mendocino County have created a Groundwater Management Plan prior to the development of this Initial Groundwater Sustainability Plan.

In October 2014, the Mendocino County Resource Conservation District (MCRCD) started incorporating Ukiah Valley wells into the CASGEM system under contract with the MCWA. Initially, advertisements were placed in local newspapers that requested well data contributions from local residents and farmers. In addition, a cold-call list of potential well owners that would be willing to contribute was developed by the MCWA and MCRCD. Recently, advertisements have been placed in the Farm Bureau and MCRCD newsletters. Other well owners have added their wells to the CASGEM network after being contacted through word-of-mouth.

Of the 39 CASGEM monitoring wells, 14 wells have 1 data point, 1 well has 2 data points, 7 wells have 3 data points, 15 wells have 4 data points, and 2 wells have 5 data points. Four DWR wells have over 75 points of data. Wells are primarily dispersed on the south side of the city of Ukiah along the river, distributed throughout Redwood Valley, and near Highway 101 north of Ukiah.

In addition to the CASGEM and DWR monitoring programs, the California State Water Resources Control Board (SWRCB) has an online data management system for groundwater remediation projects called GeoTracker (SWRCB, 2016). There were a total of 436 monitoring wells within the UVGB boundary for 36 environmental remediation projects. The groundwater monitoring data included 6,546 data points between 1999 and 2016. Some monitoring wells had multiple latitude, longitude, and elevation surveys provided, and the most recent information was used in spatially databasing well locations.

3.0 HISTORICAL GROUNDWATER ELEVATION DATABASE DEVELOPMENT

The Historical Groundwater Elevation Database was developed in Microsoft® Excel and includes 479 wells located in the UVGB. Monitoring well locations are provided in Figure 2. As described in Section 2.2.2 of this report, historical groundwater elevation data was collected from three main sources: California Statewide Groundwater Elevation Monitoring (CASGEM) data from the DWR, Geotracker well data from the California State Water Resources Control Board (SWRCB), and groundwater elevation data from the DWR's Water Data Library. The Microsoft® Excel database includes well identification information, source data, well location data, well status, well use, ground surface elevation, reference point elevation, total depth, and perforated interval depths.

The CASGEM and Geotracker databases provided between one and five data points per well, while each of the four wells from DWR provided between 78 and 98 data points. The DWR well logs provided significantly more data points per well when compared to the well logs from the CASGEM and Geotracker databases, there are only four relevant wells in the DWR library. These four wells are the only wells that have accessible well logs before 1999. CASGEM databases provide data subsequent to the year 2014 and Geotracker databases provide data subsequent to the year 1999. GeoTracker groundwater monitoring began in 1999 and contributes data to this day; however the amount of groundwater monitoring data submitted to GeoTracker has declined by 87% since 2012, and will continue to decline as environmental sites are closed. The number of wells in the CASGEM program, facilitated by MCRCD for the MCWA, grew by 200% from 2014 to 2015 and 39 data points have been obtained year to date in 2016. Additional groundwater data can be obtained from farmers with wells that serve irrigation purposes. Hydrographs from observation wells are provided in Appendix 6.

4.0 WCR DATABASE DEVELOPMENT

A WCR database was developed based on 2,490 WCRs provided to the MCWA by Eric Senter from the DWR. The WCRs were reviewed to develop a summary of well use type (Table 1).

Table 1. Wells Drilled by Well Use Type

Well Use Type	Number of Wells
Destroy	309
Domestic	1,435
Dry Hole	18
Industrial	18
Irrigation	128
Monitoring	286
Municipal	70
Not Available	115
Remediation	65
Test Well	46
Total	2,490

Candidates for georeferencing were identified based on quality hand-drawn maps or descriptions of well locations. Only 214 of the 2,490 WCRs were georeferenced. The WCRs that were discarded were either outside of the UVGB boundary, lacking a site map or a location description, or illegible. Georeferencing was conducted using Google Earth and importing .KMZ files into ArcGIS®. Data recorded from the georeferenced wells included longitude, latitude, elevation, summaries of lithology encountered by the well driller, estimated well yield, and drawdown. The WCR Database was developed in Microsoft® Excel. WCRs utilized in the WCR analysis are provided in Appendix 7.

Boundaries between geologic and hydrogeologic formations were estimated based on a combination of the information collected in the WCR Database and descriptions from Larsen and Kelsey's 2005 publication "Geologic maps of late Neogene and Quaternary deposits in the Ukiah Basin", C. D. Farrar's 1986 publication "Ground-water Resources in Mendocino County, California. United States Geological Survey", and Cardwell's 1965 publication ***Geology and Ground Water in Russian River Valley Areas and in Round, Laytonville, and Little Lake Valleys – Sonoma and Mendocino Counties, California***. The boundaries are described in detail in Sections 6 and 8 of this report.

Mapped location data obtained from the WCRs presented an uneven spatial distribution of wells in the UVGB. A map showing the wells recorded from the WCRs is provided in Figure 2. Many of the wells are clustered in residential or agricultural areas because the majority of the wells are for domestic or irrigation use, as shown in Table 2 below.

LACO

Table 2. Well Use Type of Georeferenced WCRs

Well Use Type for Georeferenced WCRs						
Domestic	Irrigation	Municipal	Test Well	Unknown	Industrial	Total
154	40	13	4	2	1	214

The information that was collected from the WCRs was limited in some locations. Specific areas with data gaps are illustrated in the Ukiah Valley Groundwater Basin Data Gap Analysis, prepared by LACO Associates in December 2016, as a part of this IGSP. Only 31% of the georeferenced WCRs recorded the well penetrating the Franciscan formation.

Estimates for transmissivity and specific capacity were developed based on groundwater yield and drawdown data from WCRs in the WCR Database. The specific capacity is described as the quotient of the yield (gallons per minute) and the drawdown (feet) and has units of gallons per minute per foot of drawdown. Transmissivity has units of square feet per day, and the values were estimated to describe hydrogeologic properties for the varying formations in Section 8 of this report. Transmissivity values were estimated using the methodology proposed by Driscoll in 1986 (Equation 1).

$$T = SC \times 2000 \quad \text{(Equation 1)}$$

where T = transmissivity (square feet per day)
SC = specific capacity (gallons per minute per foot of drawdown)

Transmissivity estimates ranged from 7 to 600,000 gallons per minute per foot per day.

5.0 GROUNDWATER BASIN BOUNDARY HISTORY

The UVGB was first delineated by the DWR in the 1952 Water Quality Investigations Report No. 3 Ground Water Basins in California (DWR, 1952). The 1952 report included the UVGB in the North Coastal hydrologic study region that ranges from the Oregon border to the northern border of Lagunitas Creek in Marin County. The groundwater basin was given identification number 1-15 and included the alluvial regions near Ukiah, Talmage, and El Roble, but the northern border closed the basin south of Calpella. In 1975, the DWR released California's Ground Water – Bulletin 118, where the UVGB was moved to the San Francisco Bay hydrologic study area and the basin identification number was updated to 2-15 (DWR, 1975). The basin was described to have an area of 16 square miles, a depth of 470 feet, a storage capacity of 369,000 acre-feet, and a usable capacity of 35,000 acre-feet. The basin boundary was redefined and younger alluvium was shown near Redwood Valley and the City of Ukiah, with older alluvium near Calpella and along the eastern border of the groundwater basin. In 2003, the UVGB was returned to the North Coast region during the Bulletin 118 update (DWR, 2003). The basin identification number was updated to 1-52, and the boundary shape was changed to include a greater alluvial area south of Lake Mendocino and the alluvium in the drainage of Robinson Creek. The 2003 report did not include information regarding the groundwater basin area, groundwater budget type, well yields, monitoring, or TDS for the UVGB, which was one of four groundwater basins with grey bars in the table of 62 groundwater basins. The southern boundary of the UVGB borders the Sanel Valley Groundwater Basin (1-53). The interface between the two basins is 2,163 feet across. For this IHCM, the UVGB boundary is modified based on the 2005 Larsen and Kelsey map. The developed DWR basin boundary has inaccuracies near Lake Mendocino, Robinson Creek, and McNab Creek. The boundary errors are corrected in a proposed basin boundary included in Figure 2 of this report.

6.0 GEOLOGIC SETTING

The UVGB has an area of approximately 37,500 acres, is 22 miles long north to south, and is 5 miles wide east to west. The UVGB is located mostly within the Mendocino Range in the northern part of the Coast Ranges Geomorphic Province (Farrar, 1986; DWR, 2004). 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, 2015). Locally, the topography is controlled by tectonic activity associated with the right-lateral Maacama Fault, a member of the San Andreas Fault System. This local faulting is expressed in numerous north-west trending lineaments throughout the Ukiah valley (Farrar, 1986). Geologic formations described in Section 6.1 of this report are predicated on the 2005 Larsen and Kelsey map (Figure 2).

6.1 Geologic Formations

6.1.1 Quaternary Alluvium

Quaternary alluvium primarily consists of unconsolidated gravel, sand, silt, and minor amounts of clay (Cardwell, 1965). The Quaternary alluvium formation includes river-channel deposits that are composed of thin surfaces of gravel, sand and silt (DWR, 1958). Older buried channels are coarser and have boulders with a coarse sand matrix (NCHR, 2004). Quaternary alluvium is not cemented and is the least weathered unit of any of the other older valley-fill units. Typically, the thickness of Quaternary alluvium in the valley is less than a few tens of feet, but in some places is greater than 100 feet. The material that makes up the Quaternary alluvium and river-channel deposits is derived mostly from the Franciscan formation, but terrace and continental basin deposits contribute material as well. Particle size of sediment is largest along the axis of the stream and becomes finer on the floodplain as distance from the stream axis increases (Farrar, 1986).

6.1.2 Terrace Deposits

Terrace deposits are generally partially to loosely cemented beds of gravel, sand, silt and clay (Farrar, 1986). Older terrace deposits consist of red, gravelly clay soil, while young terrace deposits consist of sandy or silty gravel (Cardwell, 1965). Terrace deposits in the valley are long, narrow, and elevated. The gently inclined surfaces of terrace deposits were formed by the aggradation of eroded material, most likely from the surrounding Franciscan formation (Farrar, 1986). These terraces have lithologic heterogeneity and the thicknesses of clay lenses are greater in the younger terraces (Farrar, 1986).

6.1.3 Continental Basin Deposits

Exhibit 1 – Continental Basin Deposit Outcrop near Perkins Street, Ukiah (ISRP, 2016)

Continental basin deposits contain clay in a matrix of silts, gravels, and sand. The vertical distribution of the Continental basin deposit materials include thick clay layers that lay over and below confined aquifers consisting of sands and gravels that provide well yields of up to 50 gallons per minute (MCWA, 2004). According to Farrar, no wells have fully penetrated the Continental basin deposit formation in the UVGB (Farrar, 1986). Continental basin deposit thickness ranges to a depth of up to 2,000 feet along the axis of the valley floor. Outcrops are visible near Perkins Street on the east side of the Ukiah Valley (Exhibit 1), near Coyote Dam, and to the north on the west side of the North Fork of the Russian River near Coyote Valley Rancheria (Exhibit 2).

Exhibit 2 - Continental Basin Deposit Outcrop near Coyote Valley Rancheria, Redwood Valley (Looking to South)

6.1.4 Franciscan Formation

Franciscan formation rocks are the oldest rocks located in the UVGB. These rocks are Jurassic to Cretaceous-aged and make up the majority of the local bedrock. These primarily meta-sedimentary rocks were deposited in a marine environment, then underwent stress and deformation resulting from compressional tectonism. The bulk of the Franciscan formation is composed of sandstone and mudstone with local bodies of serpentinite, greenstone, schist, shale, chert, limestone, and mafic igneous rocks. Rocks within the Franciscan formation are highly fractured and sheared by faulting.

6.2 Maacama Fault

The Maacama fault runs in a northwest-trending direction through the UVGB. The Maacama fault is located at a wide transform boundary between the Pacific Plate and North American Plate. The fault was formed 3.2 million years ago and it slips at a rate of five to eight millimeters per year on average (McLaughlin et al, 2012). The fault originated as a northeast splay from the southern portion of the Roger's Creek Fault Zone. As it formed several strike slip basins were formed concurrently (McLaughlin et al, 2012). The basins began to develop less than 4 million years ago (Farrar, 1986). The Maacama fault displays right-lateral motion and may have been active during Holocene time (Rexford, 1989). The Maacama fault is mapped by the California Geological Survey as an active fault (CGS, 2017). Due to extension, volcanism and strike-slip basin development the fault has acquired several right steps and splays during its evolution (McLaughlin et al, 2012). Due to the migration of the Mendocino Triple Junction and the northward movement of a major releasing bend in the San Andreas Fault, changes in basin geometry and fault geometry are likely due to adjustments of fault zone reorganizations. The Ukiah Valley was formed as a result of oblique pull apart extension between the en echelon and branching faults in the Maacama fault zone (McLaughlin and Nilsen, 1982). Right lateral strike slip motion caused the crustal block to wrench apart and downdrop, forming a graben. The graben, which is bounded by faults, continued to drop while deposition of sediment infilled the basin (Farrar, 1986).

6.3 Geologic History

The Mendocino Range is predominantly composed of the thick, late Mesozoic and Cenozoic sedimentary rocks of the Franciscan formation. 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 underthrusting 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 Franciscan formation displays irregular, knobby topography, and landslide-topography (DWR, 2004). Although the Franciscan formation has a low permeability, fractured zones in the Franciscan formation have low to moderate permeability (Cardwell, 1965). Fracturing in the Franciscan formation is due to faulting from active plate motion between the North American Plate and oceanic plate. The Macaama fault formed 3.2 Million years ago as a splay of the Roger's Creek Fault Zone and has developed several right steps and splays due to extension, volcanism and strike-slip basin development.

6.4 Geologic Cross Sections

Three geologic cross sections were created to illustrate the hydrogeologic boundaries in the UVGB. Figure 1 shows the cross section locations in plain view. Cross sections are presented in Figures 3, 4, and 5. Clay layers identified from the WCRs are illustrated as brown shading on the cross sections.

6.4.1 Distinction of Formation Boundaries

As described in Section 4 of this report, two boundaries between geologic and hydrogeologic formations were estimated based on a combination of the information collected in the WCR Database and descriptions from Larsen and Kelsey's 2005 publication titled *Geologic maps of late Neogene and Quaternary deposits in the Ukiah Basin*, C. D. Farrar's 1986 publication titled *Ground-water Resources in Mendocino County, California, and United States Geological Survey* and Cardwell's 1965 publication titled *Geology and Ground Water in Russian River Valley Areas and in Round, Laytonville, and Little Lake Valleys – Sonoma and Mendocino Counties, California*. The combination of Quaternary alluvium and terrace deposits are hereafter referred to as Quaternary alluvium. The uppermost boundary is between the Quaternary alluvium and the continental basin deposits. The second boundary recorded is between the continental basin deposits and the Franciscan formation. Boundaries were determined by interpreting the log data on the WCRs and using stratigraphy to identify and record any changes in geologic units. The boundaries between the Continental basin deposits were distinguished from terrace deposits (Quaternary alluvium) based on increased clay presence. The vertical boundary between the continental basin deposits and the Franciscan formation were estimated by the presence of rock. 139 WCR data points were used to define geologic units and 747 data points were used to define clay layers.

6.4.2 Discussion/Interpretation of Geologic Cross Sections

All of the cross sections are underlain by the Franciscan formation. The Maacama Fault has resulted in a vertical offset of the basement rock of around 100 feet in each of the cross sections. This offset was based on cross sections developed by Larsen and Kelsey, geologic judgement, and variability in surface topography. Continental basin deposits are divided into three subunits: high hydraulic conductivity, low hydraulic conductivity, and undetermined hydraulic conductivity. Following the trend of the longitudinal valley axis, the depth to the Franciscan formation becomes shallower from the northwest to the southeast. From each cross section, the maximum thicknesses of the two aquifers was approximated and described in Table 3 below. The continental basin deposits decrease in thickness from the northwest to the southeast of the basin. The Qal deposits increase in thickness from the northwest to the southeast of the basin.

Table 3. Maximum Unit Thicknesses of Aquifers in Cross Sections

Cross Section	Qtub (Combined k values)	Qtub (K unknown)	Low K Qtub	High K Qtub	Qal
A – A'	2,060	1,560	780	400	50
B – B'	1,460	700	750	420	120
C – C'	760	560	160	220	230

Cross section A - A' (Figure 3) has a width of 18,800 feet and a maximum depth of 1,220 feet below ground surface (bgs). The Maacama Fault intersects the western side of the cross section. In cross section A - A', hydrogeology consists primarily of continental basin deposits. Low hydraulic conductivity continental basin deposits are on the western side of the UVGB and high hydraulic conductivity continental basin deposits are on the eastern side of the UVGB. Lower hydraulic conductivities generally occur at the surface based on clay layers identified in WCRs. Higher hydraulic conductivity continental basin deposits are exposed at the surface occurring in pockets around Forsythe Creek and the Russian River. Quaternary alluvium deposits are slightly exposed around Forsythe Creek and the Russian River.

Cross section B - B' (Figure 4) has a width 22,800 feet of and a depth of 740 feet bgs. The Maacama Fault runs through the center of this cross section. Cross section B - B' depicts primarily continental basin deposits. High hydraulic conductivity continental deposits are present to the west of the Maacama fault and low hydraulic conductivity continental basin deposits are present to the east of the fault. Only low hydraulic conductivity continental basin deposits are exposed at the surface. High hydraulic conductivity continental basin deposits occur beneath Quaternary alluvium and in small lenses within the lower hydraulic conductivity continental basin deposits. Quaternary alluvium is exposed at the surface and around the Russian River.

Cross section C - C' (Figure 5) has a width of 17,400 feet and a depth of 380 feet bgs. The Maacama Fault runs through the eastern side of the cross section. High hydraulic conductivity continental basin deposits are present to the west of the Maacama fault with a thickness of approximately 200 feet, and to the east of the fault with a thickness of approximately 100 feet. Quaternary alluvium is present above the high hydraulic conductivity continental deposits and is exposed to the surface near the Russian River.

7.0 BOTTOM OF GROUNDWATER BASIN

The depth to the Franciscan formation varies throughout the valley. The bottom of the groundwater basin was estimated from gravimeter data provided in a Humboldt State University Master's thesis (Erickson, 2014). Gravimeter survey data was calibrated to gravity anomaly data collected from WCRs. Continental basin deposit fill was estimated to be in depositional contact with shallowly-dipping bedrock on the east and west margins of the valley. The cross sections provided in the thesis study ended approximately half-way along the north-south axis of the valley, and therefore the depth to bedrock was interpolated to the south based on depth to bedrock data from WCRs. The greatest depths to the Franciscan formation In cross sections A – A', B – B', and C – C' (Figures 3, 4, and 5), are approximately 1,950 feet, 1,350 feet, and 1,000 feet, respectively.

8.0 PRINCIPAL AQUIFERS AND AQUITARDS

Two principal aquifers are identified: Aquifer I – Quaternary alluvium; and Aquifer II – continental basin deposits. Groundwater occurs in the fractures of the Franciscan formation; however it is not a principal aquifer. This section describes the aquifers physical properties (Hydraulic conductivity, transmissivity, storativity, specific yield, and well yield), water quality, and the primary uses of each principal aquifer.

8.1 Aquifer I – Quaternary Alluvium

Aquifer I is the primary hydrogeologic unit for groundwater supply in the UVGB. The Quaternary alluvial deposits provide the highest well yields and specific capacities. Summaries of the physical properties, structural properties, general water quality, and primary use of Aquifer I are discussed in the following sections.

8.1.1 Aquifer I – Physical Properties

The lateral extent of Aquifer I is consistent with the mapped geologic extent of Quaternary alluvium (Figure 2). The majority of the Quaternary alluvium are north-south trending units that follow river-channel deposits of the Russian River and its east-west trending tributaries. Studies by G.T. Cardwell and Farrar estimate alluvium and younger terrace deposits have a storage capacity ranging between 75,000 acre-feet and 100,000 acre-feet; river-channel deposits have storage values estimated at 35,000 acre-feet; and in the older alluvium and terrace deposits on the upper elevations of the margins of the valley have a storage capacity of approximately 45,000 acre-feet.

Quaternary alluvium is unconfined, has high hydraulic conductivity, and is frequently separated from Aquifer II by a clay layer. Piezometric surface elevations generally fluctuate seasonally. Quaternary alluvium formations recharge fully each year with the exception of drought conditions when precipitation is 60 percent lower than the average (Kunzler Terrace Mine, 2009). Groundwater is in both unconfined and confined settings within the terrace deposits because terrace deposits occur continuously within Redwood

Valley but discontinuously along flanks in the Ukiah Valley (NCHR, 2004). Aquifer I hydrogeologic properties based on the WCR Database are provided in Table 4.

Table 4. Aquifer I Hydrogeologic Properties

Log Number	Township Range Section	Yield (gpm)	Drawdown (ft)	Specific Capacity (gpm/ft)	Transmissivity (ft²/day)	Hydraulic Conductivity (ft/day)	Screened Interval
e0235834	15N/12W-16	100	50	2.00	540.0	-	-
1079411	17N/12W-20	15	200	0.08	20.3	-	40-240
528820	14N/12W-7	25	265	0.09	25.5	-	175-275
211109	14N/12W-10	20	75	0.27	72.0	-	-
215713	15N/12W-NN	20	2	10.00	2700.0	-	9-14
239872	14N/12W-7	1	279	0.00	1.0	-	100-296
E0137670	15N/12W-29	0	0	-	-	-	-
105699	14N/12W-7	30	130	0.23	62.3	-	137-157; 177-197; 217-257
156501	-	1080	32	33.75	9112.5	-	-
61330	15N/12W-28	650	0	-	-	-	-
E0097559	15N/12W-21	20	50	0.40	108.0	-	-
451246	14N/12W-5	30	167	0.18	48.5	-	-
118658	14N/12W-14	56	330	0.17	45.8	-	50-150
E0151151	14N/12W-25	300	10	30.00	8100.0	-	20-80
141377	16N/12W-4	7.5	72	0.10	28.1	0.23	22-42; 62-82
105700	17N/12W-29	5	40	0.13	33.8	0.37	43-83
211546	16N/12W-4	51	50	1.02	275.4	2.57	60-100
125320	16N/12W-3	5	4	1.25	337.5	3.59	58-78
769737	15N/12W-7	4	45	0.09	24.0	0.10	24-44; 99-159
104950	15N/12W-26	40	4	10.00	2700.0	33.75	21-60
141431	15N/12W-8	30	38	0.79	213.2	0.82	37-57
18817	15N/12W-26	4.5	60	0.08	20.3	0.17	41-101
913091	15N/12W-8	20	140	0.14	38.6	0.14	0-38; 38-160
70735	15N/12W-8	70	45	1.56	420.0	1.67	39-99; 119-139; 159-199
211028	15N/12W-26	40	7	5.71	1542.9	9.63	20-40
509528	15N/12W-21	50	80	0.63	168.8	1.11	29-89
18824	15N/12W-33	75	1	75.00	20250.0	153.41	18-58
34433	15N/12W-28	70	8	8.75	2362.5	17.50	24-76

Average yields, specific capacity, transmissivity, and hydraulic conductivity values for Aquifer I were 100 gallons per minute, 7 gallons per minute per foot of drawdown, 1894 square feet per day, and 16 feet per day, respectively.

8.1.2 Aquifer I – Water Quality

According to information provided in the 2004 DWR report, water quality is generally good in the Quaternary alluvium deposits (DWR 2004). In general the water is of bicarbonate type and ranges from moderately hard to hard (Cardwell, 1965). Calcium-bicarbonate water is more common in the southern part of the basin and magnesium-bicarbonate groundwater is more common in the east-central portion of the basin (Kunzler, 2009). Analyses estimate that water is 40 percent calcium, 40 percent magnesium, and 20 percent sodium (Cardwell, 1965). Quaternary alluvium chemical water quality is similar to the water in the Russian River, but more dissolved solids and higher chloride levels are present in groundwater. During the baseflow season between late spring and early fall Lake Mendocino greatly influences the water quality of the Russian River. Releases from Lake Mendocino influence specific conductance, total nitrate, and turbidity. 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 (Kunzler Terrace Mine, 2009). Total dissolved solids range from 87 to 301 milligrams per liter with an average of 166 milligrams per liter based on a study of 20 wells penetrating Quaternary alluivum (DWR, 2004). Total dissolved solids and sodium content is greater in terrace deposits and in Aquifer II than in Quaternary alluvium. Shallow wells (less than 100 feet bgs) groundwater temperatures were recorded ranging from 55° to 60° F (Cardwell, 1965). A summary of Aquifer I water quality provided in Table 5.

Table 5. General Water Quality of Aquifer I

Constituent Parameter	Reported Range (units as shown)	Reference
Total Dissolved Solids	• Qal range: 87- 301 mg/l • Qal avg: 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 Levels	• 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)	Kunzler Terrace Mine, 2009
Electrical conductivity	• 250.0 (July, 2005) • 293.0 (015N012W08F001M3, October, 1981)	Kunzler Terrace Mine, 2009

8.1.3 Aquifer I – Primary Uses

According to the DWR pursuant to Water Code Sections 10723.8(a)(4) and 10723.2, beneficial uses and users of groundwater in the UVGB to include: agricultural users, domestic well owners, municipal well operators, public water systems, land use planning agencies, surface water users, resource management, state agencies, other government agencies, California Native American Tribes, private water companies, Ukiah Valley Basin residents, and disadvantaged communities. Water is primarily used for irrigation, domestic, and municipal purposes.

In 1910, irrigation began on a moderate scale in the UVGB. Between 1910 and 1940 most of the water that was irrigated was from the Russian River. By 1940, approximately 3,200 acres had been irrigated and shallow groundwater supplies below the alluvial plain began to be utilized (Cardwell, 1965). In 2008 it was estimated that agricultural water consumption in the UVGB was 8,000 acre-feet per year, with 2,500 to 5,500 acre-feet per year from groundwater resources (D.J. Lewis et al., 2008). According to the DWR pursuant to Water Code Sections 10723.8(a)(4) and 10723.2, the agency identifies the major agricultural users in the UVGB include the Mendocino County Farm Bureau, the Mendocino County Wine Growers Association and landowners. Major agricultural commodities in the greater Ukiah Valley area include wine grapes, timber, pears, apples and pasture and range. All agricultural commodities in the UVGB include fruits and nuts, livestock production, livestock and poultry products, nursery production, and field crops (County of Mendocino, 2016). Groundwater use for industrial purposes primarily serve sawmills and wood product manufacturing plants. According to the California DWR pursuant to Water Code Sections 10723.8(a)(4) and 10723.2 the agency identifies the City of Ukiah as the primary municipal well operator. Although manufacturing plants use a significant quantity of water, a vast proportion of the water is returned to the Russian River (Cardwell, 1965).

The public and domestic supply of water in the UVGB is primarily sourced from groundwater (Cardwell, 1965). There are seven public water systems within the UVGB including Redwood Valley County Water District, Millview County Water District, Willow County Water District, Calpella County Water District, Sonoma County Water Agency, Russian River Flood Control and Upper Russian River Water Agency. Private Water Companies in the area include the City of 10,000 Buddhas, Rogina Water Company and Yokayo Water Systems. Data from domestic well owners is limited to CASGEM participants, and private well owners. In October 2015, the Millview County Water District was reported to serve 6,300 residents who reside in the unincorporated area north of Ukiah. Millview Creek had 1,489 service connections in 2015 with consumption at 5,901 acre feet per year. Since the assessment the State Water Resources Control Board has allowed the District to increase capacity to at least an additional 298 service connections (Frederiksen, 2015).

8.2 Aquifer II – Continental Basin Deposits

Aquifer II (the continental basin deposits) underlay Aquifer I. Aquifer II groundwater is generally confined by clay layers. Continental basin deposits generally have a low hydraulic conductivity and yield less water. Deep wells with long screened intervals are generally required to provide substantial well production rates in the continental basin deposits (Kunzler, 2009).

8.2.1 Aquifer II – Physical Properties

The lateral extent of Aquifer II is mapped as the continental basin deposits and underlying the Quaternary alluvium and terrace deposits (Figure 2). Vertical distribution of the continental basin deposit materials include thick clay layers that lay over and below confined aquifers consisting of sands and gravels that provide well yields of up to 50 gallons per minute (MCWA, 2004). Generally the aquifer is recharged in basin margins by infiltration and percolation of streamflow and precipitation. Another source of recharge is deep percolation of irrigation water return flows. The Franciscan formation borders and underlies Aquifer II and provides localized recharge through fractures and shears (Fisher et al., 1965). Aquifer II capacity is estimated to be 324,000 acre-feet, but is difficult to develop because of low permeability (Ferrar, 1986). Aquifer I hydrogeologic properties based on the WCR Database are provided in Table 6.

Table 6. Aquifer II Hydrogeologic Properties

Log Number	Township Range Section	Yield (gpm)	Drawdown (ft)	Specific Capacity (gpm/ft)	Transmissivity (ft²/day)	Hydraulic Conductivity (ft/day)	Screened Interval
775095	16N/12W-28	12	280	0.04	11.6	0.03	260-280; 340-360; 400-440
705654	16N/12W-22	15	20	0.75	202.5	0.39	335-415
E0160418	16N/12W-17	7	230	0.03	8.2	0.01	199-239
705663	15N/12W-NN	2	130	0.02	4.2	0.01	100-160
E070302	16N/12W-16	15	340	0.04	11.9	0.01	200-355
705657	15N/12W-35	0	120	0.00	-	-	80-100; 220-260
18578	17N/12W-28	1	175	0.01	1.5	0.01	169-229
775102	16N/12W-16	8	170	0.05	12.7	0.01	137-217; 239-257
931929	17N/12W-29	15	160	0.09	25.3	0.05	140-180
36475	14N/12W-3	0	0	-	-	-	175-195
18729	17N/12W-32	8	9	0.89	240.0	0.51	80-150
210815	16N/12W-20	2	90	0.02	6.0	0.01	186-286
e0255737	17N/12W-29	15	210	0.07	19.3	0.13	60-220
210813	16N/12W-20	8	220	0.04	9.8	0.01	278-338
156544	16N/12W-4	0	0	-	-	-	83-123
713846	16N/12W-20	13	320	0.04	11.0	0.01	260-280; 300-360; 380-400
141122	16N/12W-7	0	0	-	-	-	40-80
18702	16N/12W-16	215	110	1.95	527.7	0.42	148-400
E0159420	16N/12W-33	5	0	-	-	-	23-43; 63-103
E0108596	16N/12W-28	7	200	0.04	9.5	0.01	120-220
18819	14N/12W-3	0	0	-	-	-	44-104
50229	14N/12W-3	0	0	-	-	-	80-96; 96-108
E0124475	15N/12W-34	20	200	0.10	27.0	0.05	120-240
e0209535	15N/12W-9	90	200	0.45	121.5	0.11	150-210
264526	15N/12W-34	40	5	8.00	2160.0	3.06	42-105
65419	15N/12W-34	0	0	-	-	-	40-102
E0111792	14N/12W-3	60	91	0.66	178.0	0.25	31-91
3003	16N/12W-7	7	135	0.05	14.0	0.03	146-206
398391	16N/12W-8	20	200	0.10	27.0	0.05	200-340
13364	15N/112W-26	0	0	-	-	-	130-160

Average yields, specific capacity, transmissivity, and hydraulic conductivity values for Aquifer II were 19.5 gallons per minute, 0.61 gallons per minute per foot of drawdown, 173 square feet per day, and 0.25 feet per day, respectively.

8.2.2 Aquifer II – Water Quality

The groundwater in Aquifer II is generally of good mineral quality but has higher levels of dissolved solids than Aquifer I (Fisher et al., 1965). Wells on the west side of Redwood Valleys have been reported to have poor water quality and one well was reported to have flammable gas. Underlying Franciscan formation water quality locally impacts Aquifer II through local recharge. Pressurized carbon dioxide gas was encountered during drilling into Aquifer II near Coyote Valley, southwest Ukiah, and Talmage (Cardwell, 1965). Aquifer II Water quality is summarized in Table 7.

Table 7. Aquifer II - Water Quality Summary

Constituent or Parameter	Reported Range (units as shown)	Reference
Total Dissolved Solids	Qtub also generally has higher levels of dissolved solids when compared to the Qal which averages at 166 mg/l	Fisher et al., 1965
Total Hardness	The groundwater in the Qtub is generally of good mineral quality but contrasting to the groundwater within the Qal and Qt it is less accessible so little data is available describing water quality parameters.	Cardwell, 1965
Chloride Levels		
Electrical conductivity		

8.2.3 Aquifer II – Primary Use

Aquifer II primarily serves domestic water needs.

8.3 Franciscan Formation

The Franciscan formation is not a principal aquifer, but groundwater is contained in the fractures of this formation and utilized by the UVGB population.

8.3.1 Franciscan Formation – Physical Properties

Wells drilled in the Franciscan formation tend to have low well yields and substantial drawdown compared to wells drilled in Aquifer I and Aquifer II. The average specific capacity and transmissivity of wells penetrating the Franciscan formation were 0.03 gallons per minute per foot of drawdown and 8.35 square feet per day, respectively. Franciscan formation hydrogeologic properties based on the WCR Database are provided in Table 8.

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Table 8. Franciscan Formation Hydrogeologic Properties

Log Number	Township/Range /Section	Yield (gpm)	Drawdown (ft)	Specific Capacity (gpm/ft)	Transmissivity (ft²/day)	Screened Interval
E0182651	16N/12W-3	5	0	-	-	100-200
916438	15N/12W-23	1	200	0.01	1.4	60-80; 100-120; 140-160
775088	16N/12W-27	12	300	0.04	10.8	167-187; 247-327; 367-387
213780	14N/12W-6	3	32	0.09	25.3	34-74
23302	15N/12W-18	0	0	-	-	50-58
916508	17N/12W-20	2	163	0.01	3.3	83-143
239695	14N/12W-8	1	272	0.00	1.0	87-107; 237-257; 277-297; 317-337
56199	14N/12W-27	2	0	-	-	45-65; 105-125
e0231794	15N/12W-32	0	105	0.00	-	87-127

8.3.2 *Franciscan Formation – Water Quality*

Franciscan formation springs generally have high mineral content, however acceptable chemical water quality has been encountered. Analysis of the water quality of Vichy Springs identified 4,600 parts per million dissolved solids, 2,000 parts per million carbon dioxide, elevated Boron concentrations, 700 parts per million total hardness, and chloride concentration of 300 parts per million at a temperature of 90° F. Concentrations of Boron measured from 20 wells penetrating the Franciscan formation ranged between 1 and 73 parts per million. Wells that contain boron concentrations less than 14 parts per million were reported to have no other anomalies in chemical composition, whereas wells that contain boron concentrations greater than 14 parts per million also contain high levels of sodium chloride. Regions of elevated levels of Boron are located in East Ukiah, North and South Talmage, North Redwood Valley, Coyote Valley, and in McNab Creek Valley (Cardwell, 1965). Water quality contamination of Aquifer I and Aquifer II from recharge from the Franciscan formation should be a concern during water well development.

8.3.3 *Franciscan Formation – Primary Use*

The Franciscan formation primarily serves domestic water needs.

9.0 FUTURE WORK

Future work to fully address the Emergency SGMA regulations pertaining to the HCM includes creating maps that depict the following, based on input from the UVGB Groundwater Sustainability Agency and Technical Advisory Committee:

- 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
- Surface water bodies that are significant to the management of the basin
- The source and point of delivery for imported water supplies

In addition to these maps, data gaps should be addressed by the following:

- Characterization of hydrogeologic properties related to specific storage and specific yield by conducting several pump tests with monitoring wells in Aquifer I and Aquifer II
- Coupling new streamflow gauges with existing wells or new monitoring wells to quantify surface water-groundwater interaction
- Estimation of Aquifer I and Aquifer II total storage capacity based on specific storage and specific yield values based on pump tests and three dimensional hydrogeologic geometry created as a part of the concurrent Water Budget component of this IGSP
- Incorporating high density gravimeter data for the bottom of groundwater basin section provided in the next few years by the USGS
- Acquire geophysical survey data along the banks of the Russian River near the southern boundary of the UVGB.

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11.0 LIST OF ACROYNMS

California Land Stewardship Institute (CLSI)
California State Groundwater Elevation Monitoring (CASGEM)
Continental basin deposits (QTub)
Continental deposits (QTc)
Department of Water Resources (DWR)
Dissected alluvium (Qdal),
Franciscan and Knoxville formations (KJu),
Franciscan Formation (KJf)
Hydrogeologic Conceptual Model (HCM)
Independent Science Review Panel (ISRP),
Initial Groundwater Sustainability Plan (IGSP)
Mendocino City Community Services District (MCCSD)
Mendocino County Resource Conservation District (MCRCD)
Mendocino County Water Agency (MCWA)
National Marine Fisheries Service (NMFS)
National Oceanic and Atmospheric Administration (NOAA)
Pleistocene non-marine formation (Qc)
Plio-Pleistocene non-marine formations (Qp)
Quaternary alluvium (Qal)
Quaternary alluvium (Qal)
Redwood Valley Community Water District (RVCWD)
Sonoma County Water Agency (SCWA)
Sustainable Groundwater Management Act (SGMA)
Terrace deposits (Qt)
Ukiah Valley Groundwater Basin (UVGB)
Undivided Cretaceous marine (K)
United States Army Corps of Engineers (USACE)
United States Geological Survey (USGS)

FIGURES

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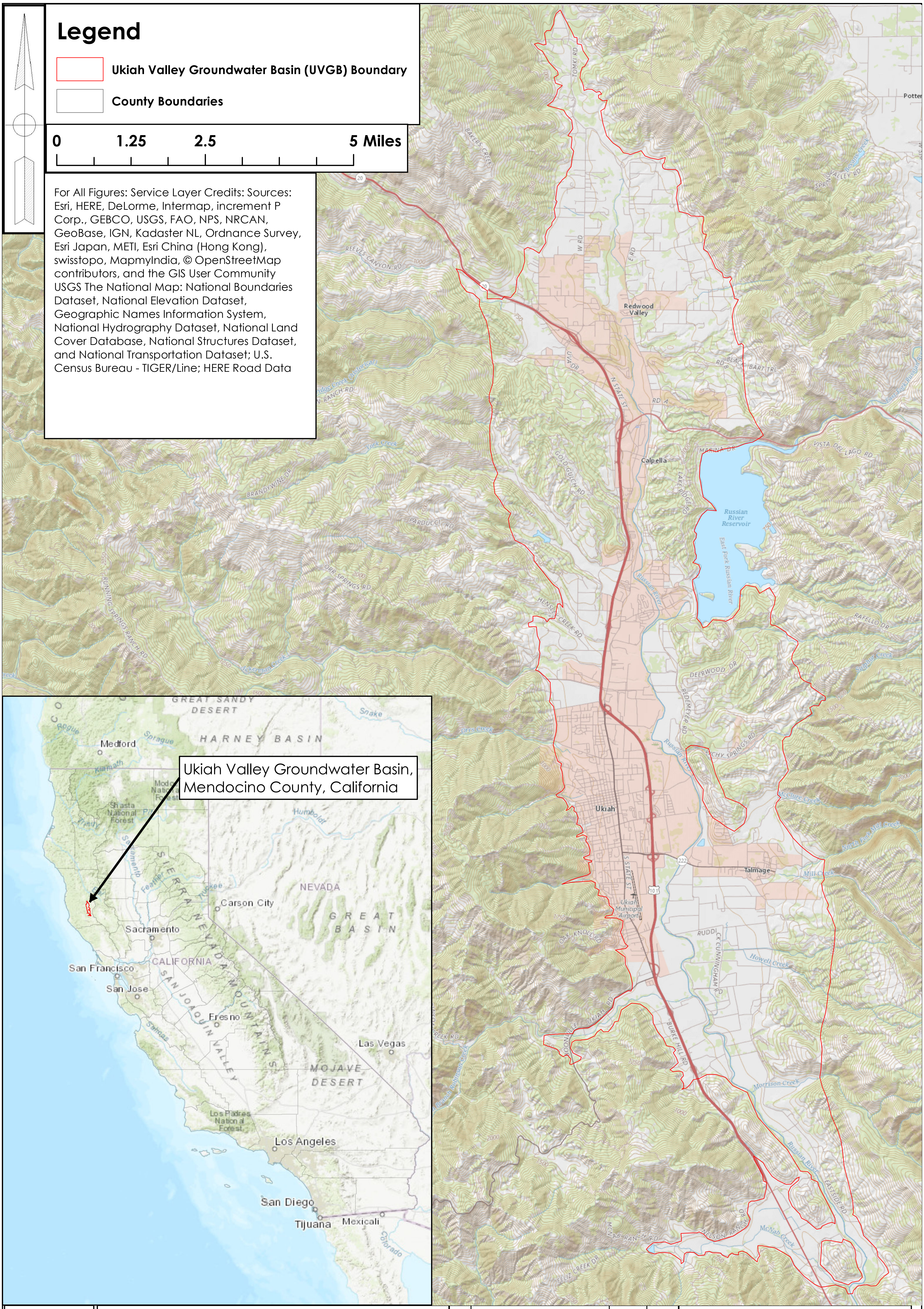

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FIGURE	1

Ukiah Valley Groundwater Basin
Hydrogeologic Conceptual Model
UVGB Vicinity and USGS Topography Map

Mendocino County Water Agency
DWR Grant No. 4600011503

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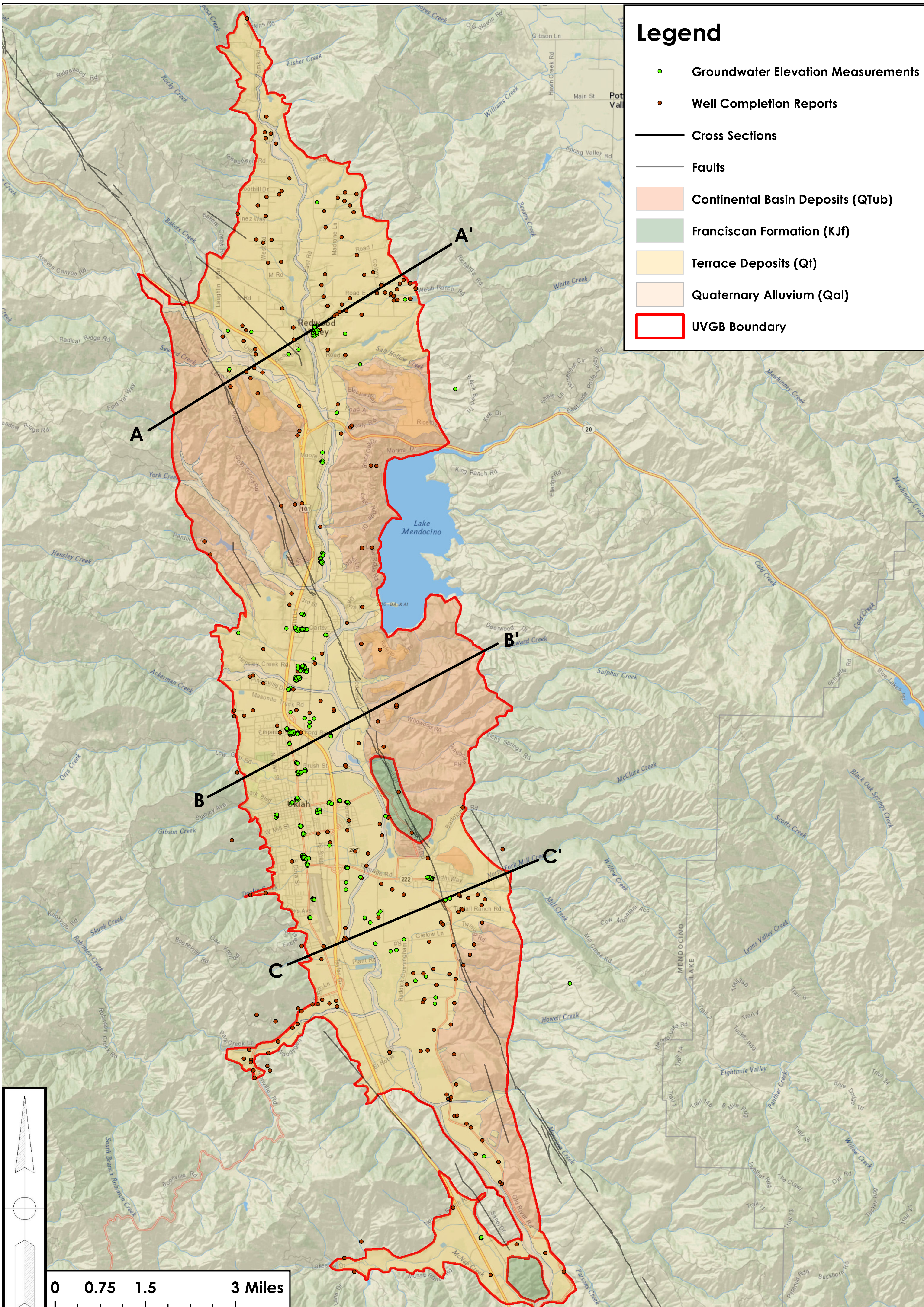

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FIGURE	2

Ukiah Valley Groundwater Basin
Hydrogeologic Conceptual Model
Geologic Map

Mendocino County Water Agency
DWR Grant No. 4600011503

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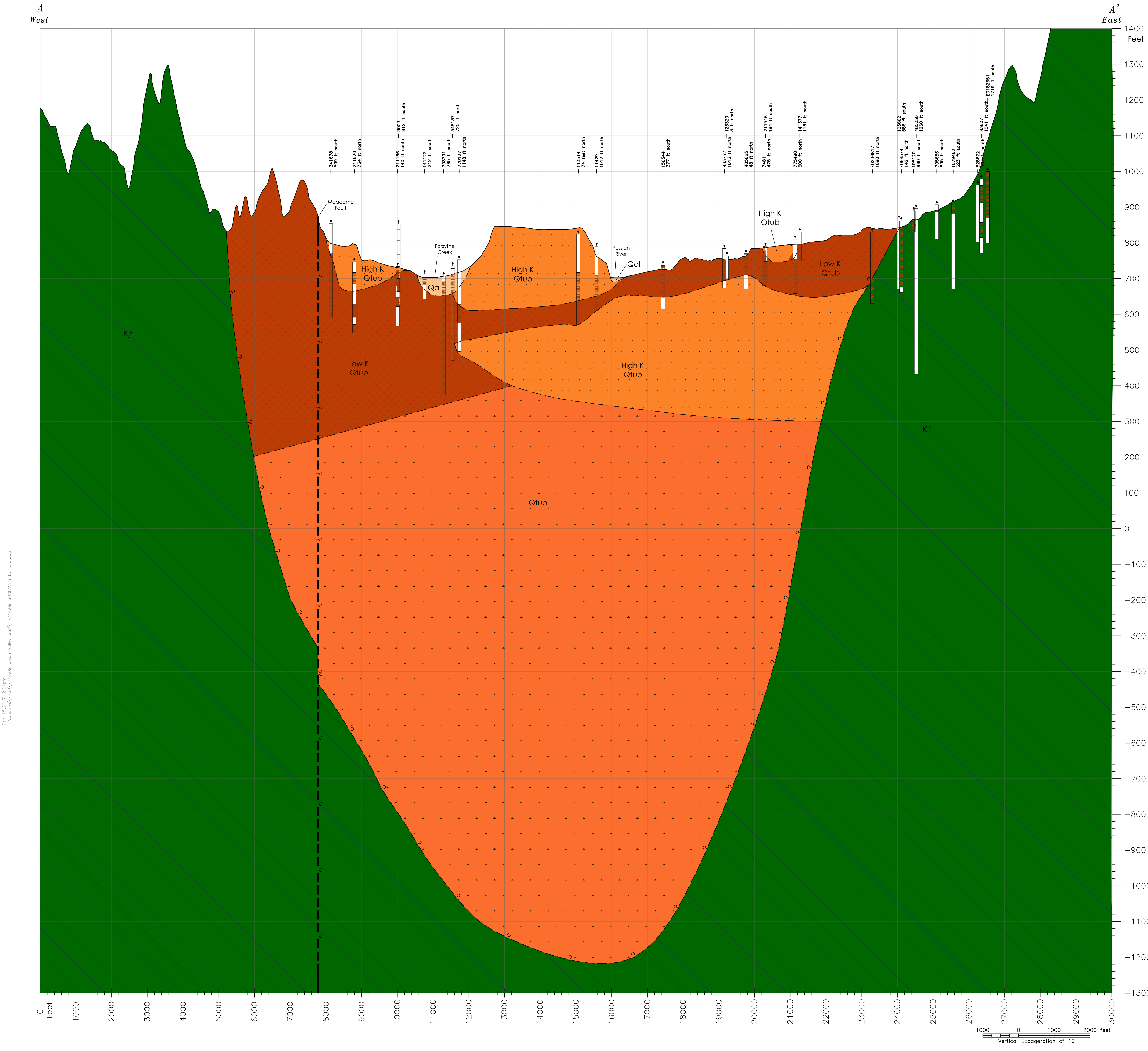
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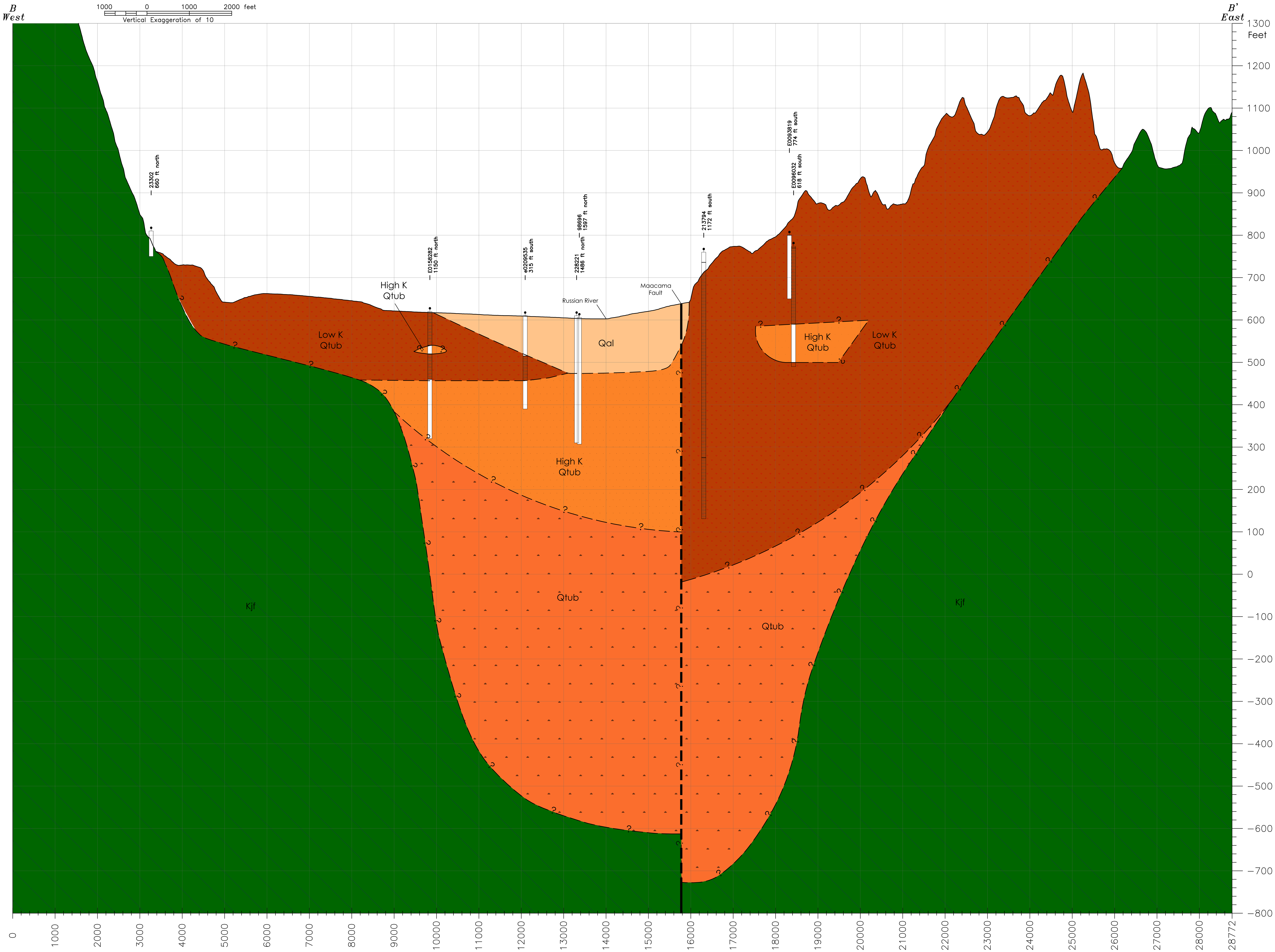

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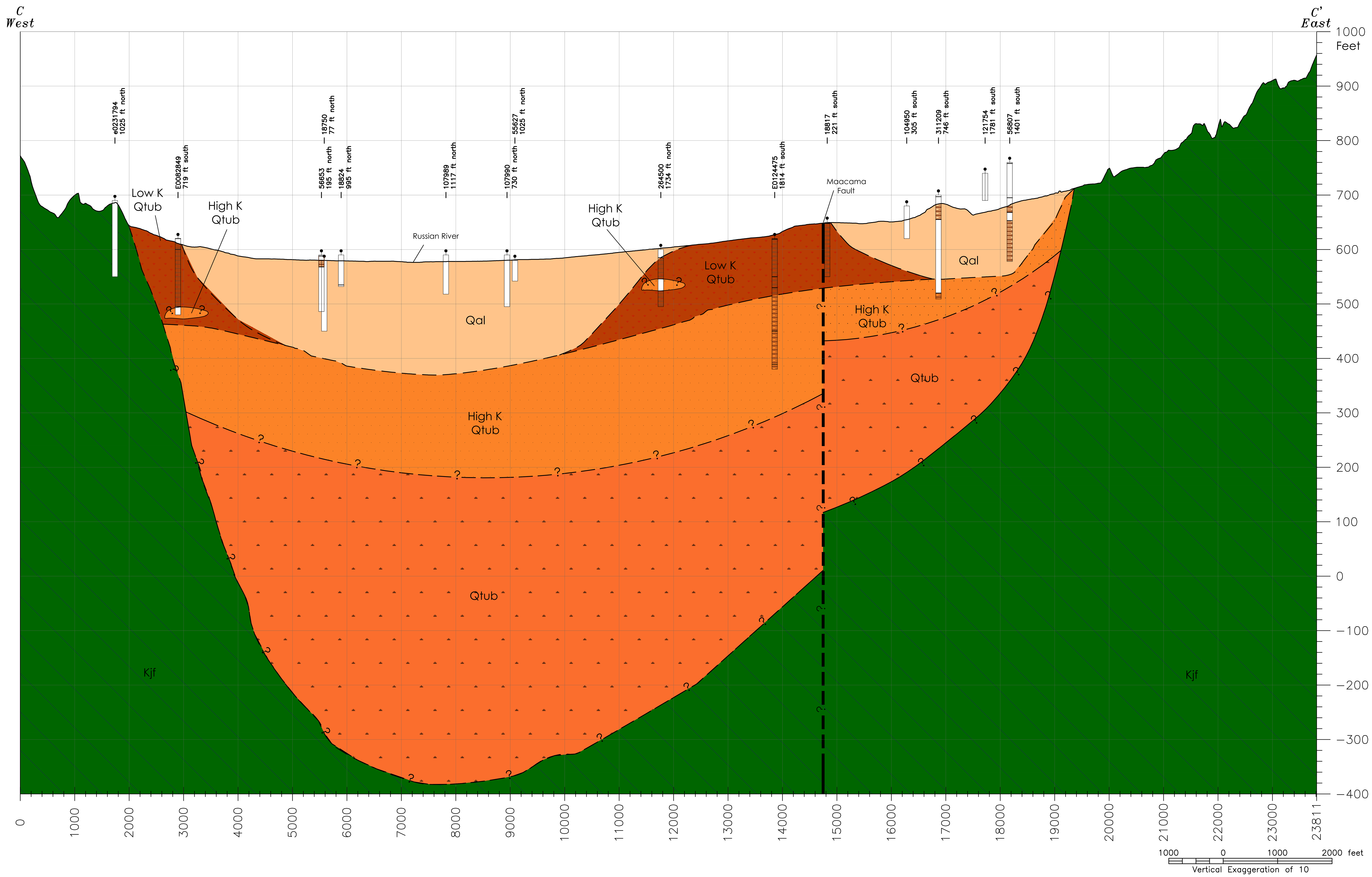

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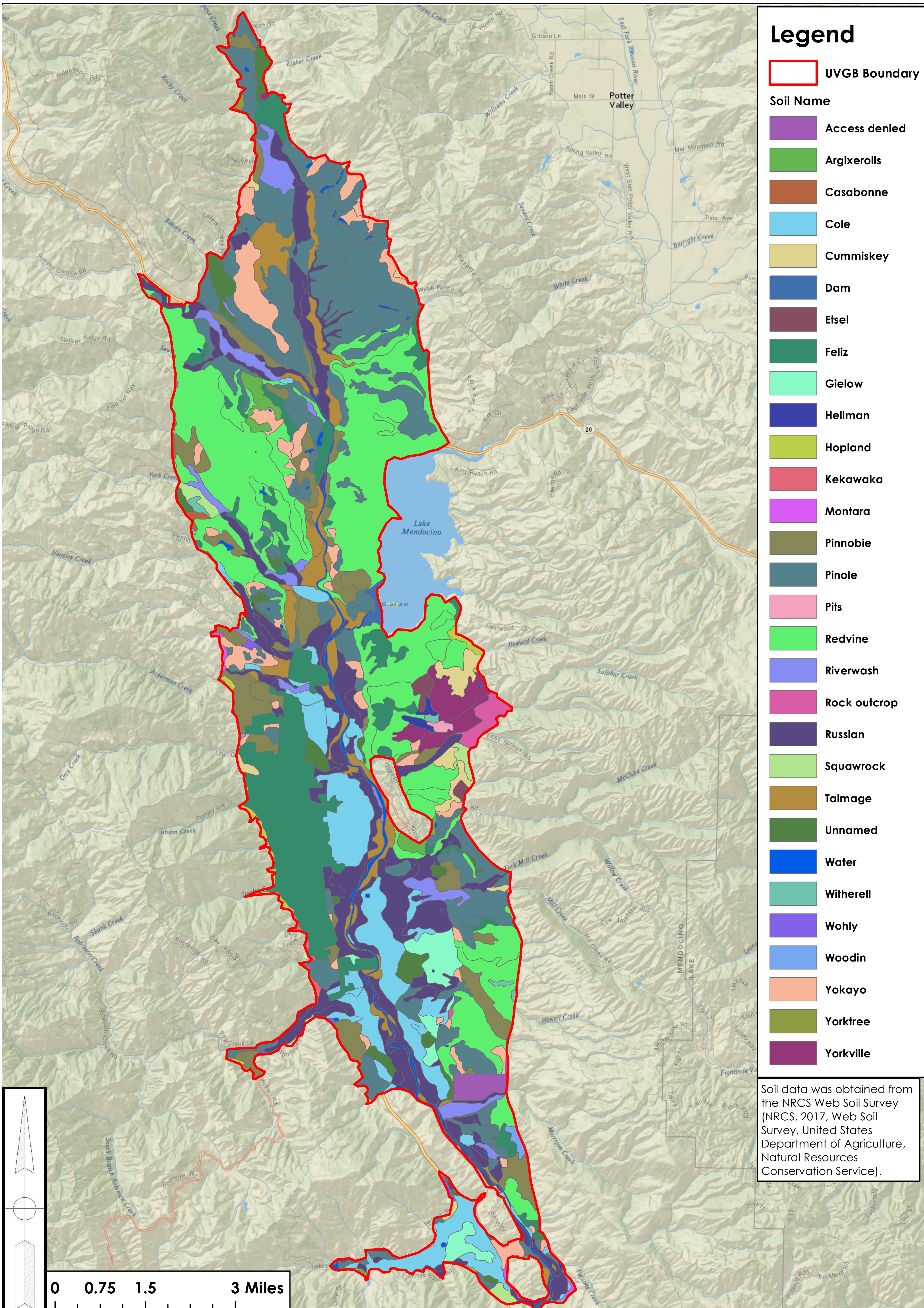

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FIGURE	6

Ukiah Valley Groundwater Basin
Hydrogeologic Conceptual Model
NRCS Soil Map

Mendocino County Water Agency
DWR Grant No. 4600011503

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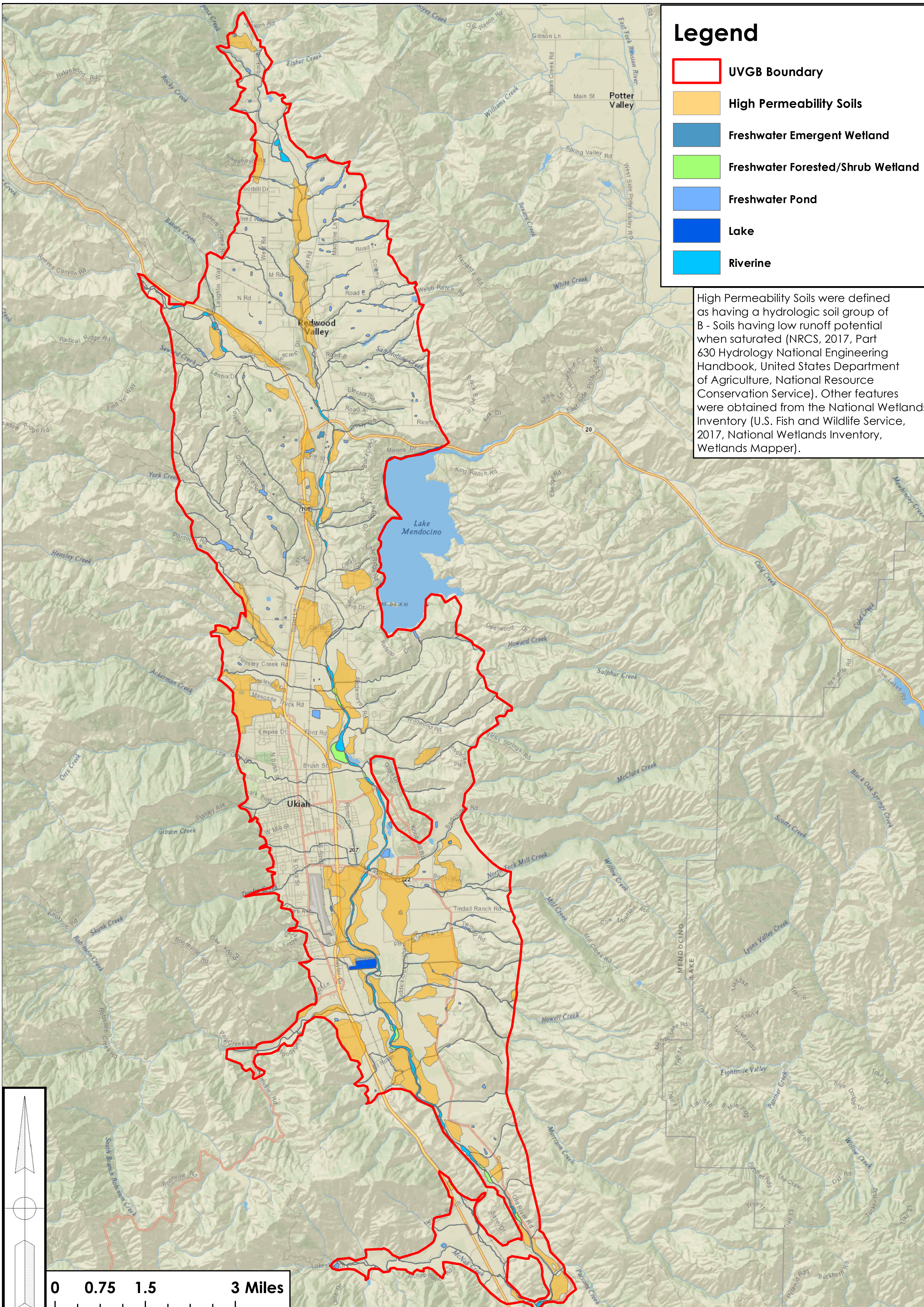

High Permeability Soils were defined as having a hydrologic soil group of B - Soils having low runoff potential when saturated (NRCS, 2017, Part 630 Hydrology National Engineering Handbook, United States Department of Agriculture, National Resource Conservation Service). Other features were obtained from the National Wetlands Inventory (U.S. Fish and Wildlife Service, 2017, National Wetlands Inventory, Wetlands Mapper).

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FIGURE	7

Ukiah Valley Groundwater Basin
Hydrogeologic Conceptual Model
Recharge Area Map

Mendocino County Water Agency
DWR Grant No. 4600011503

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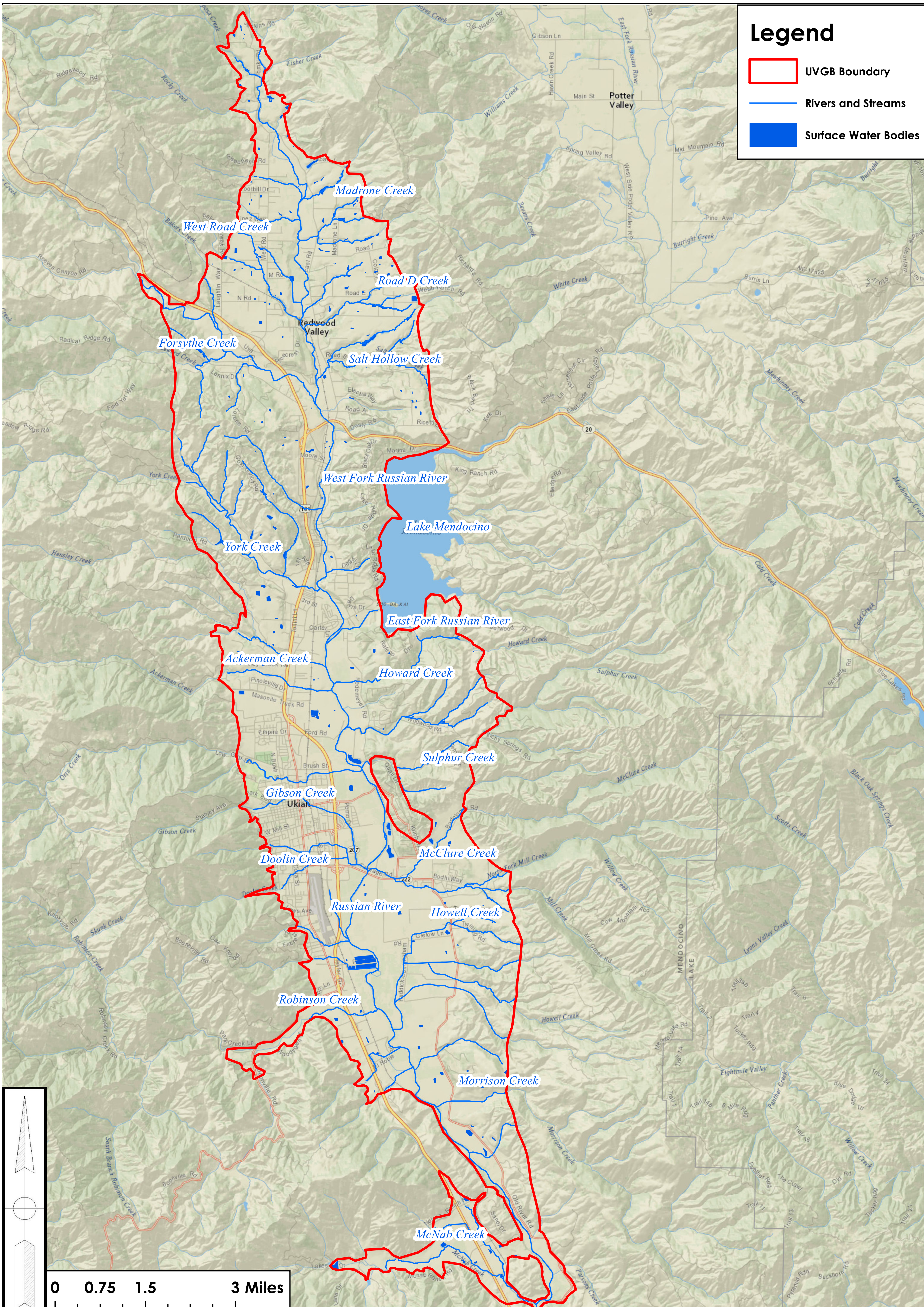

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FIGURE	8	Mendocino County Water Agency DWR Grant No. 4600011503	

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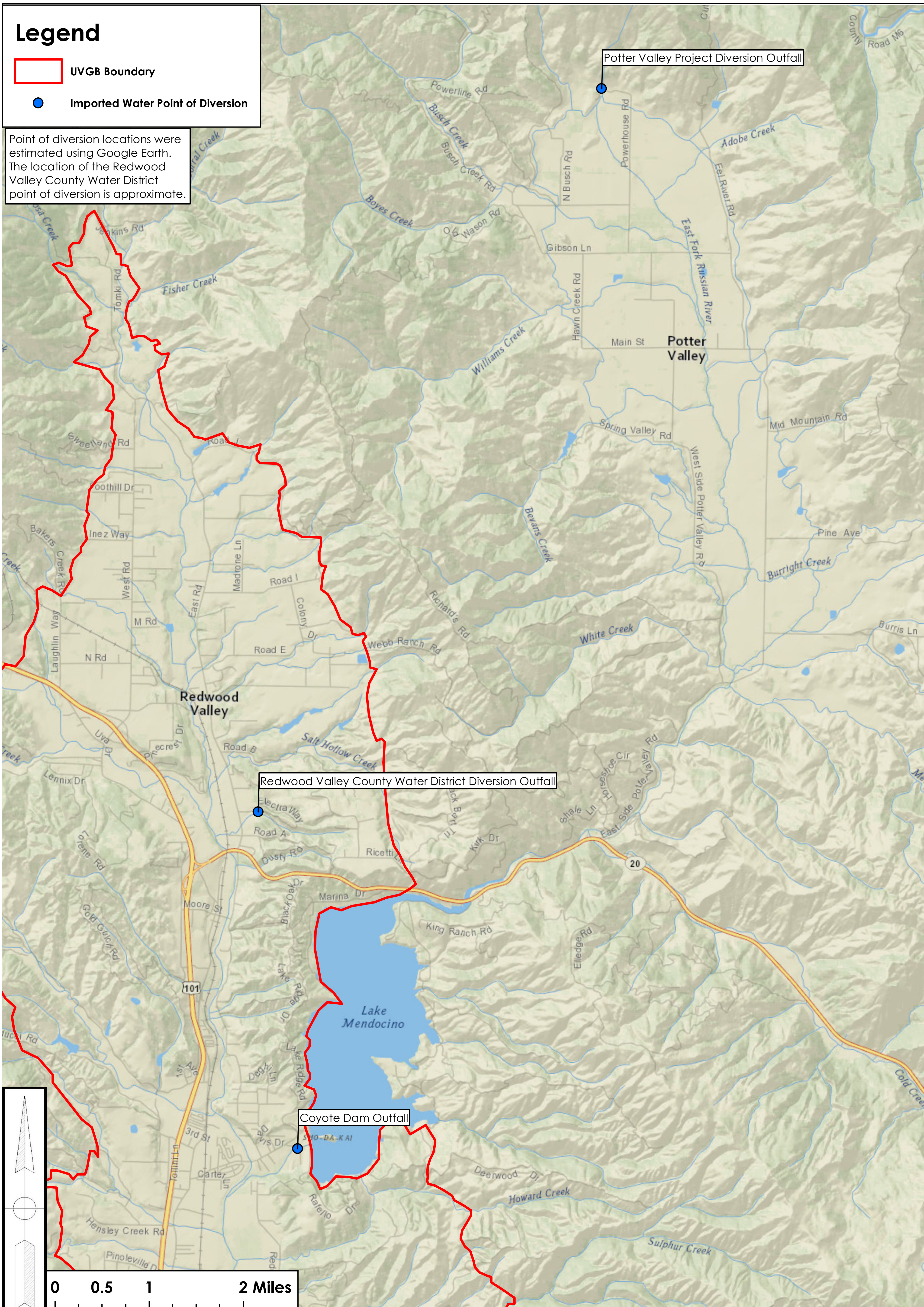

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FIGURE	9		

Ukiah Valley Groundwater Basin
Hydrogeologic Conceptual Model
Imported Water Map

Mendocino County Water Agency
DWR Grant No. 4600011503

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APPENDIX 1

Cardwell Ukiah Valley Hydrogeology

Base from U.S. Army Corps of Engineers topographic maps

Geology by California Division of Water Resources, 1956. Canvass of wells by California Division of Water Resources and U.S. Geological Survey, 1951–54

GEOLOGIC MAP OF THE UPPER RUSSIAN RIVER VALLEY AREA MENDOCINO COUNTY, CALIFORNIA, SHOWING LOCATION OF WELLS

SCALE 1:62 500

1 ½ 0 1 2 3 MILES

1 .5 0 1 2 3 KILOMETERS

CONTOUR INTERVAL 80 FEET
DATUM IS MEAN SEA LEVEL

APPROXIMATE MEAN DECLINATION 1965

Mineral springs are numerous in the Sanel Valley area, and several have been developed for commercial use. (See Waring, 1915, and O'Brien, 1953.) Duncan Springs, a group of five cold springs about 1½ miles southwest of Hopland, has been developed for a resort. The water of the springs is of the magnesium bicarbonate type and rises in serpentine bedrock. Waring (1915, p. 168) reported that McDowell Springs, which is about 5 miles southeast of Hopland, at the south edge of McDowell Valley, and discharges into Coleman Creek, yields a calcium magnesium bicarbonate water that contains a high concentration of iron. An analysis of water from these springs made in 1908 shows a concentration of 53 ppm iron (Waring, 1915, p. 169). Waring also reported that the Humanity Springs, located about 2 miles north of Hopland, at the west edge of the Russian River, discharges carbonated water into the river.

"Dry ice" made from the carbon dioxide associated with hot ground water is produced by the Cal-Dri Ice Co. on the east side of the Russian River about 2 miles north of Hopland. The gas is obtained from seven wells 350–790 feet deep that penetrate bedrock beneath the river alluvium. According to Hubbard (1943, p. 301), the wells were drilled "* * * close to strong seeps of carbon dioxide gas bubbling up through the Russian River." He reported that analyses of the gas show 97 percent carbon dioxide (CO_2), 1.75 percent methane (CH_4), 0.75 percent oxygen (O_2), and 0.50 percent nitrogen (N_2). The hot-spring water reportedly contains a high concentration of boron and thus is a source of boron both to the river water and, locally, to water in the alluvial deposits. This water, with its unusual chemical composition, probably rises from deep-seated sources along a fault that cuts the underlying bedrock.

Analyses of samples of river water collected during the autumn of 1953 and spring of 1954 at the head of Sanel Valley are shown graphically in figure 8. The river water is of excellent quality. The variation in dissolved-solids content normally is not great, although the turbidity and temperature vary widely. The water is similar in character to that in the alluvium, but it has less dissolved solids and is softer. During periods of low flow, the concentration of boron increases to nearly the critical limit for most crops, owing to the inflow of boron-rich water from springs in and near the river.

UKIAH VALLEY AREA

GEOLOGY AND WATER-BEARING CHARACTER OF ROCK UNITS

The Ukiah Valley area, comprising Ukiah Valley and its tributary valleys, is the largest of the ground-water basins along the Russian River. The geology of the area, modified from reconnaissance mapping by the California Division of Water Resources (1956), is shown on pl. 2. The general character and water-bearing properties of the rock units are summarized in table 3. The principal source of ground water is the alluvium of Recent age. Continental deposits of Pliocene and Pleistocene age yield small to moderate amounts of water to wells over an extensive area. Terrace deposits, dissected alluvium, and the Franciscan and Knoxville Formations also yield limited quantities of water to wells.

FRANCISCAN AND KNOXVILLE FORMATIONS

The Franciscan and Knoxville Formations in the Ukiah Valley area consist principally of sandstone, mudstone, and shale, with subordinate amounts of limestone and chert; many conspicuous masses of intrusive serpentine and occasional beds of greenstone and pillow basalt also occur. The rocks generally are fractured and contain numerous faults and local zones of intense shearing.

The ability of these rocks to absorb, store, and transmit water varies with the degree of fracturing; however, they generally yield water slowly to wells. Many springs and the base flow of streams tributary to the Russian River are sustained mainly by ground-water discharge from the large upland areas that are underlain by the Franciscan and Knoxville Formations.

CONTINENTAL DEPOSITS

Continental deposits of probable Pliocene and Pleistocene age crop out almost continuously along the east side of Ukiah Valley as far north as Calpella, in Redwood Valley, where they extend across the valley. The deposits crop out over an area of about 20 square miles and probably underlie an additional 20–25 square miles beneath a mantle of terrace deposits and alluvium.

These deposits correlate with those of similar character in the Sanel and Potter Valleys and probably with the Glen Ellen Formation in Sonoma County. The deposits were described briefly by Marliave (in U.S. Army Corps of Engineers, 1948) and by Treasher (1955). Treasher studied the strata with special reference to their occurrence in the Coyote Valley area and referred to them as the Ukiah beds.

The deposits are remnants of a once-extensive thick fill that was deposited in elongated basins or troughs which were formed on the Mendocino Plateau probably during the latter part of Pliocene time. After their deposition, the beds were uplifted, tilted slightly, and cut by northwest-trending faults. The regional dip is 5°–7° NW; locally, however, the beds are steeply tilted, apparently as a result of faulting. Marliave (in U.S. Army Corps of Engineers, 1948) reported that the deposits are 1,500 feet thick at the Coyote Valley dam site, about 4 miles northeast of Ukiah. The maximum thickness of the beds in the Ukiah Valley area is probably about 2,000 feet. However, because the beds are inclined and overlie an uneven bedrock surface, the thickness probably varies from place to place.

The rocks consist of poorly consolidated and poorly sorted clayey and sandy gravel, clayey sand, and sandy clay. The beds generally are lenticular, and locally they are massive. Thick lenses of moderately indurated gravel interfinger with large bodies of blue-gray sandy silt and clay. Concretionary masses as much as 18 inches in diameter occur commonly in the thick clay beds. The gravelly deposits generally are buff to brown in color, although occasionally they are blue gray. The finer grained deposits range from brown to yellow to blue gray. The interbedded materials were deposited in alluvial fans and as flood-plain, stream-channel, and lake sediments.

Gravels of the formation are well exposed in the bluff at the east edge of the alluvial valley, northeast of the city of Ukiah. The buff-colored gravels are coarse and cobbly; the matrix is coarse silty sand. The pebbles and cobbles consist of sandstone, chert, greenstone, and rock types typical of the Franciscan Formation.

Northeast of Calpella, and also along the road that trends east from Calpella, the beds consist of crossbedded massive buff-colored silty and sandy gravel, sandy silt, and silty clay. Locally the beds weather to a reddish-brown color. Blue-gray beds are not so common near Calpella as in the areas east and southeast of Ukiah.

Terraced remnants of the continental deposits are exposed along U.S. Highway 101 in the steep-walled valley of Forsythe Creek. In several places, 75–100 feet of gravel containing boulders as much as 1 foot in diameter in a matrix of silty sand is exposed. Lenses of unoxidized blue-gray silt and clay containing some interbeds of gravel also occur here.

The subsurface character of the continental deposits is illustrated in table 11 by drillers' logs of wells, particularly by the log of the Corps of Engineers test hole 16/12–34N2.

The continental deposits of Pliocene and Pleistocene age in the Ukiah Valley area generally have low permeability, because the interstices between the coarser textured materials are partly clogged with silt and clay derived from the weathering of the bedrock formations. The condition resembles that of the Glen Ellen Formation in the lower and middle Russian River valley.

Most wells drilled in the continental deposits of Pliocene and Pleistocene age are designed to produce small yields for domestic and stock use. Specific capacities are generally less than 1 gpm per foot of drawdown. A few wells yield about 50 gpm. Commonly only a few feet of the well casing is perforated, and water is obtained predominantly from the strata opposite the perforations. Yields could probably be increased by constructing wells by the gravel-pack technique or by increasing the length of the perforated section.

Many drillers' logs of wells in the vicinity of Calpella show a thick strata of blue clay, and wells commonly are drilled to depths of 150–250 feet before reaching a stratum that will yield the desired quantity of water. A few wells drilled to depths of as much as 250–300 feet reportedly do not yield sufficient water for domestic and stock use.

TERRACE DEPOSITS

A series of alluvial-terrace deposits, mainly of Pleistocene age, overlie large areas of older continental deposits and locally overlie bedrock. These deposits were mapped by the California Division (now Department) of Water Resources (1956) (pl. 2) and separated into (1) younger terrace deposits beneath the low, undissected to slightly dissected terraces adjacent to the flood plain and (2) older terrace deposits beneath the higher, somewhat dissected terraces. These terrace deposits have not been mapped in detail, and small patches likely occur where the geologic map shows continental deposits.

The older terrace deposits veneer a large part of the higher valley flats north of Calpella. The deposits in many places consist only of a red, gravelly clay soil. They are remnants of deposits that were once much more extensive and perhaps thicker. These deposits are generally too thin to be a source of water to wells.

The younger, and topographically lower, terrace deposits occur discontinuously on both sides of the river from several miles north of Calpella to the south end of Ukiah Valley. The terraces are best developed on the west side of the river, notably where they form the prominent broad, flat terrace north and west of the city of Ukiah. The private road of the Masonite Co. cuts through this younger terrace near the U.S. Highway 101 overpass at 15/12–8L, and 15/12–8M and exposes about 30 feet of these beds. The deposits consist mostly of sandy or silty gravel, including fragments as large as cobbles, and contain occasional lenses of sandy silt as much as 2 feet thick. All the material was apparently derived from the Franciscan Formation. The beds are compact, although unconsolidated, and nearly flat-lying except for local depositional dips. The younger terrace deposits locally may attain a thickness of as much as 200 feet.

Wells in the younger terrace deposits generally yield quantities of water adequate for domestic uses if an appreciable thickness of the deposits occurs beneath the water table. Well 15/12–8N1, 80 feet deep (table 10), yielded 63 gpm with a drawdown of 30 feet when drilled. Well 14/12–5K1, 94 feet deep, penetrates bedrock at 84 feet, thus indicating the local thickness of the terrace deposits plus a thin veneer of alluvium. The yield of the well is reportedly only 5 gpm with a drawdown of 56 feet (table 11). Many of the wells drilled into the younger terrace deposits extend into the underlying older continental deposits, but the contact between the units generally cannot be determined from drillers' logs.

Except for local high concentrations of boron, the overall quality of ground water in the terrace deposits is good.

DISSECTED ALLUVIUM

The alluvium along Sulphur Creek below Vichy Springs and along McNab Creek has been termed "dissected alluvium" because it is found some distance above the levels of the streams and is being dissected in their downstream edges. The gravelly alluvium along Sulphur Creek is thin, and headward erosion would have removed it long ago but for the fact that it is cemented, locally to concrete hardness, by carbonate precipitated from water discharged by the Vichy Springs. At the lower end of the narrow deposits along Sulphur Creek, the cemented stratum is being undercut and gradually worn back.

The alluvium of McNab Creek valley is at least 60 feet thick, and it consists mainly of sand and gravel. (See well 14/12–26H, table 11.)

ALLUVIUM AND RIVER-CHANNEL DEPOSITS

The alluvium, of Recent age, is the principal geologic unit of the valley from the standpoint of ground-water supply. It occupies the central part of the Ukiah Valley trough from just north of the juncture of Russian River and East Fork south to Morrison Creek, a distance of nearly 10 miles. The maximum width of the alluvial plain in this reach is slightly more than 2 miles, and the average width is about 1½ miles. The main body is joined by narrow tongues of alluvium in the tributary valleys. The areas in which gravelly stream-channel deposits are now being deposited have been delineated (pl. 2) as a subdivision of the alluvium of Recent age.

The alluvial materials consist of unconsolidated gravel, sand, silt, and minor amounts of clay, deposited in channels and on flood plains of the Russian River and its tributaries, on alluvial fans, and as colluvium on interfan slopes. The gravel in the old buried channels of the Russian River tends to be coarse and bouldery, with coarse sand as a matrix. In the central part of the valley, the alluvium extends from the surface to depths of 50–80 feet. The loose deposits of coarse sand and gravel are highly permeable and are hydraulically connected with the Russian River. A local well driller reported that he has drilled numerous wells 40–50 feet deep in loose gravel in the central part of Ukiah Valley without reaching older, consolidated deposits. A test hole drilled for the city of Ukiah about 1 mile northeast of Ukiah (15/12–16F) penetrated sand and gravel from depths of 2 to 80 feet and bottomed in loose gravel and boulders. Another test hole for the city, drilled at 15/12–20R, penetrated loose sand and gravel to a depth of 40 feet, "tight gravel" to a depth of 68 feet, and stratified clay, gravel, and clay and gravel to a depth of 282 feet. In this well the material below a depth of 68 feet, and possibly below a depth of 40 feet, probably consists of buried terrace deposits and continental deposits of Pliocene and Pleistocene age.

Drillers report that highly productive wells can be obtained almost anywhere in the alluvial valley. Specific capacities of wells range from about five to about 400 gpm per foot of drawdown, and commonly exceed 100 gpm per foot. Two of the public-supply wells for Ukiah, 15/12–16E1 and 16E2, have specific capacities of about 400 gpm per foot of drawndown; pumping tests show that they yield about 1,200 gpm with a drawdown of 3 feet (table 10). The wells are 22 and 34 feet deep and 8 and 7 feet in diameter, respectively, and they are near the river in the belt where thick channel deposits extend to the surface. Dug irrigation well 15/12–28R2, 35 feet deep and located more than half a mile from the river, has a specific capacity of about 130 gpm per foot of drawdown; the yield during a pumping test was 1,040 gpm, and the pumping level was 18 feet. Other things being equal, wells near the river will show higher specific capacities, especially during prolonged pumping, than do those farther away.

GROUND WATER

OCCURRENCE, SOURCE, AND MOVEMENT

In the Ukiah Valley area, recoverable ground water occurs in permeable bodies of sand and gravel, unconsolidated and semiconsolidated alluvial deposits, and interconnected secondary openings (fractures, joints) in the consolidated bedrock. Water in the alluvium is generally unconfined in the interconnected lenses and channels of sand and gravel. The body of water in the younger terrace deposits at most places merges with that in the alluvium; however, the lenses of silt and clay in the younger terrace deposits confine water locally. Water in the older, continental deposits generally is confined to some extent by silt and clay beds and rises in wells after being tapped; perched bodies of water also occur. Water in bedrock generally is confined.

Water levels in wells in the alluvial plain generally lie a few feet to about 20 feet below the land surface. Water levels in wells in the upland area, however, range from near the land surface to depths of 60 feet or more, reflecting differences in topography and degree of confinement in the water body.

The principal source of the ground water is precipitation. Replenishment occurs chiefly by the direct infiltration of rainfall and by seepage loss from streams that cross the low terraces and the alluvial plain. In areas where large quantities of water are withdrawn from wells near the river, recharge may be induced from streamflow. Water discharged from the adjacent and underlying formations is a continuous source of recharge to the alluvium. In areas where surface water is used for irrigation, some recharge to the alluvium is by deep percolation of excess irrigation water.

The ground water generally moves downvalley—toward the Russian River. Water-level gradients in the alluvium seem to range between 5 and 20 feet per mile. Gradients are lowest in the thick permeable channel deposits in the central part of the valley and steepest near the valley margins, where the alluvial deposits become thinner and less permeable.

Water levels in wells tapping the continental desposits of Pliocene and Pleistocene age indicate water-level gradients of 50 feet per mile or more. These deposits have inherently low permeability, and the movement of water is probably impeded locally by the barrier effect produced by faults that cut the deposits.

WATER-LEVEL FLUCTUATIONS

Since 1951, water levels have been measured periodically in five wells in Ukiah Valley. The hydrographs of two of these are shown in figure 9. They show that the seasonal decline in water levels in the alluvium generally does not exceed 10 feet— even in pumped irrigation wells. In the terrace deposits the seasonal fluctuation may be somewhat greater; the seasonal decline in well 15/12–8L1 (fig. 9) is generally about 15 feet.

In those wells measured, the water levels return to about the same level each spring, which indicates that discharge of ground water does not exceed recharge. Apparently, the imposition of pumping onto the natural regimen of discharge and recharge has not greatly affected the behavior of water levels in the principal water body in Ukiah Valley.

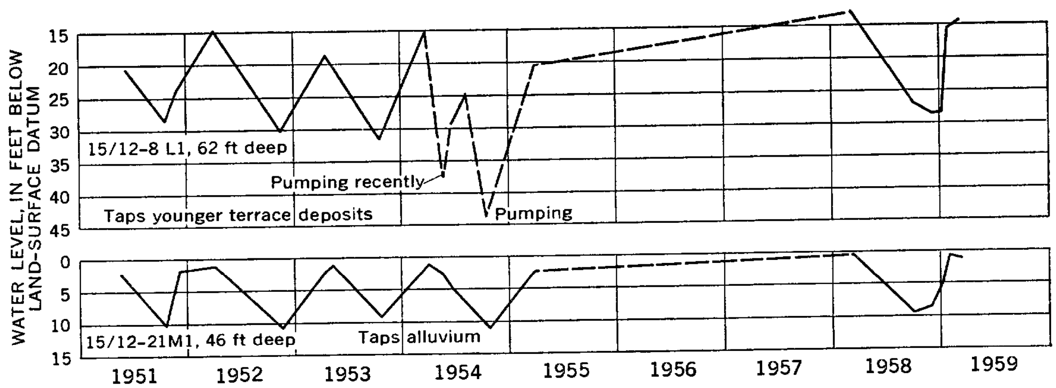

FIGURE 9.—Fluctuation of water levels in two wells in Ukiah Valley, 1951–59.

DISCHARGE AND WATER UTILIZATION

Ground water in the Ukiah Valley area is discharged by effluent seepage to the Russian River and tributaries, evapotranspiration processes, discharge through springs, underflow out of the valley, and pumping from wells.

Discharge to streams is large, especially during spring and late winter. During the summer, some of the water that moves toward areas of discharge is intercepted by pumping wells. Ground-water losses by evapotranspiration occur principally along the major streams, where growths of water-loving vegetation abound and where the water table is perenially shallow. Spring discharge, mainly from bedrock, sustains the low flow of numerous tributary streams. Much of the discharge of springs in the older, continental deposits is dissipated by evapotranspiration.

The discharge of ground water from the valley by underflow is probably small, because the cross-sectional area of the permeable deposits in the narrow segment at the south end of the valley is small. However, the constriction of the alluvial valley at its south end forces much ground water to the surface, where it is discharged as streamflow. Increased pumping of ground water would salvage some of the water now lost by seepage to streams.

Use of water in the Ukiah Valley area exceeds that in any other basin along the Russian River. The largest use is for irrigation, although large amounts are withdrawn for domestic and industrial purposes.

Irrigation in the Ukiah Valley on a moderate scale began in about 1910 (Carpenter and Millberry, 1914, p. 79), earlier than in other Russian River and North Bay valleys. By 1940, according to the U.S. Bureau of Reclamation (1945, p. 21), 3,200 acres was irrigated, mostly from the Russian River. Since 1940, shallow ground-water supplies that underlie the alluvial plain have increasingly been used.

The Corps of Engineers (1948) reported that 3,821 acres, or 60 percent of the estimated ultimate irrigation development, was irrigated in 1944. In 1954 more than 60 irrigation wells plus a somewhat smaller number of river pumps irrigated approximately 4,000 acres. The total withdrawal was about 6,000 acre-feet, half from surface water and half from ground water.

The average duty-of-water factors for the major irrigated crops in the Ukiah Valley area have been estimated from data supplied by the Mendocino County Farm Advisor's office, as follows:

Crop	*Acre-feet per acre*
Alfalfa	2.0
Permanent pasture	2.0
Hops	1.5
Pears	1.0
Prunes	1.0

The population of the Ukiah Valley area was approximately 20,000 in 1954. About 10,000 people were served by the Ukiah public-supply system and used about 2,000 acre-feet of water annually; the amount of water used is based on the 1950 per capita use of 177 gpd reported by the California Department of Public Health, Bureau of Sanitary Engineering. In addition, slightly over 1,000 acre-feet was pumped annually by the Mendocino State Hospital at Talmage (table 2). Use by the remaining population, approximately 7,500 persons, probably was on the order of 800 acre-feet, based on an estimated average use of 100 gpd per capita, the figure commonly used to estimate rural pumpage. Most of the public and domestic supply in the Ukiah Valley area was withdrawn from ground water.

Industrial use of water has increased rapidly since World War II and probably now amounts to several million gallons per day, mainly from ground water. The largest industrial users of water are sawmills and plants manufacturing wood products. The manufacturing plants, however, return much of the water to the Russian River.

Other uses of water are of negligible magnitude as compared to those listed above. The total use of water in the Ukiah Valley area is approximately 13,000–14,000 acre-feet per year, of which about 10,000 acre-feet is from ground water.

GROUND-WATER STORAGE CAPACITY

The bulk of the readily available ground water is in the alluvium and the younger terrace deposits. A rough estimate of the total amount of ground water stored in those deposits is 75,000–100,000 acre-feet.

The major part of the present ground-water draft is from the zone of coarse alluvial deposits along the Russian River. The area of development extends from the juncture of Russian River and East Fork south to Morrison Creek (pl. 2) and averages about 1 mile in width. The area includes a minimum of about 7 square miles and is underlain by gravelly deposits to a depth of 50 feet or more. Drillers' logs of wells and verbal reports indicate that most of the material in the zone between depths of 10 and 50 feet consists of sand and gravel. The amount of ground water stored in this belt of channel deposits to a depth of 50 feet below the land surface is about 35,000 acre-feet, if one assumes an average depth to water of 10 feet and an average specific yield of 20 percent.

This figure of 35,000 acre-feet is more than double the total amount of water—ground and surface—now used annually in the Ukiah Valley area, and it is greater than the foreseeable ultimate ground-water development. The channel deposits are in hydraulic connection with the Russian River, and large-scale use of ground water in storage will affect the flow of the river.

CHEMICAL QUALITY OF WATER

Most of the water in the Ukiah Valley area is of good quality, particularly that in the alluvium; however, locally the content of chemical constituents varies widely. The water is generally of the moderately hard to hard bicarbonate type; analyses show that on the average the water contains about 40 percent calcium, 40 percent magnesium, and 20 percent sodium. Representative analyses are listed in table 12, a summary of the chemical character is given in table 7, and selected analyses are shown graphically in figure 8.

Water in the alluvium is chemically similar to water in the Russian River but generally contains more dissolved solids and slightly larger amounts of chloride (fig. 8). Water in the terrace deposits and in the continental deposits of Pliocene and Pleistocene age generally contains a greater concentration of dissolved solids and sodium than does water in the alluvium.

The chemical quality of water in the bedrock ranges widely depending on the type of rock in which it occurs and the location with respect to geologic structural features. Water from some bedrock springs is highly mineralized, whereas water from others is of good chemical quality. The Vichy Springs, site of a resort about 3 miles northeast of Ukiah (pl. 2), consist of three springs that issue from beneath a bed of calcareous tufa on the south side of Sulphur Creek. Analyses (Waring, 1915) show that the water is of the sodium carbonate type. Water from Vichy Spring, the largest of the three springs, contains about 4,600 ppm dissolved solids plus about 2,000 ppm carbon dioxide.

The total hardness is over 700 ppm, and the concentration of chloride is about 300 ppm. Temperature of the water is generally about 90° F. The smaller springs contain significant quantities of boron.

Spring 15/12–22D2 (pl. 2) yields water containing a low concentration of dissolved solids (table 12). The dissolved solids include 69 percent magnesium, which suggests that the source may be in serpentine.

Temperature of ground water from shallow wells, less than 100 feet deep, ranges from 55° to 60° F but generally is 56°–58° F.

Approximately 20 wells in the area are known to yield water containing concentrations of boron ranging from 1 to 73 ppm. Most of the water that contains as much as 14 ppm boron shows no other abnormality in chemical composition. Water that contains more than about 14 ppm boron generally is nearly, or is, the sodium chloride type. In Ukiah Valley, as in other Russian River valleys, the source of the boron is probably water of volcanic origin that rises from depth along faults. Recent volcanic activity has occurred about 20 miles to the east, in Lake County. The areas in which water from some wells is known to contain objectionable concentrations of boron are (1) east of Ukiah and north of Talmadge, (2) southeast of Talmage, (3) at the north end of Redwood Valley, (4) in Coyote Valley, and (5) in McNab Creek valley.

Verbal reports indicate that local wells on the west side of both Redwood and northern Ukiah valleys yield water of poor quality, and flammable gas was reported in a well in 17/12–32E. Such gas may be derived from decomposed organic material in the continental deposits.

As in the Sanel Valley, the ground water locally contains carbon dioxide gas. Two wells in the city of Ukiah, 235 and 465 feet deep, yielded carbon dioxide gas and water under pressure when drilled (O'Brien, 1953, p. 353, 356). The wells are no longer in use, and no analyses are available. Both wells probably penetrated bedrock. The carbon dioxide undoubtedly originates in the bedrock, but it may move up into the unconsolidated sediments. Gas believed to be carbon dioxide was noted by the Corps of Engineers in "subsurface openings" in continental deposits of Pliocene and Pleistocene age in Coyote Valley (Treasher, 1955). Carbon dioxide seeps were reported near Talmadge and southwest of Ukiah by Hubbard (1943, p. 320). The carbon dioxide may be derived from deep-seated volcanic rocks or from the heating of limestone rocks at depth.

Surface water in the Russian River is generally of good chemical quality. The seasonal range in quality is usually small (fig. 8). During the low-flow period, the quality is largely determined by that of water diverted from the Eel River into the East Fork Russian River (See section. "Physiography and Drainage," p. 6). The low flow of most tributary streams is of good chemical quality, but certain tributaries contribute water of relatively poor quality. Water from Sulphur Creek, into which Vichy Springs discharge, contained 13 ppm boron on September 1, 1953. The low flows of Morrison Creek and Middle Creek (Mill Creek) are sustained by the flow of springs that rise along fault traces. Water from these streams contains relatively high concentrations of dissolved solids and of boron.

POTTER VALLEY

GEOLOGY AND WATER-BEARING CHARACTER OF ROCK UNITS

Potter Valley is at the head of the East Fork Russian River and is generally similar to the other Russian River ground-water basins in origin and appearance. Its geologic and hydrologic conditions, however, are less favorable for the development of ground-water supplies. The alluvium in Potter Valley is finer grained, thinner, and less permeable than the cobbly gravels along the main course of the Russian River farther downstream.

A large part of the present flow of the East Fork Russian River southward through Potter Valley is water diverted from the Eel River through a tunnel under the divide on the north side of Potter Valley.

The surficial extent of the geologic units mapped in Potter Valley is shown on plate 2. The mapping, in general, follows that of the California Division of Water Resources (1956), but it was modified in places, on the basis of field reconnaissance and the "Soils map of the Ukiah area" (Watson and Pendleton, 1916).

FRANCISCAN AND KNOXVILLE FORMATIONS

The bedrock that appears at the margins of the valley is dominantly sandstone and shale, probably of the Franciscan and Knoxville formations of Jurassic and Cretaceous age. Pillow basalt crops out at the north end of the valley, and a long conspicuous band of serpentine roughly parallels the east side of the valley for most of its length. Serpentine is exposed also at the extreme southeastern margin of the valley. The high concentration of magnesium in water from Bush Creek at the northwest side of Potter Valley suggests the upstream presence of serpentine.

CONTINENTAL DEPOSITS

Continental deposits, which undoubtedly are contemporary with similar deposits in the Ukiah Valley area, crop out discontinuously

APPENDIX 2

DWR Bulletin 118

Ukiah Valley Groundwater Basin

- Groundwater Basin Number: 1-52
- County: Mendocino
- Surface Area: 37,500 acres (59 square miles)

Basin Boundaries and Hydrology

The Ukiah Valley groundwater basin, located in southeastern Mendocino County, is approximately 22 miles long and 5 miles wide at the widest point, and is the largest of several groundwater basins along the Russian River. The basin is part of the Ukiah and the Redwood Valleys to the north, and their tributary valleys. The low-lying regions of the Ukiah and Redwood Valleys as well as those sloping areas along the valley edges that include Quaternary- and Tertiary-age sediments define the areal extent of this north-south trending basin. The basin surface elevation varies from approximately 1,000 feet in the upper portions of the Redwood Valley, to approximately 500 feet in the lower, southern areas of the Ukiah Valley.

The Russian River traverses the entire length of the Ukiah Valley groundwater basin and is met by many tributaries from both the east and west sides of Redwood and Ukiah Valleys. The main tributaries include Forsythe Creek, which joins with the Russian River north of the city of Calpella, and the East Fork of the Russian River, which joins the main branch of the Russian River north of Ukiah. Lake Mendocino, a reservoir created from the East Fork of the Russian River located between Redwood Valley and Ukiah Valley, is also an important feature of the surface hydrology of the region. Precipitation in the basin ranges from approximately 45 inches in the north to about 35 inches in the south.

Ukiah is the largest city within the valley and is located on its southwest side. Other cities include Talmage, east of Ukiah, and Calpella on the south end of Redwood Valley. Highway 101 travels the length of the Ukiah Valley from the south and veers west away from Redwood Valley, paralleling Forsythe Creek. Highway 20 enters the valley from the east and intersects with Highway 101 at Calpella.

Hydrogeologic Information

Water Bearing Formations

Groundwater-bearing units of primary importance within the Ukiah Valley Groundwater Basin include Recent alluvium, as well as alluvium of Pliocene and Pleistocene age. The terrace deposits and dissected alluvium of Pleistocene age are of lesser importance with regard to groundwater production. Underlying these deposits is moderately to highly fractured basement rock consisting of the Franciscan and Knoxville Formations. Even when highly fractured these formations have limited permeability, and are considered to yield only small quantities of water locally (Cardwell 1965). Information on water-bearing formations, hydrogeology, and storage capacity is available from Cardwell (1965), DWR, (1965), and Farrar (1986).

Recent Alluvium. Alluvium within the basin is considered a principal source of groundwater and consists of unconsolidated gravel, sand, silt, and minor amounts of clay deposited in channels and on floodplains of the Russian River and its tributaries, on alluvial fans, and as colluvium on interfan slopes. A subdivision of Recent alluvium includes river-channel deposits defined by those areas where gravely stream channel deposits are currently being deposited. River-channel deposits are generally very high yielding loose gravels and sands; in some cases these deposits contain boulders. Recent alluvium is thickest in the central portion of the basin and extends from the surface to depths of 50 to 80 feet (Cardwell 1965). An average specific yield of 20 percent was used for the alluvium in two separate studies (Cardwell 1965, DWR 1965). Groundwater in the alluvium generally occurs under unconfined conditions.

Pleistocene Terrace Deposits. Terrace deposits are characterized as alluvial deposits of primarily Pleistocene age, ranging from a thin veneer of red gravelly clay soil, to deposits of sandy or silty gravel up to 200 feet thick. Terrace deposits generally overly the Pliocene- and Pleistocene-age alluvium and occur discontinuously along the flanks of the Ukiah Valley and more continuously within the Redwood Valley on both sides of the Russian River. Groundwater in the terrace deposits is unconfined to locally confined (Cardwell 1965).

Production from the terrace deposits is variable based on sediment thickness, depth to water, and percentage of fine grained material; however, these deposits generally yield enough water for domestic purposes if an appreciable thickness of the deposit occurs below the water table (Cardwell 1965).

Pliocene/Pleistocene Alluvium. These deposits are described as continental deposits comprised of poorly consolidated and poorly sorted clayey and sandy gravel, clayey sand, and sandy clay. In general, thick lenses of moderately indurated gravel interfinger with large bodies of blue sandy silt and clay (Cardwell 1965). Overall, this alluvium has low permeability due to the relatively high percentage of fine sediments; however, wells can produce moderate amounts of water from these sediments if long sections of perforated (or screened) intervals are used. Bed thickness is variable, with the maximum thickness considered to be about 2,000 feet. Outcrops of this formation can be seen along the entire east side of the Ukiah Valley, as well as the southeast side of the Redwood Valley (Cardwell 1965). It is possible that current groundwater use relies more heavily on Pleistocene- and Pliocene-age alluvium than reflected in this basin description due to ongoing trends in improved well construction techniques and deeper well seal requirements. Groundwater in the older alluvium deposits is generally confined (Cardwell 1965).

Dissected Alluvium. Dissected alluvium is gravelly sediment cemented by carbonate precipitation located along Sulfur Creek below Vichy Springs and along McNab Creek. These sediments yield only very limited quantities of water (Cardwell 1965).

Groundwater Level Trends

Based on hydrographs from DWR monitored wells, groundwater levels in the past 30 years have remained relatively stable. During drought conditions there is increased drawdown during summer months and less recovery in winter months. Post-drought conditions rebound to approximately the same levels as pre-drought conditions.

Groundwater Storage

Groundwater Storage Capacity. It is estimated that approximately 324,000 af of storage exists in the older continental deposits; however, it is probably not usable for short-term storage purposes due to the low-permeability nature of these deposits (DWR 1965).

Groundwater in Storage. Groundwater in storage within the alluvium and younger terrace deposits is estimated to be about 75,000 to 100,000 af (Cardwell 1965). Groundwater in storage within the river-channel deposits between 10 and 50 foot depths is estimated to be 35,000 af based on an average specific yield of 20 percent (Cardwell 1965, DWR 1965). Farrar (1986) estimated that the quantity of groundwater stored in the upper 100 feet of the most productive area of valley fill (Type I) to be about 90,000 af using an average specific yield of 8 percent and an area of 20 square miles. Farrar (1986) also estimated the quantity of groundwater stored along the margins of the valley (Type II area) and underlain by terrace deposits or thin alluvium at 45,000 af. This estimate is based on the upper 100 feet of Type II aquifer materials, an area of 19 square miles, and an average specific yield of 5 percent.

Groundwater Budget (Type C)

There is not enough data available to provide an estimate of the basin's water budget.

Groundwater Quality

Characterization. Water quality is good in general, especially water derived from Recent alluvium deposits; however, locally the content of chemical constituents varies widely. Overall, water is moderately hard to hard bicarbonate. Based on limited data, calcium-bicarbonate groundwater occurs in the southern portion of the basin and magnesium-bicarbonate water occurs in the east-central portion of the basin (Cardwell 1965). Quality in the Recent formations is similar to Russian River water, with slightly higher TDS and chloride levels. Pliocene- and Pleistocene-age formations yield water with higher TDS and sodium than Recent-age formations. Water from springs ranges from highly mineralized to good in quality (Cardwell 1965). TDS values range from 108 to 401 mg/L and average 224 mg/L based on four wells (Cardwell 1965). Electrical conductivity ranges from 450 to 759 µmhos/cm and average 605 µmhos/cm based on two wells (Cardwell 1965). Based on analyses of 22 water supply wells in the Ukiah Valley, TDS ranges from 87 to 301 mg/L and averages about 166 mg/L.

Impairments. Wells with high boron concentrations are located in several areas along the Ukiah Valley edges and in the north end of the Redwood

Valley. Verbal reports indicate that (in general) poor quality water occurs on the west side of the basin. Flammable gas was reported in at least one well. Pressurized carbon dioxide gas was detected in two wells which probably penetrate bedrock (Cardwell 1965). Most poor quality water is believed to migrate into basin sediments from basement rock through fractures or faults.

Water Quality in Public Supply Wells

Constituent Group[1]	Number of wells sampled[2]	Number of wells with a concentration above an MCL[3]
Inorganics – Primary	23	0
Radiological	21	0
Nitrates	28	0
Pesticides	23	0
VOCs and SVOCs	22	0
Inorganics – Secondary	23	6

[1] A description of each member in the constituent groups and a generalized discussion of the relevance of these groups are included in *California's Groundwater – Bulletin 118* by DWR (2003).
[2] Represents distinct number of wells sampled as required under DHS Title 22 program from 1994 through 2000.
[3] Each well reported with a concentration above an MCL was confirmed with a second detection above an MCL. This information is intended as an indicator of the types of activities that cause contamination in a given basin. It represents the water quality at the sample location. It does not indicate the water quality delivered to the consumer. More detailed drinking water quality information can be obtained from the local water purveyor and its annual Consumer Confidence Report.

Well Characteristics

Well yields (gal/min)

Up to 1,200 gal/min from Recent Alluvium and less than 50 gal/min from undifferentiated older formations (DWR 1965)

Total depths (ft)

Domestic	Range: 15 - 600	Average: 220 (155 Well Completion Reports)
Municipal/Irrigation	Range: 36 - 115	Average: 115 (36 Well Completion Reports)

Active Monitoring Data

Agency	Parameter	Number of wells /measurement frequency
DWR	Groundwater levels	5 wells/semi-annually
Mendocino County Water Agency	Groundwater levels	23 well/annually
DWR	Mineral, nutrient, & minor element.	7 wells/ biennially
Department of Health Services	Coliform, nitrates, mineral, organic chemicals, and radiological.	25 wells as required in Title 22, Calif. Code of Regulations

Basin Management

Groundwater management:	No groundwater management plans were identified
Water agencies	
Public	Mendocino County Water Agency, Hopland PUD, Millview County WD, Redwood County WD, Willow County WD.
Private	

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Cardwell, G.T. 1965. Geology and Ground Water in Russian River Valley Areas and in Round, Laytonville and Little Lake Valleys, Sonoma and Mendocino Counties, California. USGS Water Supply Paper 1548.

Farrar, C.D. 1986. Ground-Water Resources in Mendocino County, California. USGS Water-Resources Investigations Report 85-4258.

Errata

Changes made to the basin description will be noted here.

APPENDIX 3

Ferrar Ukiah Valley Hydrogeology Study

GEOLOGY

Geologic Setting

Mendocino County lies within the Coast Ranges geomorphic province. The Coast Ranges comprise a group of mountain ranges extending 600 miles, from Santa Barbara County to the Oregon border, and ranging from a few to 70 miles in east-west dimension. The Coast Ranges lie between the Central Valley and the Pacific Coast and trend northwest, roughly paralleling the Sierra Nevada on the opposite side of the Central Valley. The northwest trend is seen in numerous elongate ranges and valleys and in the linear geologic structures of this complex province.

Mendocino County is mostly within that part of the Coast Ranges known as the Mendocino Range. This range is underlain almost entirely by rocks of the Franciscan Complex. The Franciscan Complex, the geomorphic features, and the geologic structures in the Coast Ranges are largely the result of global-scale crustal movements (plate tectonics) that involved the underthrusting and subduction of the Pacific oceanic plate beneath the continental margin of Western North America (Bailey and others, 1970). During Mesozoic time, an oceanic trench paralleling the coast marked the zone along which the overlapping of the plates occurred; this was the site of accumulation of the tectonically mixed sediments, which were later uplifted to form the mountainous terrain of the Franciscan Complex.

Geologic Units

The geologic units exposed at the surface can be divided into two major groups--basement rocks and valley fill. For this report, the term "basement rocks" includes all the rocks of pre-Pliocene age; "valley fill" refers to geologic units of Quaternary age or those that span Tertiary and Quaternary age. The geologic units discussed in this report include those that lie east of the coastal terraces and east of the San Andreas fault (fig. 4). Not including the thin mantle of soil locally concealing geologic units, about 95 percent of surface exposures consist of basement rocks. The valley fill is confined to small basins along major stream courses and thin alluvium in stream channels.

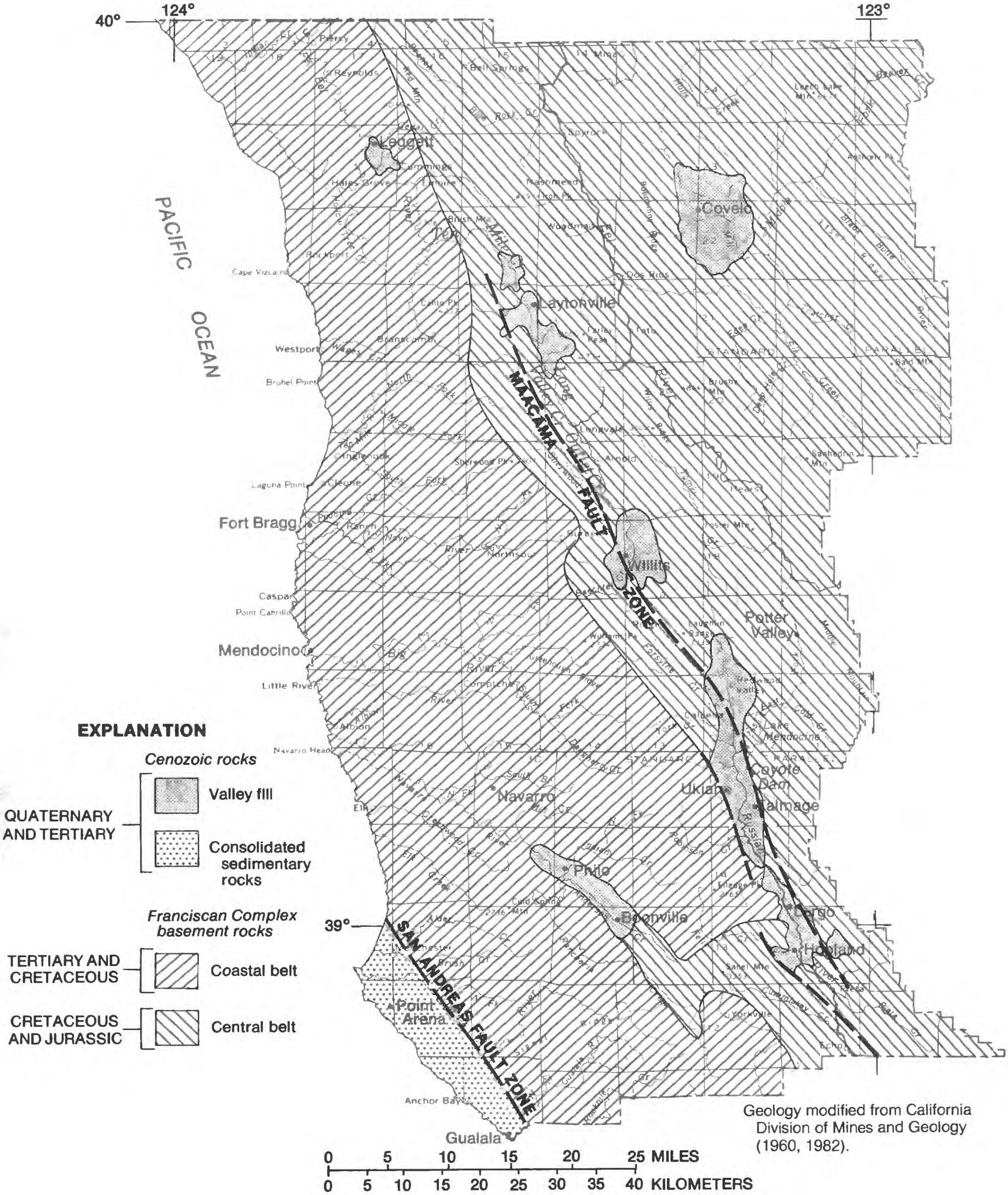


FIGURE 4. — Generalized geology of Mendocino County.

Basement Rocks

The basement rocks consist of rocks of the Franciscan Complex, a few small patches of rocks of the Great Valley sequence superimposed on the Franciscan, and outcrops of upper Tertiary sedimentary rocks. The incorporation of Great Valley rocks into the Franciscan terrane may have resulted from thrust faulting, gravity sliding, or original deposition (Maxwell, 1974). For this report, the two units are undifferentiated because of the minor presence of Great Valley rocks and their geohydrologic similarity to some of the lithologic units of the Franciscan. Upper Tertiary sedimentary rocks crop out in two areas, west of Piercy and southwest of Covelo. These rocks are present only in small areas and are not considered further in this report.

The basement rocks as defined above underlie the entire county, with the exception of the small sliver of land west of the San Andreas fault. The thickness of the basement rocks is unknown because of the complex structural relation with adjacent geologic units; however, it is estimated to be about 50,000 feet (Bailey and others, 1970).

The Franciscan Complex is a structural complex and a rock stratigraphic unit consisting of a structural aggregation of intact blocks of bedded sedimentary rocks in a faulted and sheared matrix of melange and broken formations. It has been subdivided into three major northwest-trending subparallel belts named, from west to east, the Coastal belt, Central belt and Yolla Bolly belt (Blake and Jones, 1981). In this report the Franciscan Complex is subdivided into Coastal-belt and Central-belt rocks. Rocks of the Yolla Bolly belt lie mostly east of the county; the few isolated outcrops within the Central belt are not differentiated.

Coastal-belt rocks of Cretaceous and Tertiary age lie mostly west of a line coinciding with U.S. Highway 101 and occupy about one-half of the county; Central-belt rocks cover the rest of the county. The Coastal-belt rocks consist of graywacke, mudstone, and minor conglomerate. These lithologic units contain abundant mica and potassium feldspar; low-grade metamorphism to the zeolite facies is found locally. Coastal-belt rocks are less deformed than Central-belt rocks. In places the Coastal belt includes undeformed blocks of graywacke in a highly sheared matrix of mudstone, but the Coastal belt is characterized generally by coherent rock units with a predominantly homoclinal structure striking northwest and dipping northeast under the Central-belt rocks.

The Central belt of Jurassic and Cretaceous age is a melange (Hsu, 1968; Fox, 1983a) consisting of a matrix of highly sheared graywacke and mudstone enclosing coherent blocks of graywacke, chert, greenstone, serpentine, blueschist, and limestone. Although the mudstone matrix is easily eroded, the coherent blocks are resistant to erosion. This results in a characteristic topography of resistant knobs, house-sized to boulder-sized, projecting through the hummocky hillsides. The grass-covered sheared mudstone units are unable to support dense stands of trees due to the unstable ground moving downslope by creep and debris flows.

Valley Fill

Valley fill refers to the unconsolidated to loosely cemented gravel, sand, silt, and clay deposited in the major valleys. The valley fill was deposited in topographically separated structural basins. As a consequence, the units are correlative from one basin to another but are not continuous between basins.

In this report the fill is subdivided into three distinct units--continental basin deposits, continental terrace deposits, and Holocene alluvium, based on the geologic age and origin of the units. The distinctive geologic attributes of each unit result in differences in water-bearing properties significant to this study.

The discussion of the valley-fill units presented here emphasizes the general lithologic characteristics of each and the geologic relations among the units. Not all units are present in each of the valleys studied. Specific discussion of units present in each valley and the water-bearing characteristics of each are presented later in this report under the heading "Ground-Water Conditions."

Continental basin deposits.--The oldest and stratigraphically lowest unit of the valley fill, this unit was deposited directly on the basement rocks in structural basins during late Pliocene and Pleistocene time. A schematic section of Ukiah Valley (fig. 5) shows stratigraphic relations. Lithologically, the continental basin deposits comprise a heterogeneous mixture of loosely cemented gravel, sand, silt, and clay. Bedding ranges from massive to thin. The lateral extent of individual beds is generally small for the coarse-grained material and larger for fine-grained materials. Beds of sand and gravel are typically lenticular and interfinger with beds above and below. From studies of structural basins 30 miles south of Ukiah by McLaughlin and Nilsen (1982), the origin of this unit may be inferred. The highly erodible Franciscan Complex provided material for landslides and debris flows, which built fans and talus slopes around the valley margins. Braided streams flowed across the fans and deposited sediments as they meandered out onto the valley floor. Each valley was partly occupied by a lake around which deltas were built by the inflowing streams. These sedimentary processes combined to produce and leave behind a highly complex distribution of gravel, sand, silt, and clay.

Deposition of the continental basin deposits began about 3 to 4 million years ago and continued until at least 0.45 million years ago (McLaughlin and Nilson, 1982). Since that time minor deformation of these beds has occurred, resulting from regional tectonics and movement along faults. In some outcrops at the margins of the valleys, beds are tilted as much as 10° from horizontal.

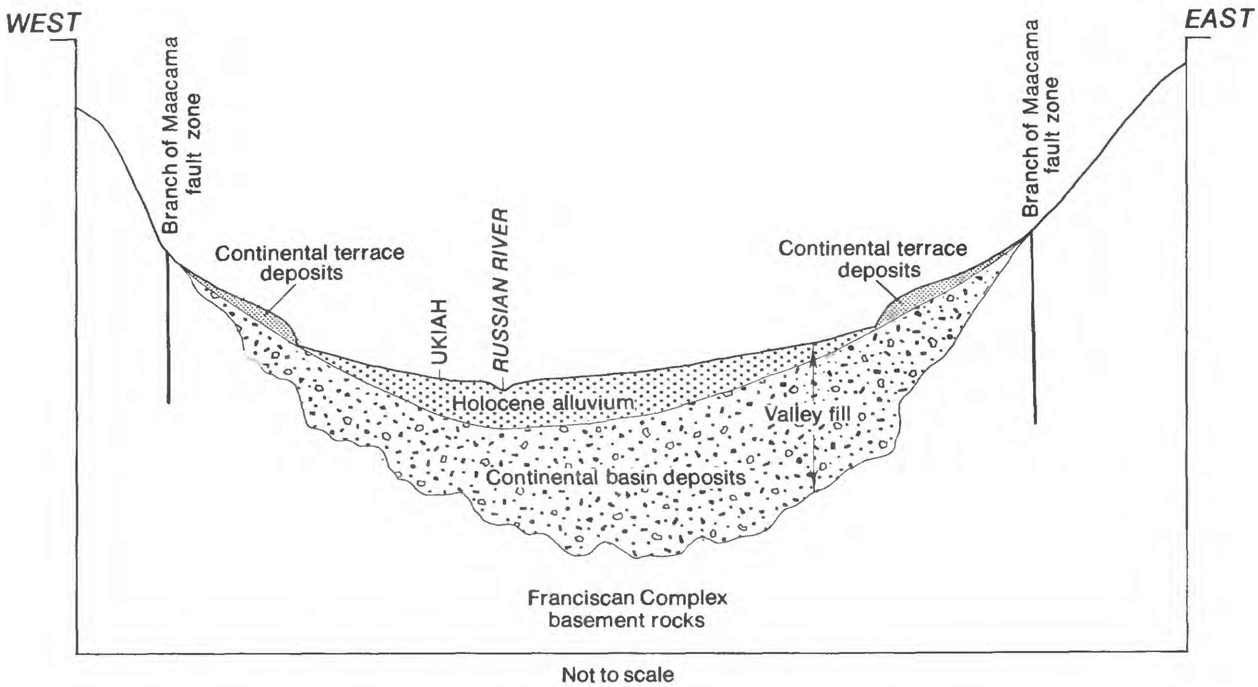


FIGURE 5. – Generalized geologic section of Ukiah Valley.

Continental terrace deposits.--The partially-to-loosely cemented beds of gravel, sand, silt, and clay underlying elevated terraces along the margins of Laytonville and Hopland-Ukiah Valleys compose the continental terrace deposits. Lithologically these deposits are similar to the underlying continental basin deposits (fig. 5); however, this unit generally contains less silt and clay. The terrace deposits are identified in part by their geomorphic expression--long, narrow, elevated, gently inclined surfaces formed by aggradation of eroded materials.

The continental terrace deposits comprise the materials deposited by streams draining the area during Pleistocene time. Downslope movement along the valley margins supplied Franciscan-derived sediment to streams that eroded and deposited material by processes similar to those active today along modern streams draining the valleys.

The fluvial origin resulted in lithologic heterogeneity of these deposits. Beds within the terrace deposits tend to be lens-shaped, laterally interfingering with neighboring beds. At depth, coarse- and fine-grained materials alternate as a result of changing hydraulic conditions at the time of deposition.

In this report the terrace deposits in parts of Ukiah Valley have been subdivided into older and younger terrace deposits, based on geomorphology. Where terraces of two distinct elevations are present, the higher terraces, generally nearest the valley margins, are considered to have formed earlier than the terraces at lower elevations.

The older terrace deposits tend to be more dissected than the younger terrace deposits and form a veneer of reddish-brown gravelly and sandy silt and clay generally less than 10 feet thick. The younger terrace deposits underlie less dissected terraces and have accumulated to thicknesses of several tens of feet.

Holocene alluvium.--The gravel, sand, silt, and clay deposited along stream channels and on flood plains during approximately the last 10,000 years compose the Holocene alluvium. The Holocene alluvium is present in all major valleys of the county and in many minor valleys along stream courses throughout the county. Appreciable thicknesses of alluvium, however, are found only in those areas with valley fill shown in figure 4. Because of its young age, the alluvium is generally uncemented and less weathered than the older valley-fill units.

In some areas along stream courses the alluvium is being reworked; deposition or erosion predominates depending on hydraulic and geologic conditions. Particle size of alluvium tends to be largest along the axis of a stream and becomes finer on the flood plain as distance from the stream axis increases. Because of the dynamic nature of stream channels, however, the alluvium in any location tends to be heterogeneous with depth due to the lateral shifting of main channels and flood plains.

In the major structural valleys the alluvium overlies either basement rocks or continental basin deposits. The alluvium is generally less than a few tens of feet thick but may exceed 100 feet in places. The material deposited is derived mostly from rocks of the Franciscan Complex, but both the continental terrace deposits and continental basin deposits contribute material as well.

Geologic Structures

Major geologic structures in Mendocino County have a predominant northwest to north-northwest trend. This trend is followed by topographic features and stream courses throughout much of coastal California from Santa Barbara northward and is related to geologic processes that affected the entire western continental margin of North America.

The courses of both the Eel and the Russian Rivers are controlled by the north-northwest trending structural grain. The main inland valleys (fig. 4) are also aligned along the north-northwest trending line. The long axis of Anderson Valley follows a northwest trend, approximately parallel with the San Andreas fault.

Within this regional setting of northwest to north-northwest structure, much of the area shows chaotic structure. Many road cuts around the county expose rocks that appear quite disrupted and with little lateral continuity. Often beds of rock are buckled and broken so they dip at various angles within one road cut.

The chaotic structure makes geologic mapping in the county extremely difficult. Generalized maps such as figure 4 can be produced emphasizing the regional geology. On the other hand, very detailed geologic maps can be produced for areas with good rock exposures, but the greatest part of the county is covered by soil and dense forest with poor rock exposures. Because of the chaotic structure, the areas lacking exposures can not be mapped with a high degree of detail or confidence.

Faults

Mendocino County occupies an area that has been subjected to a long history of compressional forces and related northwest-southeast translational movements. The translational movements have taken place along two major fault zones in the county (fig. 4). Numerous faults of lesser displacement or with more obscure surface manifestation exist throughout the county.

San Andreas fault.--The San Andreas fault is widely known due to the damaging earthquakes it has produced during historic time; its surface trace runs northwest across the extreme southwestern part of Mendocino County. The San Andreas fault is a major structural discontinuity along which the rocks on the southwest side have been displaced northwestward relative to rocks on the opposite side of the fault.

The San Andreas fault, shown as a single dashed line in figure 4, is actually a zone of en echelon faults. The individual fault-breaks trend parallel or subparallel to one another and respond to crustal stresses with similar displacement actions. Horizontal surface displacements of as much as 15 feet occurred near Point Arena in 1906 (Fox, 1983b). This segment of the fault is still considered active although there has been no measured displacement along it since 1906 (Brown and Wolfe, 1973).

Maacama fault.--The Maacama fault trends northwest through the central part of the county. Like the San Andreas, the Maacama fault is actually a zone of parallel or subparallel en echelon breaks with right-lateral displacement. As shown in figure 4, the Maacama fault can be seen to pass through or border the structural basins containing valley fill in the Ukiah, Willits, and Laytonville areas, and is related to their formation. The Maacama is an active fault zone--as attested by earthquakes centered near Willits during recent years (Simon and others, 1978).

Structural Basins

Ukiah, Little Lake, and Laytonville Valleys all are present along the trend of the Maacama fault zone. This relation is not merely coincidental; rather, the basins were created by oblique pull-apart extension between en echelon and minor branching faults of the Maacama fault zone (McLaughlin and Nilsen, 1982). The right-lateral strike-slip movement along parallel fault segments results in a wrenching apart and downdropping of the intervening crustal block. The grabens thus formed are bounded by faults on all sides. Sedimentation begins in-filling at the onset of basin formation and continues concurrent with the further down-dropping of the graben. In this way a considerable thickness of valley fill may be deposited without changing the base level of erosion.

Studies of regional tectonics (Blake and others, 1978) have demonstrated that the development of pull-apart basins in the Coast Ranges has propagated northward over time. This suggests that within Mendocino County the Ukiah Valley basin began forming first and was followed by Little Lake Valley and then Laytonville Valley. The basins began developing less than 4 million years ago and may have been undergoing subsidence until less than 0.5 million years ago.

GROUND-WATER CONDITIONS

Ukiah Valley

Description of Area

Ukiah Valley, the largest of the interior valleys, is located in the south-eastern part of the county. It occupies an area about 30 miles long and 4 to 6 miles wide along the course of the Russian River from near its headwaters to south of Hopland. The Hopland area, also known as Sanel Valley, lies at the southern end of Ukiah Valley. This area is separated from the main part of the valley by low hills, about 4 miles north of Hopland, through which the Russian River has cut a narrow gorge. Except for stream-gravel deposits this narrow gorge contains no valley fill. Hopland Valley is included as part of Ukiah Valley in this report because of the proximity of the valleys and because both areas contain similar geologic units.

Main population centers include the incorporated city of Ukiah in the central part of the valley and, from north to south, the smaller communities of Redwood Valley, Calpella, Talmage, Hopland, and Old Hopland. These communities are served by municipal and community water systems that obtain water from wells; surplus water from Lake Mendocino augments the water supply for Redwood Valley.

Residents living in rural parts of the valley obtain their water from private domestic wells. Irrigation water is obtained from wells and from direct pumping from the Russian River and its tributaries.

Lake Mendocino, 4 miles northeast of Ukiah, stores a maximum of 122,500 acre-ft. Eight thousand acre-ft of this water is currently appropriated for supply to the Flood Control and Water Conservation Improvement District. The Sonoma County Water Agency (SCWA) has established water rights for diversion of 37,544 acre-ft annually, part of which is contracted for use in Marin County. Recently the SCWA has petitioned the State of California to increase its appropriation to 75,000 acre-ft per year.

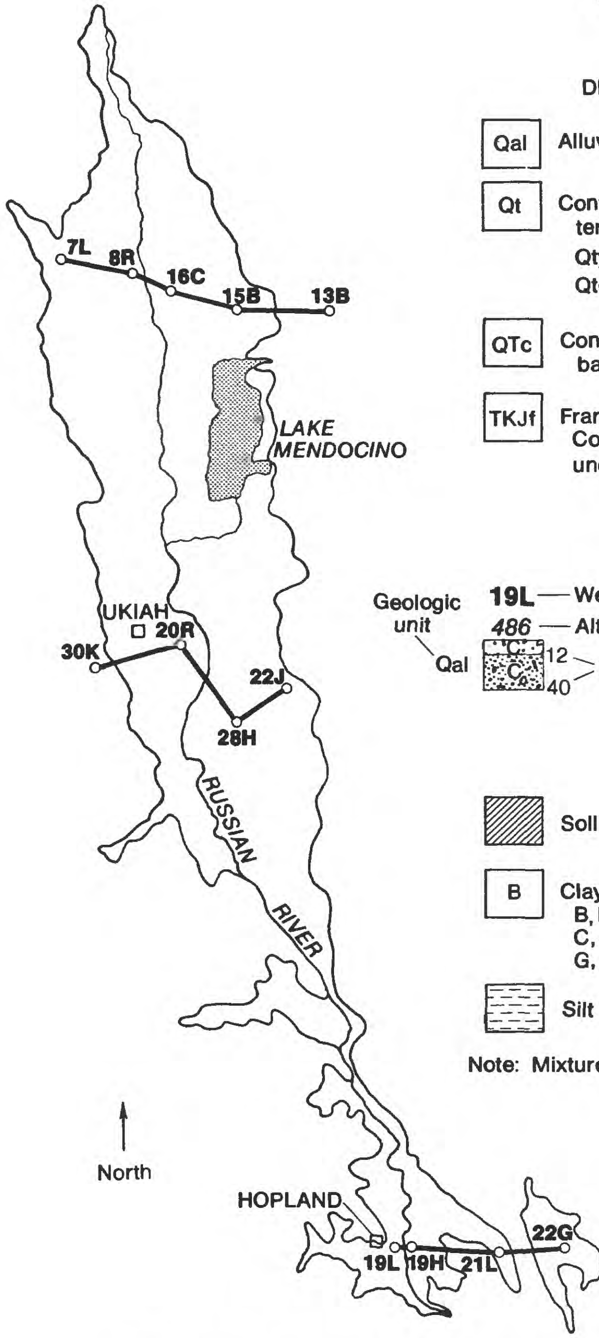
Water-Bearing Formations

Valley fill occupies about 70 mi^2 in Ukiah Valley. The fill has been subdivided into continental basin deposits, continental terrace deposits, and Holocene alluvium (pl. 1).

Continental basin deposits.--Continental basin deposits crop out over about 20 mi^2 of the valley floor. Surface exposures are widespread over the northern part of the valley and along the east side of the valley from Lake Mendocino to about 5 miles north of Hopland. About 2 mi^2 of exposures is present east of Hopland. These deposits also underlie younger valley-fill units and, where not exposed at the surface, probably are present at depth throughout most of the remaining area of valley fill (figs. 5 and 6).

Thickness ranges from 0 feet along the valley margins to an estimated maximum of 2,000 feet near the axis of the valley. The estimate of maximum thickness is based on stratigraphic analysis of outcrops. No wells have penetrated the full thickness of valley fill in the Ukiah area. The deepest well completed, 15N/12W-20R, penetrated about 500 feet of continental basin deposits.

These deposits consist of poorly sorted, heterogeneous mixtures of gravel, sand, silt, and clay. Drillers' logs show clay to be the most abundant constituent of this unit (fig. 6). The clay occurs both as beds, as much as several tens of feet thick, and as interstitial material between coarser grains of sand and gravel. The high clay content and poor sorting result in low permeability in this unit. The small average grain size and lack of cementing, however, provide high porosity. Because permeable materials are interbedded with impermeable clays, ground water occurs under confined conditions.



UKIAH-HOPLAND VALLEY – Outline of valley fill and locations of wells used for lithologic sections

EXPLANATION FOR FIGURE 6

DESCRIPTION OF GEOLOGIC UNITS

Qal	Alluvium	Holocene	Quaternary
Qt	Continental terrace deposits Qty-younger Qto-older	Pleistocene	Quaternary
QTc	Continental basin deposits	Pleistocene and Pliocene	Quaternary and Tertiary
		Unconformity	
TKJf	Franciscan Complex, undifferentiated		Tertiary, Cretaceous, and Jurassic

DESCRIPTION OF LITHOLOGY

Geologic unit — Qal
19L — Well number
486 — Altitude of land surface, in feet above sea level
12, 40 — Depth to corresponding changes in lithology, in feet below land surface

Lithologic units

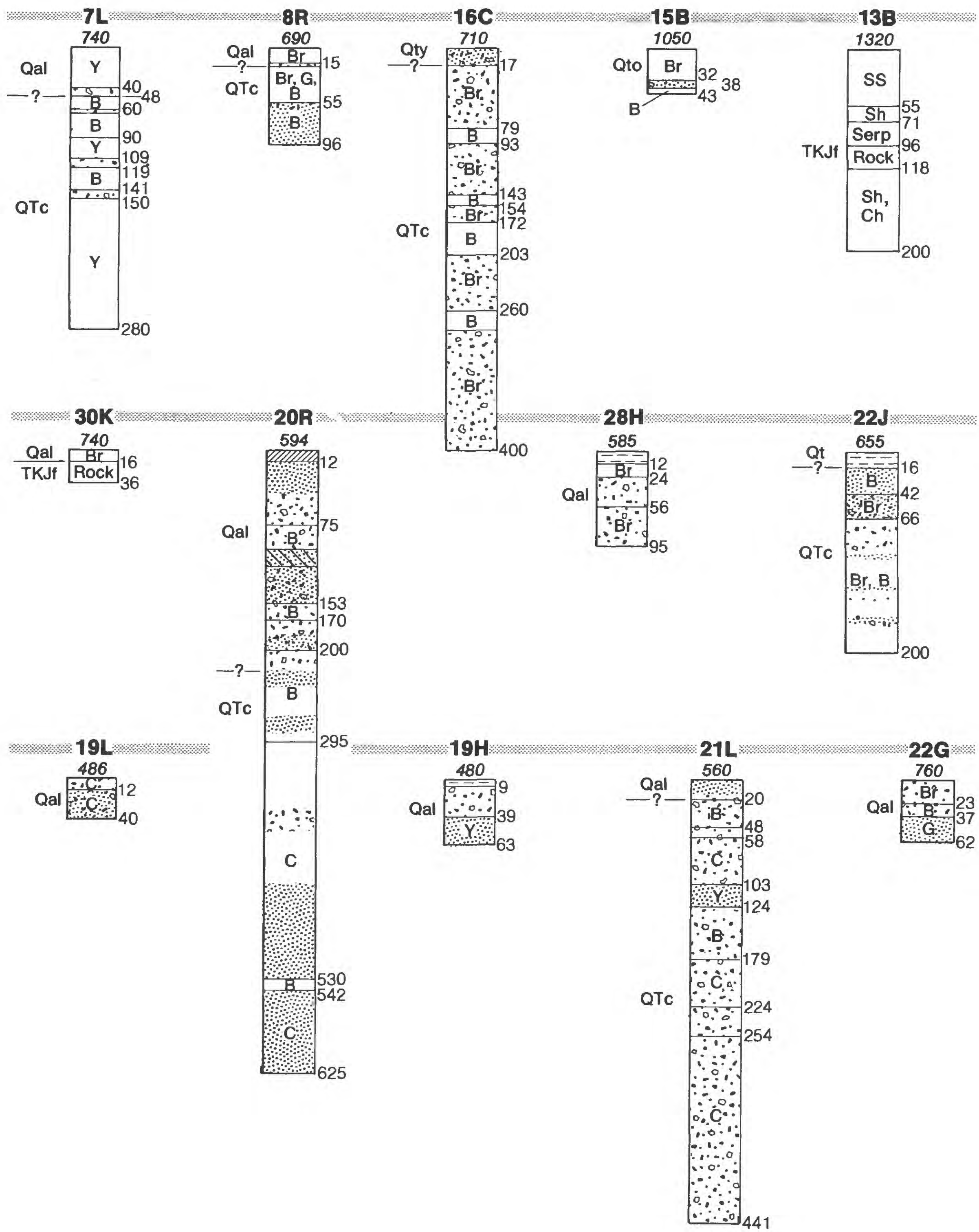
- Soil
- B — Clay; letter indicates color; B, blue; Br, brown; C, color not specified; G, grey; Y-yellow
- Silt
- Sand, crosshatching indicates cemented
- Gravel
- Rock — SS-sandstone, Sh-shale, Serp-serpentine, Ch-chert, Rock – unspecified

Note: Mixtures of these materials are shown as combinations of symbols

LINE OF SECTION

19L — WELL AND NUMBER

FIGURE 6 – Well-log profiles, Ukiah Valley.



7L
740
Qal
Y
40
48
60
B
90
Y
109
119
B
141
150
QTc
Y
280
8R
690
Qal
Br
15
QTc
Br, G, B
55
B
96
16C
710
Qty
17
Br
79
B
93
Br
143
B
154
Br
172
QTc
B
203
Br
260
B
Br
400
15B
1050
Qto
Br
32
38
43
B
13B
1320
SS
55
Sh
71
Serp
96
TKJf
Rock
118
Sh, Ch
200
30K
740
Qal
Br
16
TKJf
Rock
36
20R
594
12
Qal
75
B
153
B
170
200
QTc
B
295
C
530
B
542
C
625
28H
585
12
Br
24
Qal
56
Br
95
22J
655
Qt
16
B
42
Br
66
QTc
Br, B
200
19L
486
C
12
Qal
C
40
19H
480
9
Qal
39
Y
63
21L
560
Qal
20
B
48
58
C
103
Y
124
B
179
C
QTc
224
254
C
441
22G
760
Br
23
Qal
B
37
G
62

Wells completed in the continental deposits produce water slowly because of the fine-grained material and consequent low permeability. Information available for 30 wells tapping continental deposits shows a range in yield of 0.75 to 50 gal/min. Specific capacities range from 0.004 to 1.33 (gal/min)/ft. Dry holes are commonly encountered. The following tabulation for 30 wells shows no clear relation between well depth and yield:

Well depth, in feet	Number wells	Yield (gal/min)	Specific capacity (gal/min)/ft
0-100----------------	7	0.75-50	0.027-1.25
101-200----------------	14	2.5 -40	.044-1.33
201-300----------------	5	1 -20	.004-0.14
Greater than 300-------	4	1.25-20	.10 -0.44

These data are taken from short-term pumping tests, generally 2 hours or less, and the yields listed may overestimate the long-term yield available.

The quantity of water supplied to wells depends in part upon the total thickness of coarse materials penetrated. While deep wells do have a better chance of encountering a greater thickness of coarse material, some reduction in permeability probably occurs with depth due to compaction and cementation. Drilling deeper at any particular location does not guarantee obtaining a significantly greater yield. Instead of drilling deeper than 200 feet to increase well yield, often it may be more economical to choose a new site for drilling where permeable beds occur at more shallow depths.

In summary, this unit is large in areal extent, is generally thick, is high in porosity, and stores a large quantity of water--but because it is low in permeability, it yields water slowly to wells.

Continental terrace deposits.--Continental terrace deposits occupy about 20 mi^2 of valley floor. Surface exposures are observed in the northern part of the valley, along the west side in the vicinity of Ukiah, and along the east side near Talmage. A few small exposures occur around Morrison Creek and to the south. The terrace deposits are subdivided into older and younger based on their topographic expression and degree of dissection.

The older terrace deposits are exposed mostly in the northern part of the area around Redwood Valley. The older terrace deposits range from zero at the valley margins to a maximum thickness of 25 feet. Generally, this unit is present only as a few feet of reddish-brown gravelly-to-sandy soil. Because it is thin, the unit is generally unsaturated during summer and autumn and therefore cannot be considered an important source of water.

The younger terrace deposits crop out discontinuously along both sides of the valley from Redwood Valley to near Morrison Creek. Less affected by erosion, the younger terraces are thicker than the older terraces, and their original topographic form is better preserved. The younger terraces consist of gravel and sand, with silt and clay filling the intergranular spaces. This unit is of low-to-moderate permeability. The maximum thickness is difficult to estimate because it is generally not possible to distinguish this unit from the underlying continental basin deposits on drillers' logs. However, maximum thickness may reach 100 feet or more. In general, these deposits are partially saturated during all or part of the year.

The younger terrace deposits are not considered a major ground-water source because they are relatively thin and have low permeability. Wells completed in younger terrace deposits may provide enough water for low-capacity domestic or stock-watering wells. Many wells on terraces are drilled deep enough to obtain part of their water from the underlying continental basin deposits.

Wells completed in terrace deposits generally yield from 1 to 10 gal/min; yields as high as 100 gal/min have been reported. These values are based on short-term pump tests that may overestimate the long-term yield. Seasonal fluctuations in the water table can drastically affect the rate at which water can be withdrawn from shallow wells. Specific capacities calculated for 25 wells tapping the terraces range from 0.02 to 7.1 (gal/min)/ft. Of these wells, 17 had specific capacities of less than 1.0 (gal/min)/ft, and only 4 had specific capacities greater than 2.0 (gal/min)/ft.

Holocene alluvium.--Alluvial deposits of Holocene age cover about 30 mi^2 of the valley floor. The alluvium is distributed as narrow bands along tributary streams and along the Russian River north of The Forks. The alluvium occupies broad areas of the flood plain, as much as 2 miles wide, in the Ukiah-Talmage and Hopland areas.

The alluvium of uncemented gravel, sand, silt, and clay varies in thickness from place to place. The thickest sections occur along the course of the Russian River. Exact thicknesses are difficult to ascertain because the underlying basin deposits cannot be distinguished from the alluvium based on the descriptions given on many well logs. Although the maximum thickness is probably about 200 feet, the thickness is generally less than 100 feet.

Porosity and permeability are high because the alluvium generally consists of uncemented coarse-grained material. The low topographic position of this unit generally insures that it is partially saturated throughout the year. Where thin, as near valley margins or along tributary streams, the alluvium may not contain water during dry months.

The alluvium is the most productive aquifer in Ukiah Valley and can provide sufficient water for sustained pumpage from municipal and irrigation wells. Properly constructed wells in favorable locations could yield 1,000 gal/min or more. Areas of known high-production capacities exist east of the Russian River and south of Talmage near Howell Creek, where wells yielding more than 1,000 gal/min have been completed. A second area of high-capacity wells is near the northern end of Sanel Valley, west of the Russian River and east of U.S. Highway 101; well yields in this area have exceeded 1,000 gal/min. A third area is south of Hopland and east of U.S. Highway 101, where yields range from 100 to about 1,000 gal/min.

Ground water in the alluvium occurs under unconfined conditions. Because the Russian River and tributary streams generally occupy channels cut into alluvial deposits, surface water and ground water are in connection. Wells drilled near the banks of streams derive a part of their production from surface water that is induced to flow through permeable alluvial deposits as the ground-water level is lowered by pumping.

The permeable nature of the alluvium allows infiltration of considerable precipitation. This captured precipitation recharges the alluvial aquifer and underlying units. During most river stages, water moves from the alluvium into the Russian River. During periods of high river stage, water moves from the river into the alluvial aquifer and is held temporarily as bank storage. The bank storage is depleted as the river declines to normal flow stages.

Ground-Water Availability

The availability of ground water in any given area of Ukiah Valley is classified into one of four categories (pl. 2).

The Type I area, the most favorable area for ground-water development, is underlain by alluvial deposits that provide year-round supplies of water for domestic use; in many parts of the Type I area, properly constructed wells may obtain as much as 100 to 1,000 gal/min. The Type I area is generally narrow, except in the central part of the valley where the width broadens to 2 miles and near Hopland where it is about 1.5 miles wide.

The Type II areas, distributed along the margins of the valley, are generally underlain by terrace deposits or thin alluvium. In these areas, the quantity yielded to wells may be less than 10 gal/min. Wells in Type II areas generally provide only enough water for domestic use or limited irrigation.

Type III areas, underlain by thin terrace deposits and continental basin deposits, cover much of the northern part of the valley and smaller areas along the eastern side of the valley. Wells drilled in these areas generally provide only a few gallons per minute, and some sites may be dry.

Type IV areas include all the mountainous terrain around the valley floor and are underlain mostly by rocks of the Franciscan Complex. Ground-water conditions in the mountainous areas are described in more detail later in this report. In general, the prospect for obtaining ground water in these areas is very poor. Before attempting to drill for water in Type IV areas, site-specific studies to determine the most favorable drilling locations would be warranted. Sufficient supplies of water for domestic use are available locally along fractures, but these favorable sites are widely spaced.

Estimated Storage Capacity

The quantity of available ground water stored in the upper 100 feet of the most productive area of valley fill (Type I) is estimated to be about 90,000 acre-ft. This estimate was computed by determining the volume of saturated fill within 100 feet of the surface and multiplying the result by the estimated specific yield. The volume of saturated Type I fill is derived from the known area of 20 mi^2 (12,800 acres) and an assumed saturated thickness of about 85 feet (water levels average about 15 feet below land surface in spring). The computed volume of 1,088,000 acre-ft is probably within 10 percent of the actual volume. The quantity of water that can be withdrawn from this volume of aquifer depends on the specific yield of the aquifer materials. The specific yield was estimated from lithologic descriptions in drillers' reports and observations at outcrops. The average specific yield used in the storage-capacity computation was 8 percent. This estimated specific yield may be in error by about 25 percent, giving a possible range of 6 to 10 percent. When the possible errors in estimating the saturated volume and specific yield are considered, the storage capacity ranges from 60,000 to 120,000 acre-ft.

Additional ground water is stored in aquifer materials underlying the areas designated as Type II on the ground-water availability map. The estimated storage capacity in the upper 100 feet of Type II aquifer materials is 45,000 acre-ft, assuming an average specific yield of 5 percent.

No estimates were made of the storage capacity for areas designated as Type III or Type IV on the availability maps because these areas have marginal capacities to yield water to wells.

The above estimates of storage capacity give the maximum quantity of water that could be removed from the aquifers by pumping. The consequences of totally depleting ground water in storage are not covered in detail in this report because they involve not only geohydrology but economic and social issues as well. The geohydrologic consequences of removing all or a large part of ground water in storage include possible land subsidence, degradation of water quality, permanent loss of part of the storage capacity through compaction, and diminished baseflow to streams.

Water-Level Fluctuations

Water-level fluctuations in wells in Ukiah Valley can be classified as either seasonal or long term; the rapid short-term changes in levels caused by pumping cycles are not considered because of their transient nature. Seasonal water-level fluctuations are most closely related to precipitation patterns; long-term fluctuations are related to consumptive use.

Water-level records for periods greater than 10 years are available for eight wells in Ukiah Valley. Hydrographs for these wells (fig. 7) show seasonal fluctuations and long-term trends. Generally, both a high and a low water level for each year of record are available for each well. It should be noted that, depending on the timing of the measurement, the true high or low water level may be missed. Monthly water-level measurements made by the California Department of Water Resources at a number of wells during the 1960's show that during most years water levels are highest in March or early April and lowest in October.

Average seasonal water-level fluctuations range between 5 and 15 feet. Variations in seasonal water-level fluctuations can be seen in the hydrographs for years of precipitation extremes. During the drought years of 1976 and 1977, precipitation at Ukiah was 54 and 44 percent of normal, respectively. All hydrographs spanning the 2 drought years show that water levels were below normal. Variations from normal are not evident during years of above-average precipitation. This is apparently due to rejection of excess precipitation. Aquifers are recharged to their maximum during years of normal (mean annual precipitation is 36 inches) or slightly below-normal rainfall. Rainfall significantly greater than normal cannot be retained in the aquifer, and the excess is lost quickly through interflow to streams. The hydrographs show a conspicuous spike in the water-level high for 1975 even though precipitation was only 7 percent above normal. The reason for this apparent anomaly is that the high water levels were measured in late March, and rainfall during March that year was 266 percent of normal.

None of the hydrographs show any prominent long-term declines. Water levels measured during the 1980's are remarkably similar to those measured during the 1960's and 1970's; records for the 1950's are not sufficiently complete to make good comparisons. Even though water levels were significantly depressed during the 1976-77 drought, they recovered to normal by the end of the 1978 rainfall season.

Analysis of the hydrographs indicates that the ground-water reservoir is recharged fully each year except when precipitation falls below about 60 percent of normal. After 2 years of drought, the reservoir can be fully recharged by 1 year of normal or above-normal precipitation.

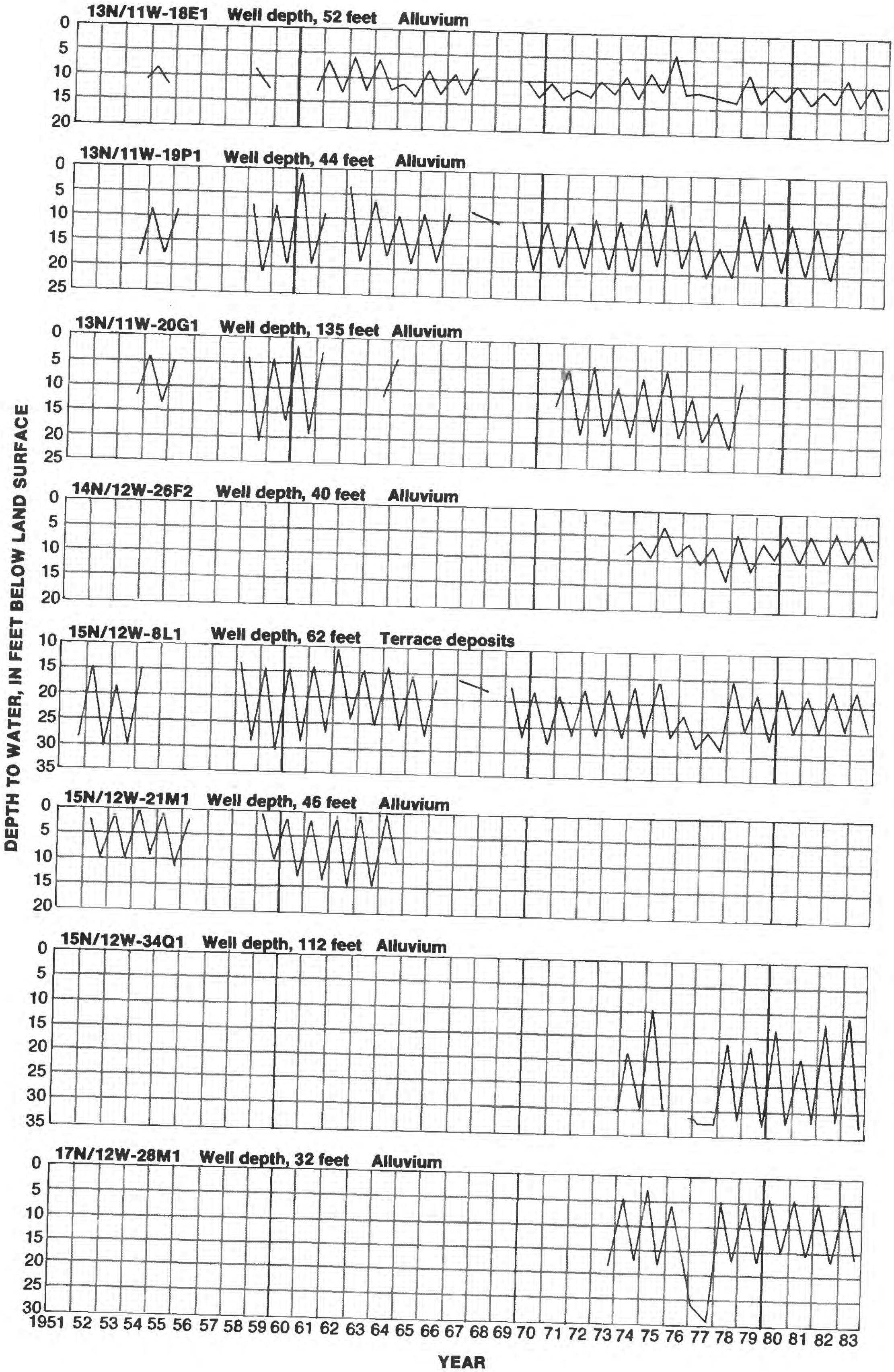


FIGURE 7. – Hydrographs for wells in Ukiah Valley. (Locations shown on plate 3)

Ground-Water Movement

The water-level contour map (pl. 3) shows the approximate altitude of the water table in the valley fill and the approximate directions of ground-water flow. Although the water-level measurements were made in wells of differing depths, the water-level contours closely approximate the altitude of the water table. The water-level measurements used to prepare the contour map were made during the period September to November 1982, at a time when the water table was at its lowest level for the year. Contours are not shown in some parts of the valley because insufficient data were available.

At any location, ground water moves downgradient approximately perpendicular to the contours. Ground water generally moves from the valley sides toward the Russian River and generally moves from north to south. The spacing of the contours is quite variable. Where closely spaced, the contours indicate steep ground-water gradients. Areas of steep gradients may be underlain by materials of low transmissivity. The geologic map (pl. 1) shows that these areas are underlain by valley-fill units of low permeability, lending support to this view. Likewise, areas where the gradient is flatter coincide with areas underlain by the most permeable units of valley fill.

Analysis of river stage and water levels in wells close to the river shows that in some reaches ground water discharges to the river; in other reaches river water infiltrates the aquifer. This analysis assumes that the river-channel material is permeable and that good hydraulic connection exists between river and aquifer. This assumption is probably valid for most of the central part of Ukiah Valley. Seasonal changes in river stage and ground-water levels cause changing patterns of water exchange between the river and aquifer. During the autumn when the water table is usually lowest, river water infiltrates to the aquifer along the reach between the 600-foot and 520-foot ground-water contours shown on plate 3. During the spring when the water table is highest, river water infiltrates to the aquifer along the reach between a point midway between the 580- and 560-foot contours and the 540-foot contour shown on plate 3.

The movement of river water into the alluvial aquifer is also caused by pumping water from wells located within a few hundred feet of the river. This happens when a drawdown cone is produced by pumping, causing a local reversal of the ground-water gradient and allowing river water to be pulled through the alluvial gravels toward the well. In this case the exchange of ground water and river water will depend on the pumping cycle of the well.

Recharge and Discharge

The quantity of ground water in storage in Ukiah Valley varies over time in response to variations in recharge and discharge. Likewise, the quantity of recharge to or discharge from the ground-water reservoir varies over time in response to variations in the quantity of water stored in the reservoir. When a ground-water reservoir is filled to capacity, further potential recharge is rejected. At times when the reservoir is at less than capacity, the quantity of discharge is reduced.

Recharge sources in Ukiah Valley include precipitation, surface-water infiltration, return flows from sewage and irrigation, and possibly ground-water inflow from outside the basin. The main source of recharge is precipitation as rainfall. Recharge to aquifers by direct infiltration occurs when rain falls over permeable aquifer materials. Indirect recharge occurs when rain falls over relatively impermeable materials either exposed at the surface or lying at shallow depth. The rejected rain moves laterally over the relatively impermeable material to contacts with permeable materials. These contacts between the permeable units (Holocene alluvium and, to a lesser extent, continental terrace deposits) and relatively impermeable units (rocks of the Franciscan Complex and continental basin deposits) constitute important recharge zones. If extensive portions of recharge areas are covered over by paving or buildings, surface runoff will increase, and recharge to aquifers will be diminished.

Surface-water infiltration occurs along the Russian River and tributary channels and from leakage from surface impoundments. Removal of sand and gravel along stream channels may locally impact recharge to aquifers by making the streambeds and channel walls less permeable to infiltration. Recharge from the Russian River along some reaches is demonstrated by water levels in wells near the river that are lower than river stage.

Return flows from sewage-disposal systems and from irrigated lands are minor sources of recharge in Ukiah Valley. In sewered areas, municipal systems dispose secondary-treated sewage by discharge to the Russian River, during high river stage, when dilution ratios equal or exceed 100:1. During low river stage the sewage is evaporated or applied to land areas by sprinklers. In either case, very little of the treated municipal sewage recharges the ground-water reservoir. In rural areas leakage from septic systems provides some water for recharge.

Ground water moving up along faults in the Franciscan rocks and recharging the reservoir may be a recharge source from outside the basin. The quantity of recharge from this source, however, is probably very minor compared to that from precipitation and surface-water infiltration.

Sources of ground-water discharge in Ukiah Valley include seepage to the Russian River, evapotranspiration, and pumpage from wells. Ground-water discharge to the Russian River is not significant during times of low ground-water levels. Discharge measurements during October 1981 at several points along the Russian River between Coyote Dam and Pieta Creek show no variation greater than the potential error in measurement. During periods of high ground-water levels, water is discharged from the ground-water reservoir to the Russian River and tributaries; the amount of this discharge is not known but is probably considerable.

Evapotranspiration includes all water transpired by plants (both crops and native vegetation) and that water lost by evaporation. Based on data for vegetative water use (California Department of Water Resources, 1975) and land-use classification (California Department of Water Resources, 1980), an estimated 30,000 acre-ft per year of water is consumed by crops, by grasses in pastureland, and by evaporation from lakes and reservoirs in Ukiah Valley. Part of this water is pumped directly from the Russian River and from small catchment reservoirs and, therefore, does not directly affect ground-water supplies. Another portion of the 30,000 acre-ft is pumped from wells that tap alluvium close to the Russian River; part of this well water is captured from the river. Another unknown portion of the 30,000 acre-ft is pumped directly from the ground-water reservoir.

Little is known about the water requirements of native vegetation. Within the Russian River drainage basin, of which Ukiah Valley is a part, about 90 percent of the land area is occupied by native vegetation. Although the consumptive use of water by native vegetation is considerably less than for irrigated crops, the large area of coverage indicates that native vegetation consumes a significant part of the rainfall that provides recharge to the ground-water reservoir in Ukiah Valley.

The California Department of Water Resources (1977) projected urban water use for 1980 to be about 11,000 acre-ft. This quantity includes water used by industry and water for domestic and municipal use. Most of this water is pumped from wells; a small portion is pumped directly from surface-water sources.

Available Supply

The estimates for ground-water storage, water use, and potential recharge indicate that sufficient ground water is available to meet present rates of consumption. Ground-water storage is estimated at 90,000 acre-ft, which is more than twice the estimated 41,000 acre-ft (part of which is surface water) consumed annually by evapotranspiration and urban water uses. During years when precipitation at Ukiah equals or exceeds about 60 percent of the average, the ground-water reservoir is filled to capacity. Thus extraction of ground water could be increased by an indeterminant amount without depleting the reservoir over the long term.

Chemical Quality of Water

The quality of water can be defined in terms of chemical, physical, and biological properties. Ground water, because it moves slowly through earth materials, undergoes a natural filtration process. As ground water passes through porous media, the solid particles in suspension tend to be removed; however, additional constituents may be taken into solution as water reacts with rock. Isolated from the atmosphere and sunlight, organisms generally do not survive long in a ground-water environment. Because suspended matter and organisms tend to be excluded from ground water, ground-water quality is most commonly described in terms of dissolved chemical constituents. In the dissolved state, chemical constituents are present as electrically charged particles or ions. In this report water quality is described in terms of the concentrations of various ions detected in water samples.

General chemical quality.--For this study, 26 water samples were collected from 22 wells in Ukiah Valley. The samples were analyzed at the U.S. Geological Survey's Denver Central Laboratory in Arvada, Colorado. The areal variation within Ukiah Valley in terms of the relative abundance and actual concentrations of dissolved constituents is shown on plate 2. In terms of major constituents, the ground water could be classified generally as calcium bicarbonate or calcium magnesium bicarbonate. Some samples, however, show a predominance of sodium over calcium and magnesium. The range in concentrations of major and minor constituents is shown in table 3.

The quality of ground water is generally good, and the water is suitable for most uses. A comparison of the analyses with drinking-water standards (U.S. Environmental Protection Agency, 1975; 1977) indicates that the water generally meets the standards. Analysis of only one sample exceeded the standard for nitrate concentration; the sample was collected from an irrigation well, 13N/11W-30A, south of Hopland. The high nitrate value may be related to the application of nitrate as fertilizer. Analyses of several samples exceed the standards set for iron and manganese. These standards are based on cosmetic and taste considerations. Both iron and manganese in sufficiently high concentrations can cause staining of plumbing fixtures and laundry and can give an unpleasant metallic taste to water. The iron and manganese are derived from solution of minerals in the rocks containing the ground water. The generally slightly acidic water (pH 6 to 7) increases the solubility of iron and manganese and accounts for the generally high concentrations of these two elements. As water is pumped from a well, changes in pH and dissolved-oxygen concentration can decrease the solubility of iron and manganese. The iron and manganese then begin to precipitate as hydrated mineral encrustations. Encrustation of pump parts, pipes, and well-casing perforations may be a problem in areas where iron and manganese are present in high concentrations.

Variations in chemical quality.--The composition of dissolved constituents in ground water is dependent on the history of the water prior to sampling. Geologic, hydrologic, and anthropogenic factors may influence the final composition.

Table 3.-- Chemical quality of ground water in Ukiah Valley

[EPA standard: National Interim Primary Drinking Water Regulation, U.S. Environmental Protection Agency, 1975; and National Secondary Drinking Water Regulations, U.S. Environmental Protection Agency, 1977]

	Number of analyses	Maximum	Minimum	Mean	EPA standard
Major constituents, in milligrams per liter					
Alkalinity as $CaCO_3$------------	20	330	68	147	--
Calcium------------------------	20	50	7.3	28.2	--
Chloride-----------------------	20	31	3.4	10.4	250
Fluoride-----------------------	20	.3	<.1	<.16	1.6
Magnesium----------------------	20	42	8.0	18.6	--
Nitrogen NO_2+NO_3 as N----------	20	11	.09	2.1	10
Potassium----------------------	20	1.6	.3	.88	--
Silica-------------------------	20	36	1.4	19.4	--
Sodium-------------------------	20	92	6.6	19.1	--
Sulfate------------------------	20	38	5.0	18.1	250
Sum of dissolved constituents--	20	392	89.0	216	--
Minor constituents, in micrograms per liter					
Aluminum-----------------------	9	<100	<100	<100	--
Arsenic------------------------	9	<1	<1	<1	50
Barium-------------------------	9	230	52	112	1,000
Boron--------------------------	26	8,700	20	1,012	--
Cadmium------------------------	9	<3.0	<1.0	<2.3	10
Chromium-----------------------	9	<10	<10	<10	50
Copper-------------------------	9	<30	<10	<23	1,000
Iron---------------------------	20	8,100	9	820	300
Lead---------------------------	9	<100	<1	<89	50
Manganese----------------------	20	1,300	<1	<186	50
Mercury------------------------	9	<.1	<.1	<.1	2
Nickel-------------------------	9	<100	<100	<100	--
Zinc---------------------------	9	70	<12	23.2	5,000

Geologic factors that influence the quality of water include geologic structures and variations in lithology. In the Ukiah Valley area, rocks rich in magnesium (such as serpentine) may be the source of the high magnesium concentrations in some samples.

Waters high in sodium and boron are found at some sites near faults. The source of the sodium and boron may be ground water rising from great depths along fault zones (Barnes, 1970). Carbon dioxide has been detected in some wells and was produced from wells in the past for a dry ice plant located 2 miles north of Hopland (Hubbard, 1943). The carbon dioxide, probably derived from metamorphism of carbonate sediments, moves up from depth along fault zones (Barnes, 1970).

Boron.--For 26 samples, boron ranged from 20 to 8,700 µg/L. Boron is an essential element for plant nutrition; however, the difference between required amounts and toxic amounts is very small. The sensitivity of crops to boron varies considerably, but generally concentrations less that 1,000 µg/L can be applied to crops without adverse effects. Because boron concentrations are known to exceed 5,000 µg/L in some locations and concentrations considerably less than this are toxic to some crops, chemical analysis for boron in irrigation water is advisable. Boron toxicity for most animals has not been established; however, toxic accumulations are unlikely because boron is rapidly eliminated by animals in urine (Gough and others, 1979).

Potential for contamination.--Ground water in Ukiah Valley is found at shallow depth. Therefore, it is subject to rapid recharge during the rainy season. Precipitation, applied water, or other liquids can rapidly percolate to the water table because of the shallow depth to the zone of saturation. This means spilled or discarded liquids or substances soluble in water may be carried into the ground-water reservoir within a period of days. The thinness of the unsaturated zone between land surface and the water table reduces the ability of this zone to inhibit movement of contaminants by the processes of adsorption, absorption, dispersion, and evaporation. The possibility of rapid traveltime from surface to reservoir also reduces the amount of time available to contain contaminants or to remove contaminated earth materials.

Minor incidents of ground-water contamination have occurred in Ukiah (J. Davis, Director of Environmental Health, written commun., 1985). These incidents have mostly involved gasoline leaks from buried storage tanks. However, in 1982 discharge of formaldehyde from an idle railroad tank car illegally released by vandals contaminated shallow wells in a small area near the southern end of the city. The formaldehyde also entered the Russian River, causing a temporary shutdown of some drinking-water supply wells in downstream communities. If this discharge had occurred farther from the river or in an area with poor surface drainage, a larger part of Ukiah's principal aquifer could have been affected.

The most sensitive areas to potential ground-water contamination are those underlain by permeable materials, such as sands and gravels in the Type I and II ground-water availability areas; areas with poor surface drainage; areas of excavation (for example, construction sites and gravel pits); areas where septic tanks provide sewage disposal; agricultural areas where the application of chemical fertilizers and pesticides may exceed the capacity of the soil and biota to inhibit and break down the chemicals; and areas close to pit wells, abandoned wells, or wells with no surface seals.

During the course of this study numerous well houses were found to serve also as storage sheds for fertilizers, pesticides, gasoline, oil, and other potential contaminants. This practice has the potential for causing localized ground-water contamination.

APPENDIX 4

UVAP Study Groundwater Supplies

SECTION 4. GROUNDWATER SUPPLIES

4.1 Ukiah Valley Groundwater Basin

The 56 square-mile Ukiah Valley groundwater basin, designated as groundwater basin 1-51 by the Department of Water Resources (DWR, 2004), is located in southeastern Mendocino County and encompasses the Ukiah and adjacent Redwood valleys (Figure 4-1). Although there are anecdotal reports of localized overdrafting, the basin as a whole is reportedly not experiencing overdraft conditions (DWR, 2004). As discussed elsewhere, the most significant issue regarding the Ukiah Valley groundwater basin is not the potential for overdrafting, but whether or not all or at least most of the "groundwater" in the basin is, for legal purposes, underflow from the Russian River and associated tributaries. This section summarizes the principal hydrogeologic features of the Ukiah Valley groundwater basin, groundwater elevation and historical pumping trends, and concludes with a discussion of the basin's potential to provide a potable water supply.

4.1.1 Hydrogeology

The Ukiah Valley groundwater basin lies within the Coast Range geomorphic province. The geology of the Ukiah and adjacent Redwood valleys is composed of four principal geologic units; the Cretaceous-aged Franciscan Formation, the Pliocene and Pleistocene Continental basin deposits, Pleistocene Terrace deposits, and Quaternary Recent Alluvium (Figure 4-1 through Figure 4-4).

<u>Franciscan Formation (Kjf)</u>

The Franciscan Formation, the oldest of the Ukiah Valley's four geologic units, underlies the entire Ukiah Valley groundwater basin and comprises the ridges that surround the valley (DWR, 2004). In general, the Franciscan Formation, which consists of consolidated marine rocks, sandstone, siltstone, shale, chert, serpentine, greenstone, and schist is not considered to be a particularly reliable or economically significant source of groundwater.

<u>Continental Basin Deposits (Qp)</u>

The Continental basin deposits overlie the Franciscan Formation in the Ukiah and Redwood valleys and consist primarily of poorly sorted, heterogeneous mixtures of gravel, sand, silt, and the predominate material – clay. The thickness of the Continental basin deposits ranges from essentially zero along the margins of the two valleys to as much as 2,000 feet in the Ukiah Valley floor. Clay occurs both as beds, as much as several tens of feet thick, and as interstitial material between sand and gravel. The high clay content and poor sorting result in low permeability. However, porosity is high due to the lack of cementing. Because permeable materials are interbedded with impermeable clays, groundwater occurs under confined conditions.

Wells completed in the continental deposits typically produce water slowly – 0.75 to 50 gallons per minute. Dry holes are not uncommon. In summary, due to their thickness, areal extent and porosity, the Continental basin deposits store substantial quantities of water, but due to low permeability yields water slowly to wells (USGS 1965; USGS, 1968).

Terrace Deposits (Qt)

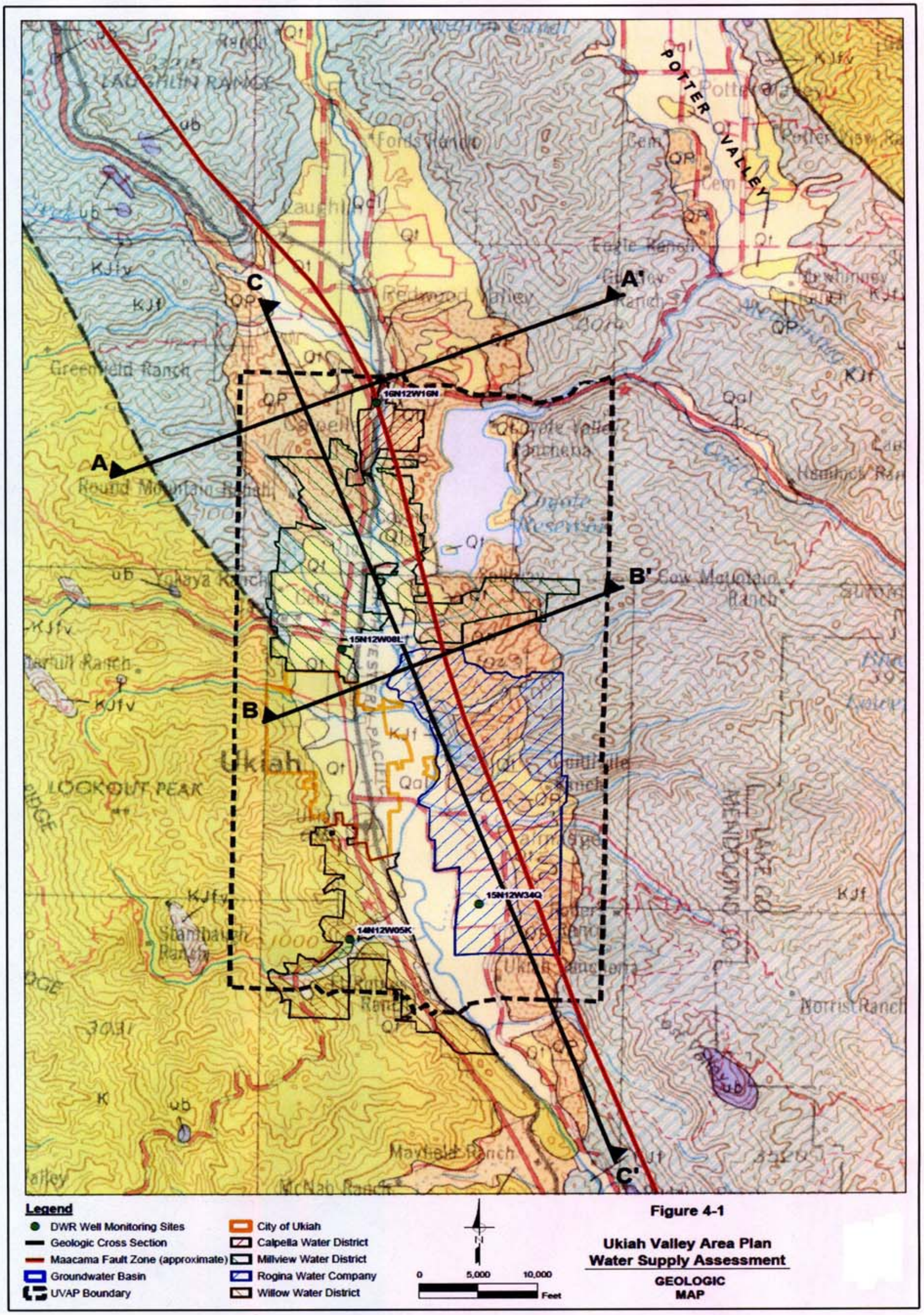
The Pleistocene-aged Terrace deposits overlie the Continental basin deposits and occur discontinuously along the edges of the Ukiah Valley, on both sides of the Russian River, and more continuously throughout Redwood Valley (DWR, 2004). The thickness of the Terrace deposits range from essentially zero along the margins of the two valleys to over 100 feet thick in portions of the Ukiah Valley (USGS, 1968). The Terrace deposits are generally unconsolidated and lithologically similar to the Continental basin deposits, but contain less silt and clay. Consequently, the permeability of the Terrace deposits is somewhat higher than the corresponding Continental basin deposits. Groundwater occurs under confined as well as unconfined conditions, depending on site specific lithology. Wells completed in terrace deposits generally yield one to 10 gallons per minute, however, yields as high as 100 gallons per minute have been reported (USGS, 1968). In general, the Terrace deposits are not considered to be a major source of groundwater because they are relatively thin and exhibit comparatively low permeabilities.

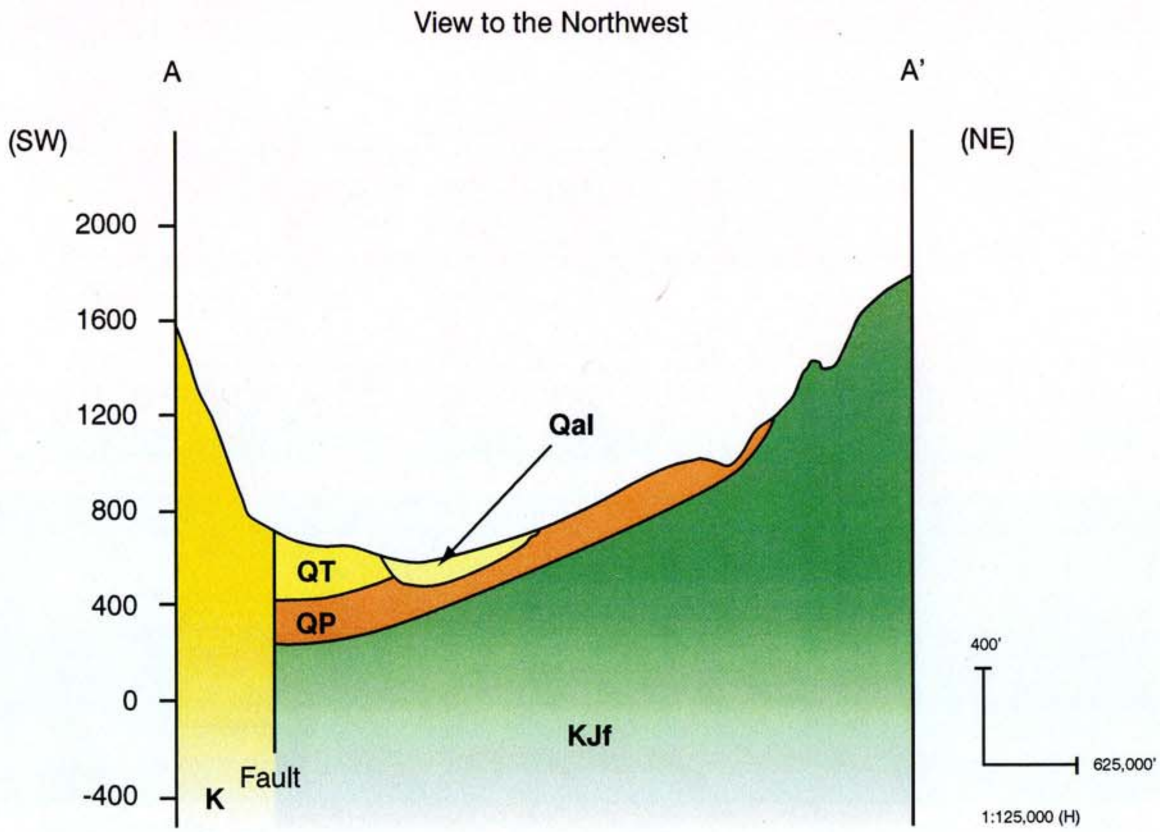
Recent Alluvium (Qal)

Recent Alluvium deposits typically occur as narrow bands along tributary streams and the West Fork of the Russian River in Redwood Valley, and throughout the comparatively wide floodplain of the Russian River, in the Ukiah Valley. In general, the Recent Alluvium deposits range in thickness from 10 to over 100 feet and consist of unconsolidated gravels, sands, silts, and to a lesser extent clay (DWR, 2004). The porosity and permeability of the Recent Alluvium deposits is typically high, groundwater occurs under unconfined conditions. Wells completed in the Recent Alluvium deposits, particularly east of the Russian River and south of Talmage, reportedly yield as much as 1,200 gallons per minute (DWR, 2004).

The high porosity and permeability of the Recent Alluvium allows for considerable recharge by precipitation (USGS, 1965; USGS, 1968). Due to the close proximity to the Russian River, water readily moves between the Recent Alluvium deposits and active river channel. The Recent Alluvium deposits constitute the most productive aquifer in the Ukiah Valley and can provide sufficient water for sustained pumpage from municipal and irrigation wells. However, as discussed in section 4.1.2, institutional constraints related to the differentiation of percolating groundwater versus underflow may seriously limit the future availability of this supply.

Figure 4- 1. Geologic Map



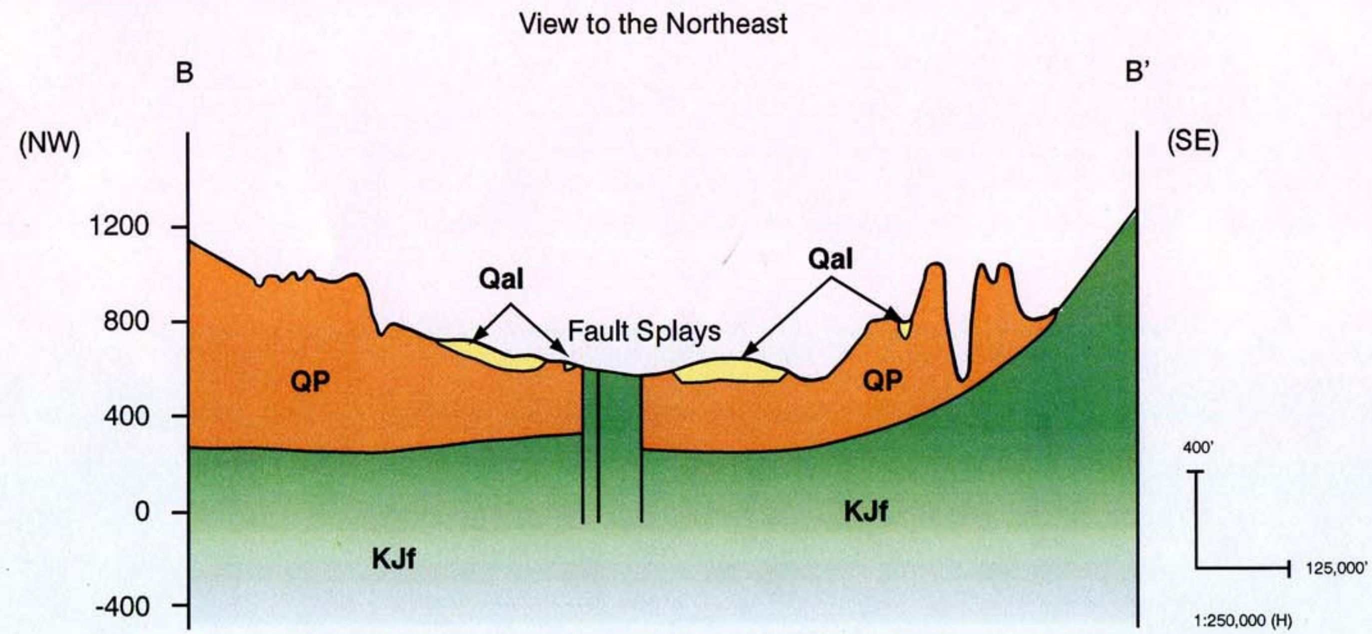


Note:
Refer to Figure 4-1 for cross section locations.
Refer to text for explanation of geologic symbols.

Figure 4-2

Ukiah Valley Area Plan
Water Supply Assessment

DRAFT GEOLOGIC CROSS SECTION A-A'

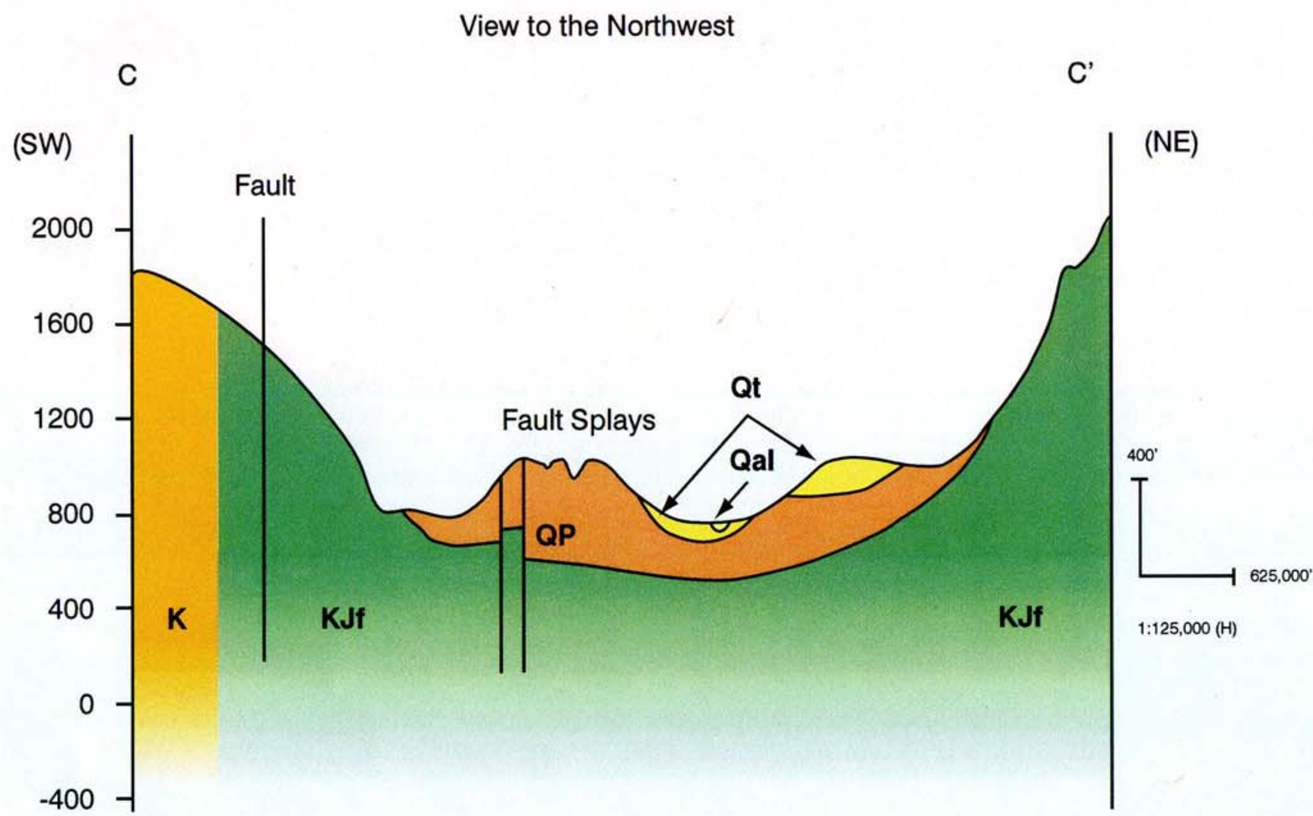


Note:
Refer to Figure 4-1 for cross section locations.
Refer to text for explanation of geologic symbols.

Figure 4-3

Ukiah Valley Area Plan
Water Supply Assessment

DRAFT GEOLOGIC CROSS SECTION B-B'



Note:
Refer to Figure 4-1 for cross section locations.
Refer to text for explanation of geologic symbols.

Figure 4-4

Ukiah Valley Area Plan
Water Supply Assessment

DRAFT GEOLOGIC CROSS SECTION C-C'

4.1.2 Groundwater Elevations and Availability

The Ukiah Valley groundwater basin reportedly has a usable storage capacity of 90,000 acre-feet and is fully recharged each year, except in years when precipitation is less than approximately 60 percent of normal (USGS, 1968). The principal sources of recharge for the Ukiah Valley groundwater basin are precipitation and to a lesser extent surface water infiltration (USGS, 1968). Although relatively limited, the available data indicate that groundwater elevations have remained stable since at least the 1960s, declining somewhat during periods of drought but then quickly recovering to pre-drought levels (DWR 2004; USGS, 1968). Average seasonal fluctuations range from 5 to 15 feet, with groundwater elevations generally highest in March or April, immediately after the winter rains, and lowest in the month of October, just prior to the onset of the next rainy season.

Groundwater typically moves from the margins of the Ukiah Valley to the Russian River, then southerly, toward Sonoma County. The movement of groundwater in the vicinity of the Russian River is highly variable, both spatially and temporally. Groundwater elevation data for shallow wells near the Russian River indicate that there are locations and times when surface water from the Russian River infiltrates the adjacent aquifer and by legal definition, constitutes underflow that is subject to the jurisdiction of the SWRCB. Within recent years the SWRCB has asserted that all of the groundwater in the Ukiah Valley, including groundwater associated with the deeply underlying Continental basin deposits, is underflow. While it is clear from the available data that there are locations and times where underflow occurs, the available data are arguably insufficient to support the contention that virtually all groundwater in the Ukiah Valley is by definition underflow – unless the definition of underflow is expanded.

A regulatory determination that all groundwater in the Ukiah Valley is underflow could create considerable uncertainty, not only with regard to the region's groundwater supply, but the surface water supply as well. In such a scenario individuals and entities that are currently extracting groundwater – or thought they were – could be required to file for appropriative water rights, which would be junior to all existing appropriative water rights and given the SWRCB's previous determination that the Russian River drainage is fully appropriated in the summer and fall (SWRCB, 1998), would, even if they were granted, most likely prohibit the continuation of extractions in the summer and fall. Accordingly, the demand for surface water sources – to replace groundwater – would likely increase. In at least some instances the only economically viable source of water available to rural properties in the Ukiah Valley is groundwater and therefore, the deprivation of the groundwater supply could have significant economic consequences for the Ukiah Valley and the county as a whole

4.1.3 Groundwater Pumping

Historical groundwater extraction data for Ukiah Valley are limited and therefore must be inferred from agricultural crop records and municipal groundwater production data reported by Calpella, Millview, Ukiah, Rogina and Willow. The University of California Cooperative Extension (D.J. Lewis et. al., 2008) estimates that each year approximately 8,000 acre-feet of water is consumptively used for agricultural purposes in the Ukiah Valley. The available data are limited but suggest that a portion of this total – 2,500 acre-feet to

5,500 acre-feet – is derived from groundwater sources. Similarly, recent annual municipal groundwater extraction records indicate that each year approximately 2,000 acre-feet of groundwater is used for municipal purposes (Table 4-1), and therefore, the combined total groundwater extraction rate for the Ukiah Valley – the combination of agricultural and municipal uses - is estimated to be between 4,500 acre-feet and 7,500 acre-feet per year.

Because nearly all of the irrigable land in the Ukiah Valley is already in production, future agricultural water demands are not expected to increase appreciably unless there is a pronounced shift toward crops with higher water demands (D.J. Lewis et. al., 2008). Similarly, other than Ukiah, which anticipates increasing groundwater extractions by approximately 800 acre-feet, from 1,075 acre-feet in 2006 to 1,875 acre-feet by as soon as 2010 (Ukiah, 2007), no substantial increase in future municipal groundwater extraction rates is currently planned.

Table 4- 1. Historical Groundwater Pumping in Acre-Feet [(a)]

Water Purveyor	2000	2001	2002	2003	2004	2005	2006
Calpella	34	33	30	36	35	33	33
Millview	0	0	0	0	0	0	0
Ukiah[(b)]	340	810	906	1,030	976	1,048	1,075
Rogina	642	694	687	632	668	563	635
Willow[(c)]	N/A	N/A	N/A	N/A	N/A	N/A	N/A

(a) Source: California Department of Public Health (2007) unless otherwise noted.
(b) Source: Ukiah (2007)
(c) Willow does not distinguish between Russian River underflow and percolating groundwater.

4.2 Groundwater Sufficiency

Based on the available data it appears that the Ukiah Valley groundwater basin is not in overdraft conditions and that current groundwater extraction rates remain well within sustainable yields. As previously discussed, groundwater elevations have been reasonably steady since the 1960's. In view of the comparatively large storage capacity of the Ukiah Valley groundwater basin, relative to existing groundwater extraction rates and the relatively modest projected incremental increase in water demands, less than 4,300 acre-feet by 2030, it would appear that there is sufficient groundwater to satisfy the UVA water service provider's future demands. However, the SWRCB's assertion that virtually all of the groundwater in the Ukiah Valley is underflow creates considerable uncertainty as to the institutional availability of this supply, and therefore, at least for now, it is assumed that none of the groundwater in the Ukiah Valley is available for future growth.

APPENDIX 5

Russian River ISRP Report

6.1 Redwood Valley

General Description and Topography

The Redwood Valley subarea includes the West Fork of the Russian River, and a number of tributaries, York Creek and Forsythe Creek (Figure 6.1.1). At the southern, downstream end of the subarea, the West Fork is joined by the East Fork just downstream of where it exits from Lake Mendocino. Redwood Valley, an ovoid valley that is longest in the north-south direction, is filled with alluvium. The western portion of the Redwood Valley subarea includes extensive mountains that are dissected by the Forsythe Creek and York Creek stream networks.

Geology

Geologic mapping at the 1:250,000 scale is available for the Redwood Valley subarea (Jennings 1985) (Figure 6.1.2). The mountains are made up of Franciscan Complex that is derived from volcanic rocks and sediments originally deposited from 200 to145 million years ago and Coastal Belt Rocks composed of materials originally deposited from 145 to 66 million years ago. These mountains were uplifted about 5 million years ago.

Redwood Valley is filled with Quaternary Alluvium, the erosional product of the surrounding mountains. Another alluvial unit - Loosely Consolidated Deposits (QPc) make up a series of terraces to the east and west of the West Fork channel in the southern portion of the subarea. These terrace deposits are the remnants of an older alluvial deposit lifted above present depositional levels through tectonic movements. A third alluvial unit, Continental Basin Deposits occurs beneath the Loosely Consolidated Deposits and Quaternary Alluvium and are up to 2,000 ft. deep and made up of cemented sands and silts with lenses of gravel. These were the first deposits in the pullapart basin and formed from alluvial fans, lake sediments and valley alluvium (Cardwell 1965). Table 6.1.1 outlines the rock types and their coverages.

The Maacama Fault, a subparallel fault related to the San Andreas Fault, dissects the Redwood Valley subarea crossing a number of creeks in the western mountains and the Russian River near the confluence of the East and West Forks.

Table 6.1.1. Redwood Valley subarea geology.

Map Label	Rock Type	Total Acres	Percentage of Total Subarea
Q	Quaternary alluvium	9,134	14.1%
QPc	Loosely consolidated alluvial deposits	7,806	12.0%
TK	Coastal Belt Rocks	14,701	22.7%
KJf	Franciscan Complex (Coast Ranges)	33,153	51.2%

Groundwater

Figure 6.1.1 depicts the extent of the major groundwater basin in the Redwood Valley subarea which generally coincides with the extent of the two surficial alluvial geologic units. The Franciscan Complex is by comparison to other rocks, considered generally non-water bearing except for fracture zones. Well yields are only a few gallons per minute or less. Ca. Department of Water Resources (2004) estimated the storage capacity of the Ukiah Valley and Redwood Valley groundwater basins together at 75-100,000 AF. of storage in the Quaternary Alluvium and Loosely Consolidated Deposits. Farrar (1986) estimated storage for these areas at 135,000 AF. The Ca. Dept. of Water Resources (2004) also states that review of groundwater level monitoring for the 1974-2004 period shows relatively stable groundwater levels.

Farrar (1986) investigated and mapped geologic features and groundwater for Redwood and Ukiah Valleys. He describes subsurface layers in Redwood Valley as Continental Basin Deposits overlying a basement of Franciscan Complex with younger alluvium on the surface. This study included review of well drilling logs to evaluate subsurface layers. The Continental Basin Deposits consist of older alluvium similar to the Loosely Consolidated Deposits. The upper most transect on Figure 6.1.3 depicts Redwood Valley well logs and subsurface layers. In the alluvial areas the well logs show layers of sand and gravel interspersed with clay layers (16C, 8R on Figure 6.1.3) and rock layers in the mountains without sand or gravel layers (13B on Figure 6.1.3). Log 16C is 400 ft. deep and depicts the younger alluvium and Continental Basin Deposits. Generally the Continental Basin Deposits support low production wells (1-50 gallons/minute or gpm) This study also rated groundwater availability in this subarea based on geology and groundwater information such as well production (gallons per minute). Areas of abundant groundwater with high production wells (ranked I on Figure 6.1.4) occur along the West Fork channel. Areas of available groundwater with low production wells (ranked II on Figure 6.1.4) occur along the margins of river and creek channels. Areas of groundwater presence with very low production wells (ranked III on Figure 6.1.4) occur in Redwood Valley where alluvial fill is thinner or composed of a high percentage of fines rather than sand and gravel. Areas where groundwater is generally not available (ranked IV on Figure 6.1.4) occur in the mountains made up of Franciscan Complex. This study also includes a map of groundwater flow direction (Figure 6.1.5). Groundwater movement is from the mountains towards the West Fork and Forsythe Creek channels, and from north to south.

Redwood Valley is part of the Ukiah groundwater basin which is rated as medium priority by the California Department of Water Resources. This ranking will require a plan be developed under the Sustainable Groundwater Management Act.

Climate and Rainfall

The Redwood Valley subarea has hotter summers (average high temperature 94° F) and colder winters (average low temperature 35° F) than many of the areas in the Russian River watershed. Rainfall station Willits Howard Forest shows a rainfall average of 48.4 inches annually (Western Regional Climate Center 2013). The Willits Howard Station was located at an elevation of 1925 ft. near the northern boundary of the subarea and has a 20 year period of record from November 1935 to March 1955 (Ca. Dept. Water Resources 2015).

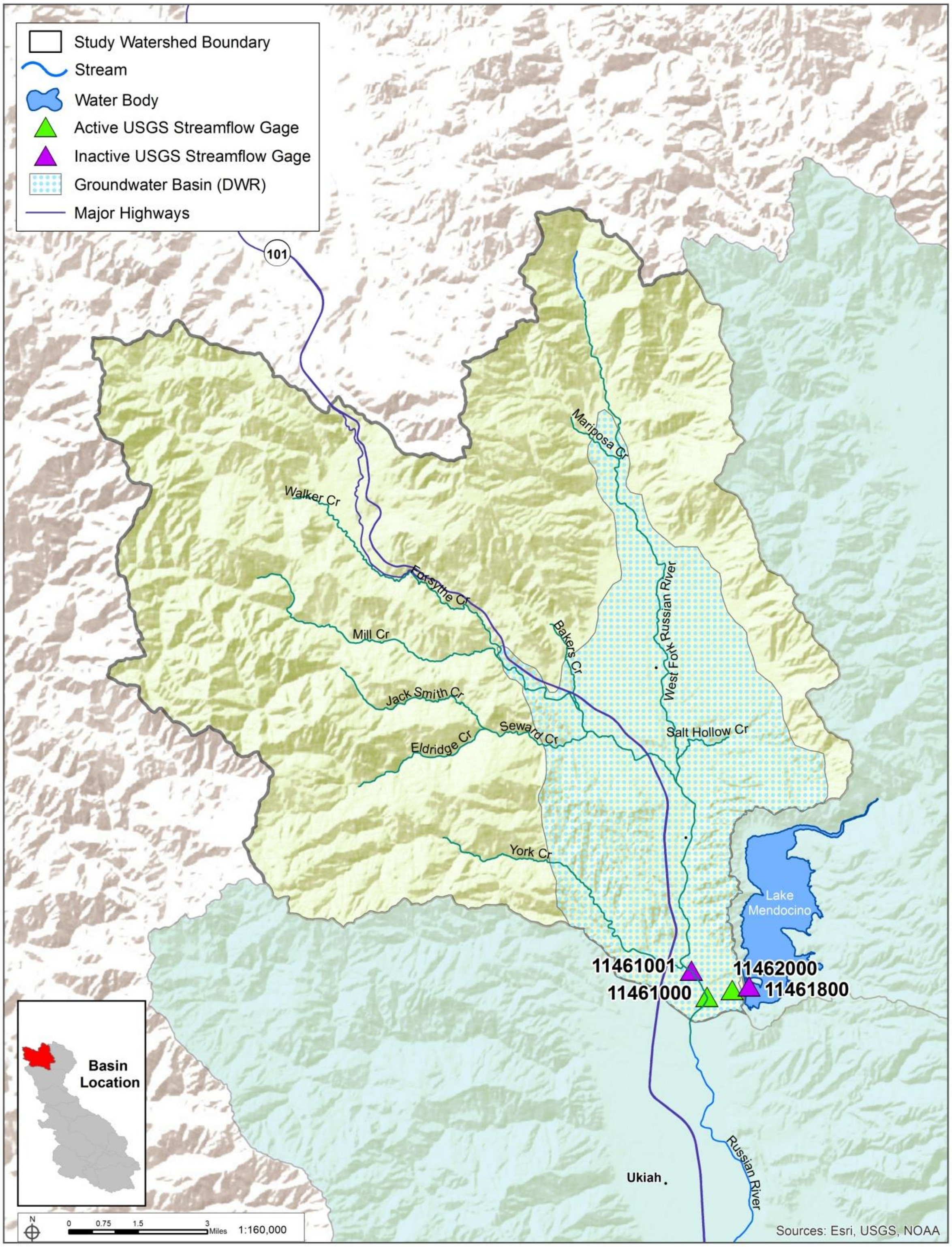


Figure 6.1.1. Redwood Valley subarea topography, hydrography and groundwater basins.

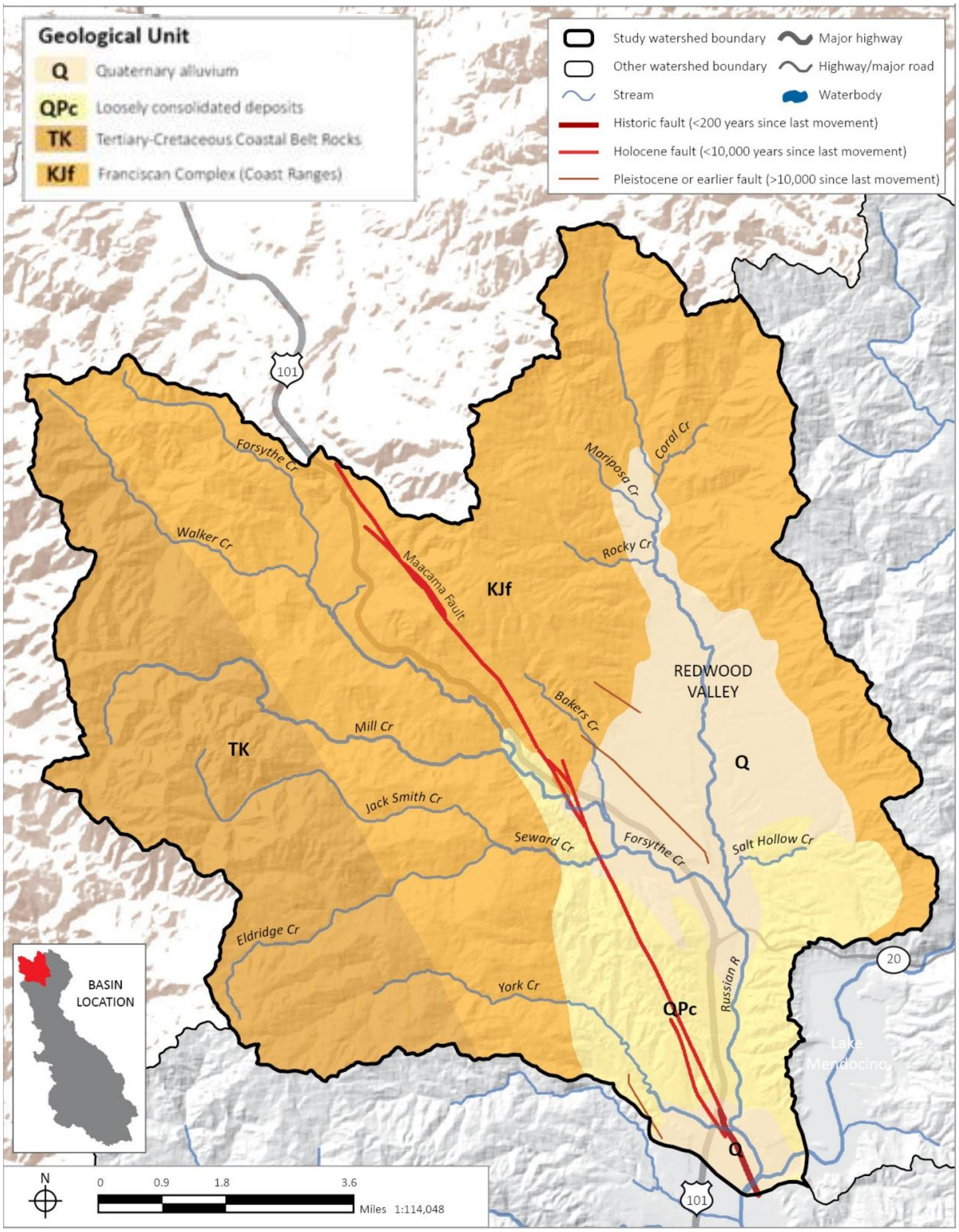


Figure 6.1.2. Redwood Valley subarea geology.

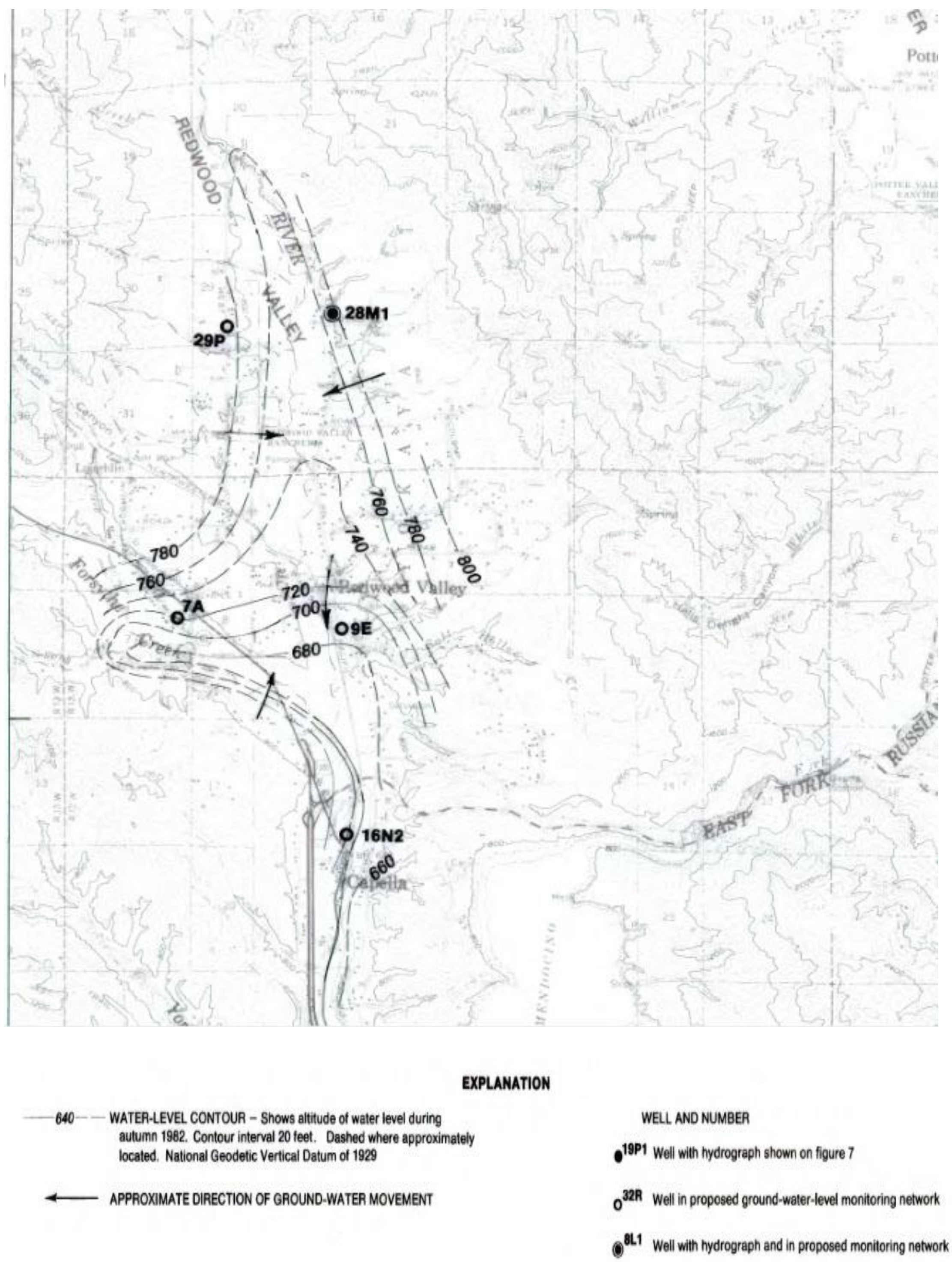


Figure 6.1.5. Water level contour map showing directions of groundwater movement and locations of monitoring wells in Redwood Valley subarea. From: Farrar 1986.

Vegetation

About half of the Redwood Valley subarea is covered with hardwood forest/woodland which is made up of interior live and coast live oak, Douglas fir, tanbark oak and manzanita. Conifer and mixed conifer hardwood forest occurs in the mountains at the headwaters of Forsythe Creek and the northern border of the subarea. Table 6.1.2 lists the areas of different vegetation types in the Redwood Valley subarea and these are depicted in Figure 6.1.7.

Table 6.1.2. Redwood Valley subarea vegetative cover.

Map Label	Cover Type	Total Acres	Percentage of Total Subarea
HDW	Hardwood forest/woodland	32,749	50.60%
HEB	Herbaceous	12,510	19.30%
MIX	Mixed conifer/hardwood woodland	7,140	11.00%
CON	Conifer forest / woodland	4,168	6.40%
AGR	Agriculture	3,485	5.40%
SHB	Shrub	2,229	3.40%
URB	Urban/residential	1,426	2.20%
BAR	Barren	960	1.50%
WAT	Water	129	0.20%

Channel Types and Surface/Groundwater Interactions

Figure 6.1.8 depicts the channel types mapped for the Redwood Valley subarea. The Redwood Valley subarea has the highest proportion of unconfined alluvial channels (33%) among the eight study areas (Table 6.1.3). Most of the length of the West Fork Russian River is mapped as unconfined alluvial channel, as are the downstream portions of Forsythe Creek and York Creek. Immediately upstream of the unconfined alluvial section, the West Fork Russian River flows through a dissected alluvium channel where channel slopes are generally <2%, but interspersed with several short, steeper sections (Figure 6.1.9). Upstream of the unconfined alluvial reach of Forsythe Creek, bedrock canyon reaches dominate. The Mill Creek tributary to Forsythe Creek, in particular, has extensive segments of low (0-2%) and moderate gradient (2-4%) bedrock canyon channel, but there are several very short, steep (4-8%) reaches in the downstream section of Mill Creek. In addition the lower 2 miles of Seward Creek (another tributary to Forsythe Creek) is composed of low gradient (<2%) bedrock canyon channel. The lower 4 miles of York Creek is primarily low gradient (0-2%) channel consisting of semiconfined alluvial and unconfined alluvial channels. York Creek, immediately upstream of these alluvial reaches, is a steep (4-8%) bedrock canyon reach. Dissected alluvium channels occur on Bakers Creek, Salt Hollow Creek, Mariposa Creek and the upstream area of the West Fork Russian River. Table 6.1.3 outlines the length of each channel type in this subarea for fish-bearing streams only.

There are a number of historical accounts and early gaging records that provide an idea of the conditions in Redwood Valley prior to development. Early accounts of the Redwood/Ukiah Valley describe Redwood Valley covered in coastal prairie and oak savannah (Carpenter and Millberry1914). An early historical account of this area is found in the Journal of George Gibbs, a member of the Expedition of Colonel Redick M'Kee, United States Indian Agent through Northwestern California in 1851 (Gibbs 1852). This account includes observations of the West

Table 6.1.3. Channel types for fish-bearing streams in the Redwood Valley subarea.

Channel Type	Length (miles)	Percentage of Total Length of Fish-Bearing Streams in Subarea
Bedrock canyon	20.60	40.1%
Unconfined alluvial	16.94	33.1%
Semiconfined alluvial	6.94	13.5%
Dissected alluvium	5.72	11.1%
Regulated river	1.15	2.2%

Fork of the Russian River on August 24-25, 1851 as *"a completely dry channel"* and that water was scarce in this area that summer. There are no local rainfall records that include 1851; however, rainfall records do exist for San Francisco and show a total of 7.42 inches of rain for the 1850/1851 water year. This is 37% of the average of 20 inches of rainfall San Francisco receives.

There are records of the early use of water in this subarea. In 1858, Thomas Elliott built a water powered sawmill in Redwood Valley which would need a year round supply (Palmer 1880). Other records show that water from "Forsythe's" creek was brought to Gold Gulch for gold mining just north of the confluence of the East and West Forks of the Russian River (Palmer 1880).

The USGS gage on the West Fork (11461000 Russian River near Ukiah) shows very low flow conditions (0.2-2.5 cfs) from July to October for the 1912 and 1913 records (Tables A-2 and A-3 in Appendix A). These records predate the use of water for irrigation of crops in this area and rainfall was normal in both of these years.

A 1913 report summarizing water resources in California (USGS 1913) reports gage heights and discharge measurements for the Russian River near Ukiah gage (11461000) on the West Fork. Discharge on 8/8/1911 was 0.5 cfs with a stage reading of 3.12 feet in the gage pool. These readings represent very low flow with the gage likely located in a pool of just over three feet deep. The November 1911 readings were 0.2 cfs and 3.10 feet stage on 11/2/1911; 0.5 cfs and 3.25 feet stage on 11/20/1911. The 1912 readings were 652 cfs with a stage of 6.05 feet on 1/27/1912; 510 cfs with a stage of 5.6 feet on 3/6/1912; 3,390 cfs with a stage of 10.35 feet on 3/15/1912; 1,090 cfs with a stage of 6.78 feet on 3/16/1912; 60 cfs with a stage of 4.13 feet on 3/28/1912 and 32 cfs with a stage of 3.85 feet on 4/5/1912. Other miscellaneous measurements in this report include Russian River near Calpella (West Fork) 1.2 cfs on 9/21/1905 and Russian River one mile north of Calpella (West Fork) 0.7 cfs on 8/11/1910. All of these measurements show low to very low stream flow, but stage readings at the gage are over three feet. These measurements indicate isolated pools connected by a low level of surface flow.

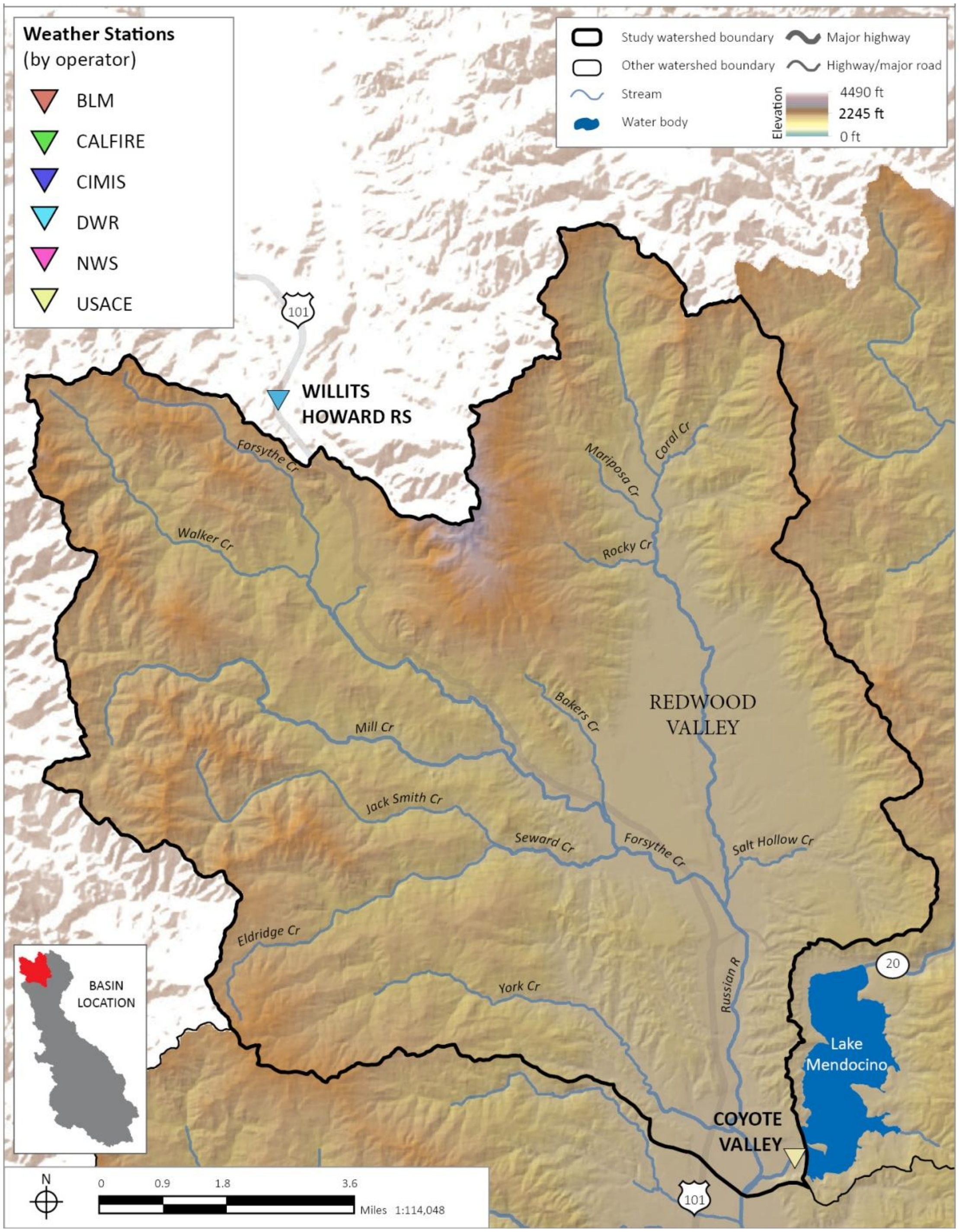


Figure 6.1.6. Elevation and weather stations in the Redwood Valley subarea.

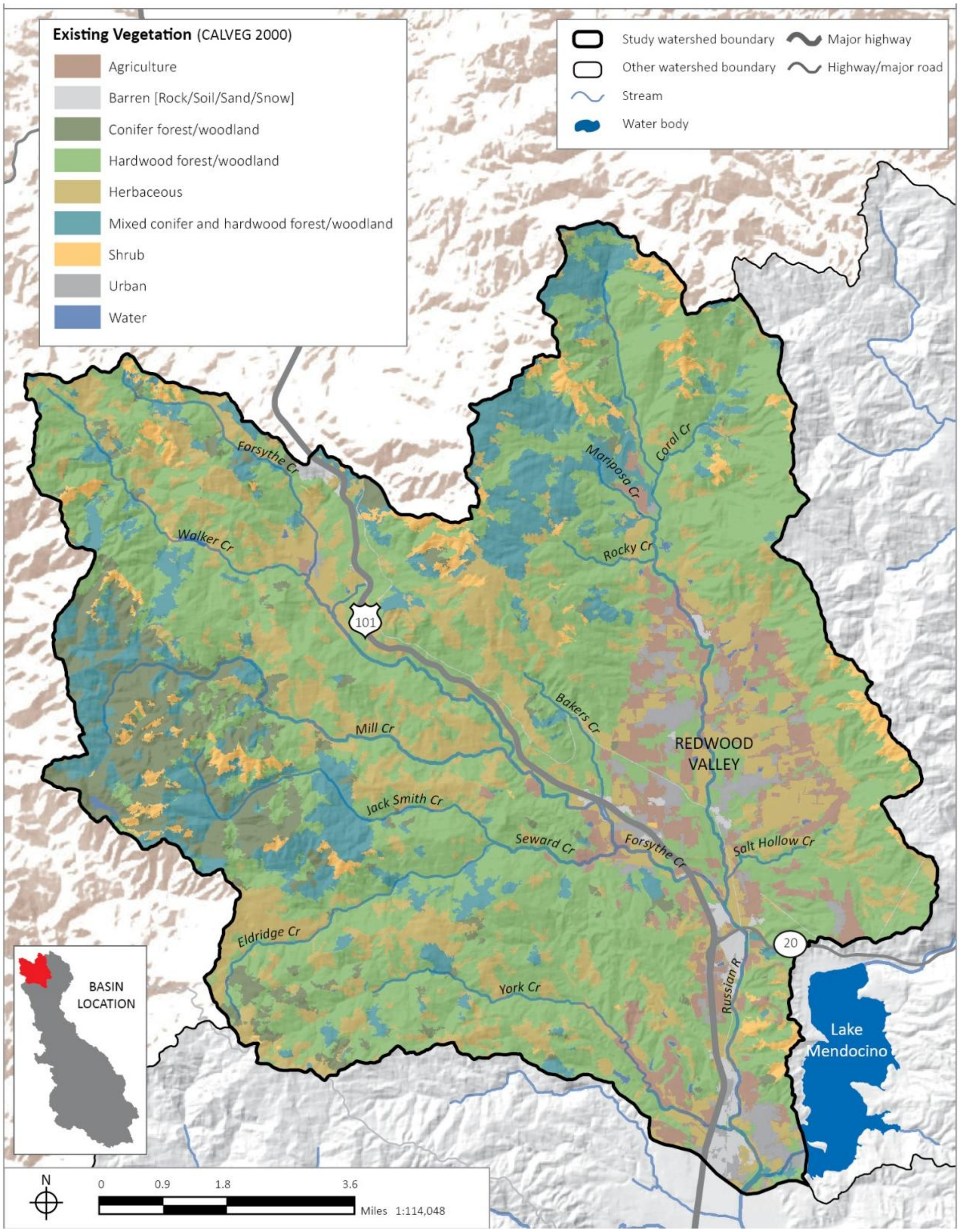


Figure 6.1.7. Existing vegetation in the Redwood Valley subarea.

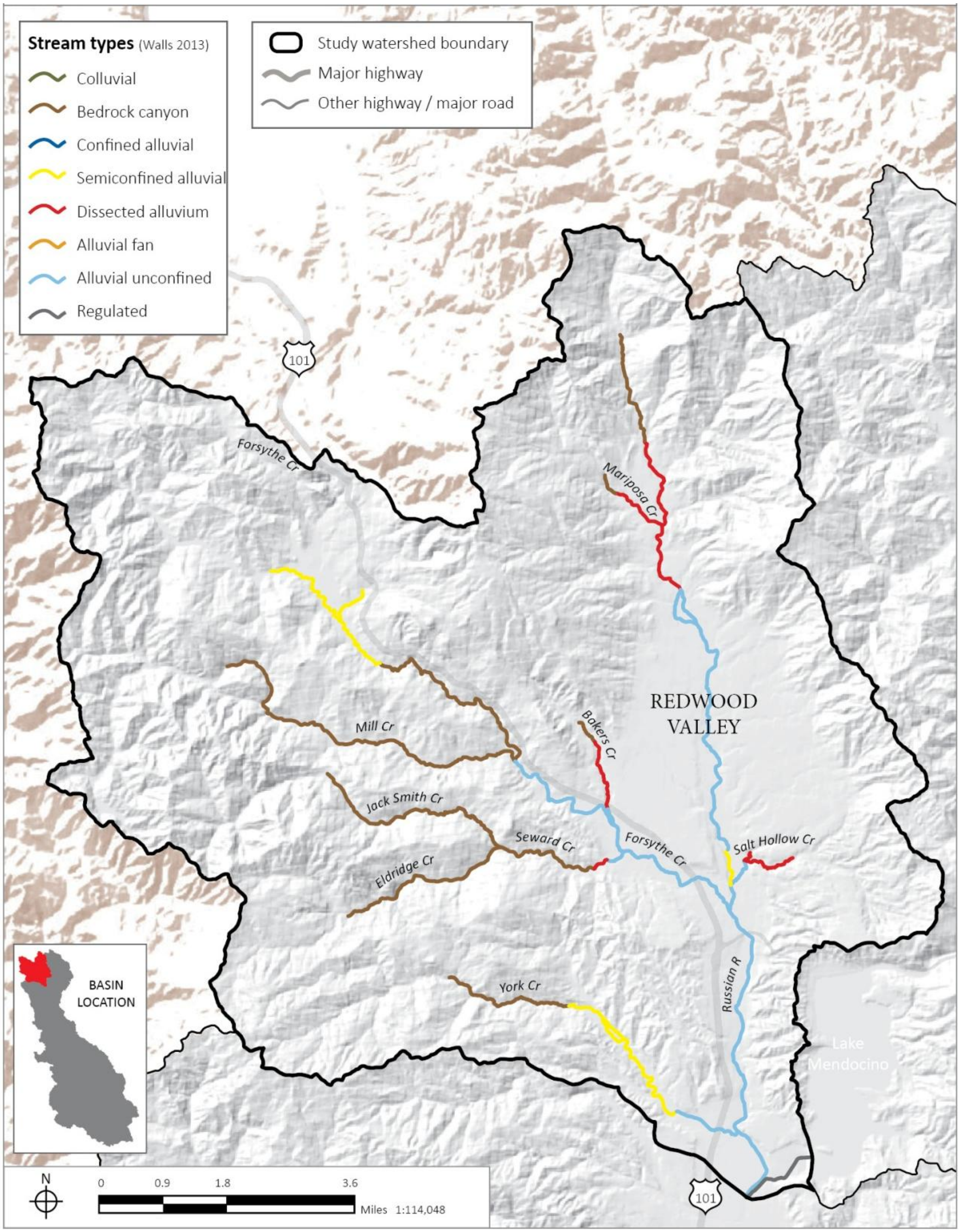


Figure 6.1.8. Stream typology for fish-bearing streams of the Redwood Valley subarea.

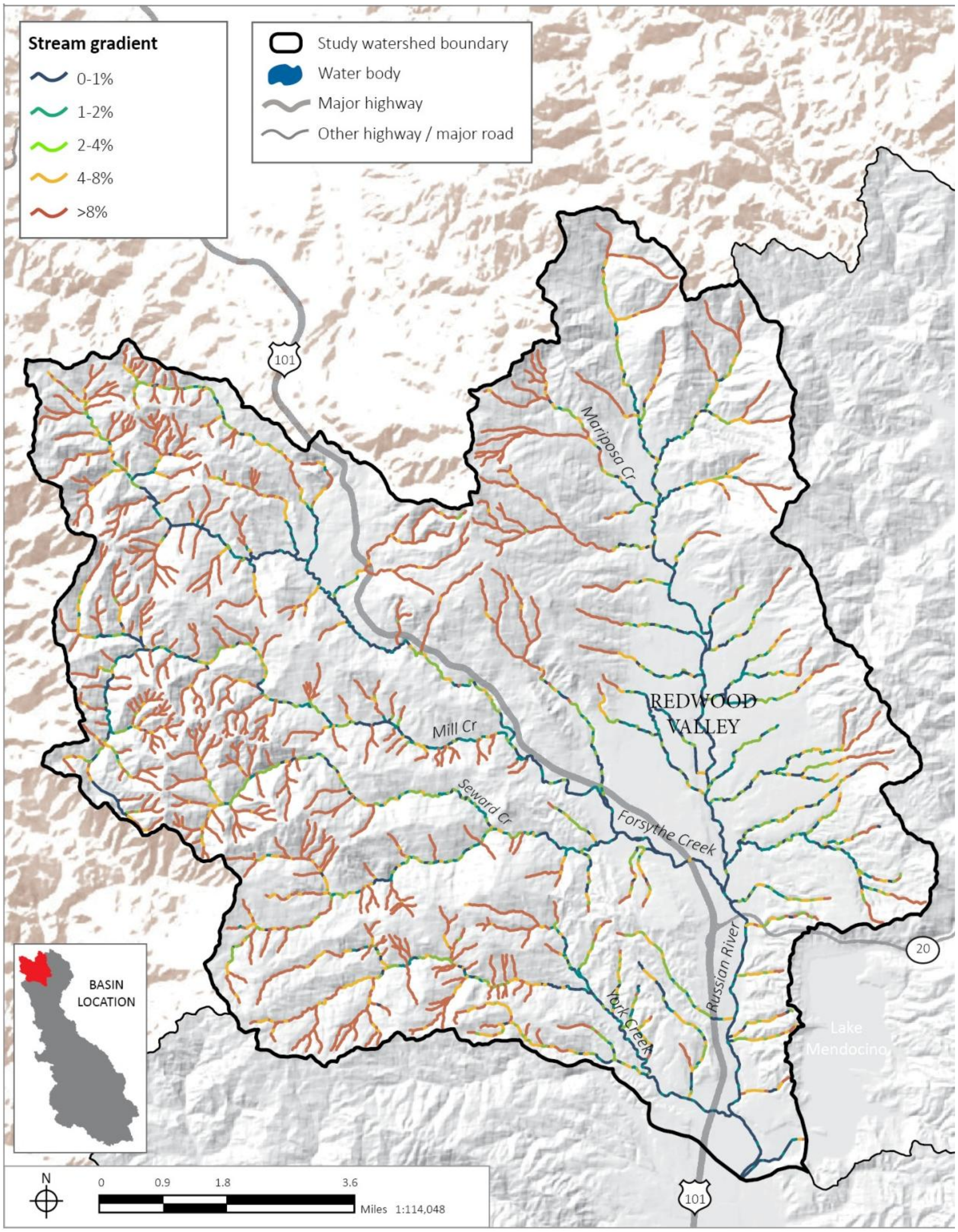


Figure 6.1.9. Stream gradients of Redwood Valley subarea.

Based on the geology, stream gradient, channel types and historic information, we can speculate on pre-development conditions in Redwood Valley. The West Fork Russian River is an unconfined alluvial, low slope channel that flows through a valley with a wide and moderately deep (15-80 ft.) alluvial deposit. Historically this channel likely was wide and shallow with riffle/pool morphology and an adjacent floodplain. Stream flow would have been highly affected by surface and groundwater interactions; stream flow would have likely ceased, or been very low in the summer. Intermittent pools filled by groundwater and connected by hyporheic flows may have occurred. The extent of riparian forest is unknown, but unconfined alluvial channels and their floodplains would have had adequate area and shallow groundwater to support a diverse riparian corridor whenever shallow groundwater was available over the summer.

The groundwater-fed pools may have supported steelhead trout if temperatures were cool, oxygen was adequate and food was available. The availability of groundwater in the summer would have varied by the amount of rainfall each year. In dry years, such as 1851, the river was completely dry (Gibbs 1852). The 1912/13 stream flow gage records show very low flows in years of average rainfall. We can speculate that wet rainfall years may have had higher groundwater levels and summer pools may have occurred in the West Fork. The local use of water for sawmills and gold mines indicate that some channels had flow. However no exact locations for these diversions are available limiting our interpretation of this information.

The downstream reaches of Forsythe and York Creeks also consist of unconfined alluvial channels that are low slope. The alluvial deposit is narrow and shallow and would provide less water to these channels likely resulting in dry conditions.

Historically the bedrock channels of Forsythe, Mill, Walker and York Creeks likely had perennial flow except in low water years. The western mountains in this subarea support redwoods indicating high rainfall amounts and cooler summer temperatures. Additionally bedrock channels infiltrate low amounts of water and tend to have more persistent flows than alluvial channels.

Semiconfined alluvial channels occur in 3 locations in upper Walker Creek, where a small valley occurs, along York Creek, and a very small reach of the West Fork. These channels might have supported year round pools, but also may not have the depth of alluvial deposit needed to provide for perennial flows.

Dissected alluvium channels occur along Bakers, Seward and Salt Hollow Creeks and the upstream area of the West Fork. All of these dissected alluvial reaches are low in slope indicating that they may have incised to bedrock and therefore could function similarly to bedrock channels and may have supported perennial flow in years with adequate rainfall. Gaging in dissected alluvium channels shows years of perennial flow and others with dry summer conditions (Figure 4.2.20). However the gaging records are limited to three locations.

Figure 6.1.10. The West Fork Russian River in Redwood Valley in 1907.

Fisheries
Stream flow in the West Fork is strongly tied to groundwater levels. Groundwater levels may have produced consistent, cool, perennial flow through the dry season in above average rainfall years. Chinook salmon could have used the West Fork of the Russian River for spawning and rearing. Steelhead trout may have used the West Fork in wet years and used accessible bedrock canyon channels, especially in the Forsythe Creek sub-basin including Mill Creek and Seward Creek in dry, normal and wet years. Coho salmon are not believed to have been present in the West Fork Russian River; however, there is anecdotal evidence of Coho salmon in Forsythe Creek.

Current Conditions

Land Use
Figure 6.1.11 depicts land uses in the Redwood Valley subarea. This subarea is primarily rural with no incorporated cities. Rural residential land uses are concentrated in Redwood Valley along with much of the irrigated agricultural lands in the subarea. There is slightly more land in rural residential uses (Rural Residential and Rural Commercial, Urban and Built-Up Land) at 4444 acres than in agricultural land (Farmland of Statewide Importance, Prime Farmland, Unique Farmland) at 4088 acres. The largest land use is grazing in the hills that surround the valley. Table 6.1.4 outlines the acreage of various land uses.

Hydrologic and Geomorphic Changes
The main stem of the Russian River has entrenched up to 20 ft. (Florsheim and Goodwin 1995). The wide, shallow river channel changed to a narrow, deep channel due to the effects of Coyote Dam cutting off the river's sediment supply and due to channelization of the main stem Russian

Water Use
Public Water Districts

Redwood Valley County Water District
The Redwood Valley County Water District provides water service in Redwood Valley and was incorporated on January 16, 1964. Facilities were constructed between 1977 and 1979, and the District went into operation with a dual distribution system for irrigation water service in April 1979 and for domestic water service in November 1979. The District's water supply comes from Lake Mendocino, if excess water is available. In January 1989 the District was found by the Superior Court of Mendocino County (Superior Court of Mendocino County 1989) to have a potentially undependable water right which required it to purchase excess water from the Mendocino County Russian River Flood Control & Water Conservation Improvement District during the summer months and ordered a moratorium on new domestic connections. The resulting moratorium brought a halt to the growth of domestic water service customers. State legislation in 1998 enabled the installation of 135 domestic water service connections to relieve hardship water service on property parcels with existing structures and certifiable water quality, or water quantity problems. The moratorium upon new domestic connections remains in effect. The District serves about 3,969 people (SCWA 2014). In 2001 the Board of Directors recognized deficiencies in the irrigation distribution system and declared a moratorium on new irrigation water service connections until the delivery deficiencies could be corrected with expansion of sections of the irrigation distribution system.

Millview County Water District
This district provides domestic water supply to about 5,500 people with two appropriative water rights and purchase of water from the MCRRFCWCD. Recently there have been legal issues regarding the validity of a recently purchased pre-1914 water right.

Calpella County Water District
This district serves the Calpella area and a customer base of 500. Table 6.1.5 outlines the water use of these districts.

Table 6.1.5. Major water systems in the Redwood Valley subarea.

Major Water System	Size (million gallons/yr.)	Population Served	Size (gpm)	Size (cfs)	Total (AF/yr.)
Redwood Valley County Water District	250	3,969	476	1	767.2
Calpella County Water District	37	490	70	0	113.5
Millview County Water District	540	5,500	1,027	2	1,657.2

From: Sonoma County Water Agency 2014.

Table 6.1.6 describes water rights by diversion type for both public and private entities. The majority of diversions are on unnamed creeks.

Table 6.1.6. Water rights in the Redwood Valley subarea.

Type and Status of Right	Number of Rights without Storage	Number of Rights with Storage
Riparian	11	16
Appropriative Licensed	44	74
Appropriative Permitted	6	10
Appropriative Pending	4	15
Total	65	115

From: State Water Resources Control Board database.

Monitoring and Data

Ca. Dept. of Water Resource (DWR) Monitoring Wells

There are two DWR monitoring wells in the Redwood Valley subarea (Figure 6.1.15). The level in each well is measured in spring and fall. Figures 6.1.16 and 6.1.17 show the measurements from these wells from 1973 to 2014. The graphs show the groundwater levels rise between autumn and spring each year except when drought conditions occur. Drought conditions occurred in 1976/77 and well 28 m shows lower water levels. The annual variations in groundwater level are 2-25 ft. for well 28M and 5-32 ft. for well 16N.

Well Driller Logs

When a well is drilled a report is filed with the Dept. of Water Resources that describes the material encountered at different depths, the depth of the well and other features. The drilling logs are not public documents, so we have summarized some of the information in aggregated format. Figure 6.1.18 shows the locations of wells and rock types. There are 143 records of which 112 are active wells; the remainder are dry holes, or well closures. The deepest well is 695 ft. and the shallowest is 15 ft. All but one well are for private domestic use. Table 6.1.7 summarizes the number and depths of wells in the Redwood Valley subarea.

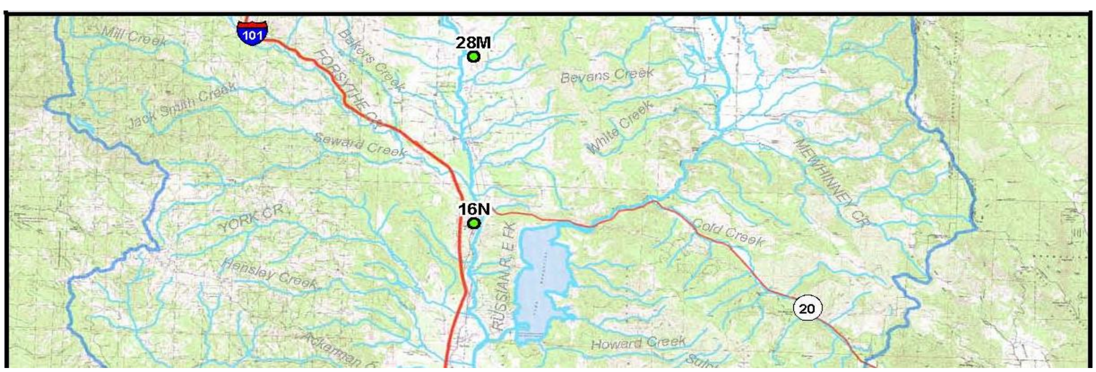


Figure 6.1.15. Locations of Dept. of Water Resources monitoring wells in the Redwood Valley subarea.

Table 6.1.7. Drilling log information for Redwood Valley subarea.

Surface Rock Type	Number of Wells*	Average Well Depth (ft.)	Range of Well Depths (ft.)	Type of Well
Quaternary Alluvium and Fluvial Terrace Deposits (Q)	46	154	24 - 400	Public (1), Monitoring (2), Domestic (43)
Loosely Consolidated Deposits (QPc)	20	332	140 - 600	Domestic
Tertiary-Cretaceous Coastal Belt Rocks (TK)	9	248	160 - 335	Domestic
Franciscan Complex (Coast Ranges) (KJf)	37	257	40 - 466	Domestic

*Abandoned, backfilled and dry wells were not included.

Stream Flow Gaging

There is one long-term U.S. Geological Survey (USGS) stream flow gage in the Redwood Valley subarea, the Russian River near Ukiah (11461000) located on the West Fork of the Russian River upstream of the confluence with the East Fork (Figure 6.1.1). This gage has a period of record from 1911 to 1913 and from 1952 to present. The highest peak flow of 22,500 cfs occurred on Dec. 30, 2005 (Table A-1 in Appendix A). Appendix A also includes Tables A-2 and A-3 listing mean monthly discharge and the mean daily discharge for the period of record for this gage.

Figure 6.1.9 depicts hydrographs for the Russian River near Ukiah stream flow gage for the wettest (1983) and driest (1977) years of the gaging record. Figure 6.1.20 shows the number of days of zero discharge for this gage. Zero discharge occurs relatively frequently. Figure 6.1.21 depicts annual discharge for this gage.

The average stream flow is less than 1 cfs during the months of August, September and October including the 1911-1913 period when it is unlikely irrigation was widespread. Low flows in the West Fork Russian River in the summer are fairly common throughout the gage record. Rainfall as recorded at the Ukiah Station (049122) was 34.72 inches in 1911, 36.25 inches in 1912, and 38.32 inches in 1913. The average annual rainfall at the Ukiah station is 37.27 inches for a period of record from 1893 to present.

USGS gage 1140940 Russian River (West Fork) near Redwood Valley is located at the upstream end of Redwood Valley (Figure 6.1.1). This gage was in operation from 1963 to 1968 for year round gaging and as a peak flow gage from 1964 to 1977 (Table A-4 Appendix A). Tables in Appendix A list mean monthly discharge and show mean daily values (Tables A-5 and A-6) for this gage. Both tables show low to no flow from June to October.

We completed an analysis of the gaging record for the Russian River near Ukiah USGS stream flow gage to determine if dry season stream flow was changing over time. This gage has a long record and dry season flows are not regulated by reservoir releases. Appendix B contains the full analysis.

The gage record was evaluated for annual data and monthly data. Two approaches were used – rank-correlation between water years, and an annual discharge parameter such as annual minimum discharge. The second method divides the period of record into several time periods to test if there is a statistical difference between data from each period including magnitude, or distribution.

The analysis found that for the 1912–1972 period there was a weak, but long-term, trend of decline in dry season stream flow in the months of July, August and September. For the 1973-93 period the trend from the prior period is not seen except for a weak trend of declining dry season stream flow in September. For the 1994-2014 period there is a weak trend of decline in dry season stream flow in May, July, August and September. There is also a reduction in the median discharge in January and February.

A monthly analysis was also done using only the years with less than median rainfall (dry years). This analysis looked at all 65 years of data for each month. The dry year monthly analysis found evidence of declining stream flow in February, May, July, August and September.

An analysis of the discharge during the frost season (March 15 to May 15th) was also done. This analysis looked at several discharge parameters over all years, over just the dry years and over the 1912-1972, 1973-1993 and 1994-2015 periods. The frost season analysis found only a weak trend of declining stream flow during dry years.

There are a number of causes for these declines in dry season stream flow including channel incision, increased diversion of surface and groundwater and climate change. It is not possible to identify a single cause from an analysis of the gage data. Appendix B includes a longer discussion of this analysis.

6.2 Ukiah Valley

General Description and Topography

The Ukiah Valley subarea begins just downstream of the confluence of the East and West Forks of the Russian River. This subarea has numerous tributaries including Mill/McClure, Ackerman, Robinson, Morrison, Hensley, and Sulphur Creeks. With the exception of Robinson Creek, most creeks drain relatively small watersheds and do not have extensive creek networks. Smaller creeks include Doolin/Gibson, Howell, Orrs and several unnamed creeks (Figure 6.2.1).

Geology

Geologic mapping is available at a 1:250,000 scale for the Ukiah Valley subarea (Figure 6.2.2). Mountains surrounding Ukiah Valley are made up of Franciscan Complex. This complex consists of highly sheared graywacke and mudstone with occurrences of harder rock in an easily-eroded matrix.

The mountains along the western side of the valley are also Franciscan Complex, but termed Tertiary-Cretaceous Coastal Belt Rocks (Figure 6.2.2) These Coastal Belt rocks include more coherent rock units than the mountains on the eastern side of this subarea. This rock type has low permeability; wells produce only a few gallons per minute.

Ukiah is a pull-apart basin formed by movements along the Maacama and other faults (Figure 2.2.3) (McLaughlin & Nilsen 1982). Movements of parallel faults cause the land in between to drop down and widen creating a subsided basin. Erosion of the surrounding mountains through landslides and debris flows fill the subsided basin. On the surface these materials are indicated as Quaternary Alluvium in Figure 6.2.2. Loosely Consolidated Deposits, (Figures 6.2.2, 6.2.3) older than the Quaternary Alluvium, are partially cemented sand, gravel and clay and occur as terraces along the eastern edge of Ukiah Valley where they have uplifted. Beneath these two alluvial units lie the Continental Basin Deposits, the oldest alluvial layer as described by Farrar (1986) and Cardwell (1965). Table 6.2.1 outlines the rock types and their areas of surface coverage.

Table 6.2.1. Ukiah Valley subarea geology.`

Map Label	Rock Type	Total Acres	Percentage of Total Subarea
Q	Quaternary Alluvium	12,072	14.4%
QPc	Loosely Consolidated Deposits	5,986	7.2%
TK	Tertiary-Cretaceous Coastal Belt Rocks	41,367	49.4%
um	Ultramafic Rocks	359	0.4%
KJf	Franciscan Complex (Coast Ranges)	23,907	28.6%

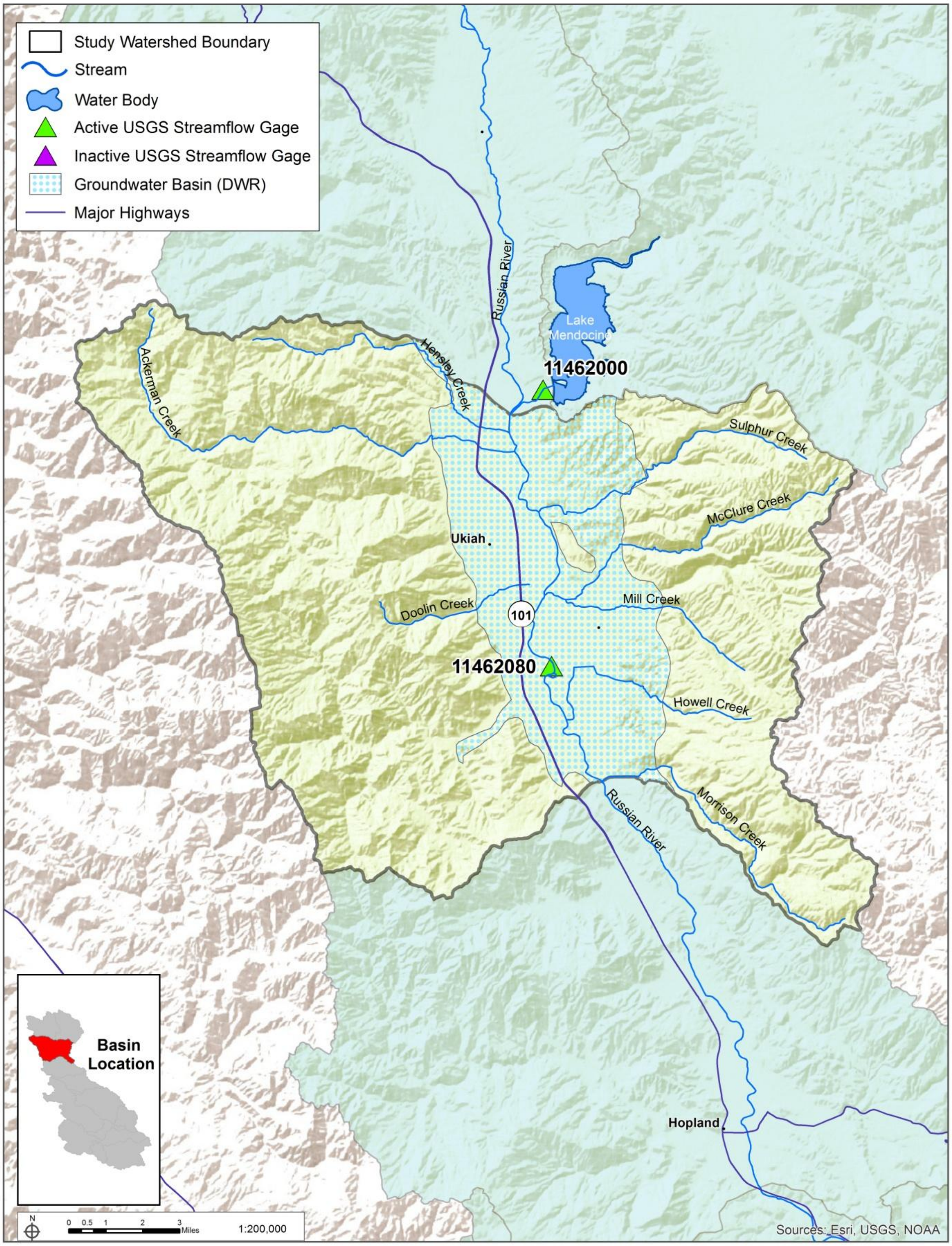


Figure 6.2.1. Topography, hydrography and groundwater basins of the Ukiah Valley subarea.

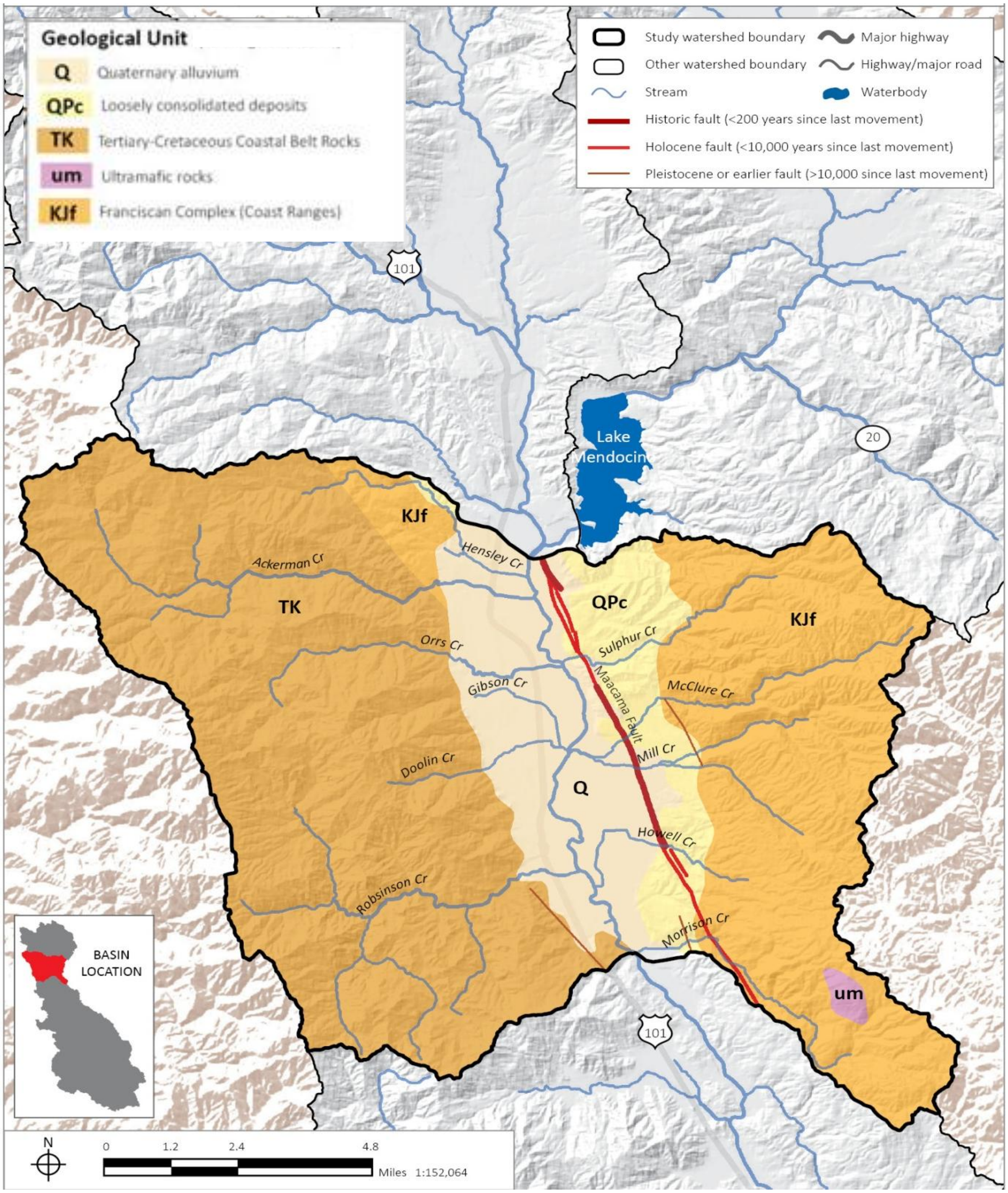


Figure 6.2.2. Geology of the Ukiah Valley subarea.

Figure 6.2.3. Loosely Consolidated Deposits visible near Perkins St. along the east side of the Russian River.

The Maacama Fault is a major feature of this subarea and occurs along the eastern side of the valley. As indicated in Figure 6.2.2, sections of the Maacama Fault are active, having moved in the past 200 years. All of the creeks on the eastern side of the valley cross the Maacama Fault.

Groundwater

Figure 6.2.1 outlines the extent of the major groundwater basin in the Ukiah Valley subarea which generally coincides with the extent of alluvial rock units. The California Department of Water Resources (2004) estimated the storage capacity of the Ukiah Valley and Redwood Valley groundwater basins together at 75-100,000 AF of storage in the Quaternary Alluvium and Loosely Consolidated Deposits. Farrar (1986) estimated storage for these areas at 135,000 AF. The California Dept. of Water Resources (2004) also states that review of groundwater level monitoring for the 1974-2004 period shows relatively stable groundwater levels.

Both Cardwell (1965) and Farrar (1986) evaluated geology and groundwater in the Ukiah Valley. Farrar provides greater detail about the geology and stratigraphy of the groundwater basin. The deepest alluvial unit in the valley overlies the basement of Franciscan Complex rocks and is termed Continental Basin Deposits. The Continental Basin Deposits are up to 2,000 ft thick in the middle of the valley and formed from erosion of the surrounding mountains into the pull-apart basin starting about 3 to 4 million years ago continuing until 0.45 million years ago. The Continental Basin Deposits contain a large amount of clay with small areas of sand and gravel resulting in a low permeability deposit with groundwater confined in the sand and gravel within the clay matrix.

Alluvial deposits of more recent age (10,000 years) lie on top of the Continental Basin Deposits. Figure 6.2.4 depicts a cross section of Ukiah Valley showing the relative locations and depths of alluvial deposits. These deposits are heterogeneous with layers of clay interspersed between layers of sand and gravel.

Figure 6.2.5 shows the location of a transect across Ukiah Valley (middle transect) and four well drilling logs. Well 2DR is 625 ft. deep, and intersects the Continental Basin Deposits and more recent alluvial layers, and shows the clay layers found at depth. By comparison well 25H shows a more shallow well (95 ft.) in Quaternary Alluvium with gravel and clay layers. Well 30K is a 36 ft. deep well in hard rock, typical of the Franciscan Complex.

According to Farrar (1986), wells in the Continental Basin Deposits have low production levels of 1 - 50 gallons/minute (gpm). Wells in the Continental Terrace Deposits (Loosely Consolidated Deposits) generally yield 1 - 10 gpm but some produce as much as 100 gpm. Wells in the Quaternary Alluvium are the most productive with outputs of up to 1,000 gpm. The recent alluvial layers are highly permeable where surface stream flow and groundwater are frequently connected. Figure 6.2.6 depicts the availability of groundwater in the Ukiah subarea rated from well data, geology, and drilling logs. A description of each rating is included on page 141. Figure 6.2.6 also depicts groundwater quality (pie charts). Figure 6.2.7 depicts groundwater contours and movement. Groundwater generally moves from the mountains towards the river channel and from north to south in this subarea.

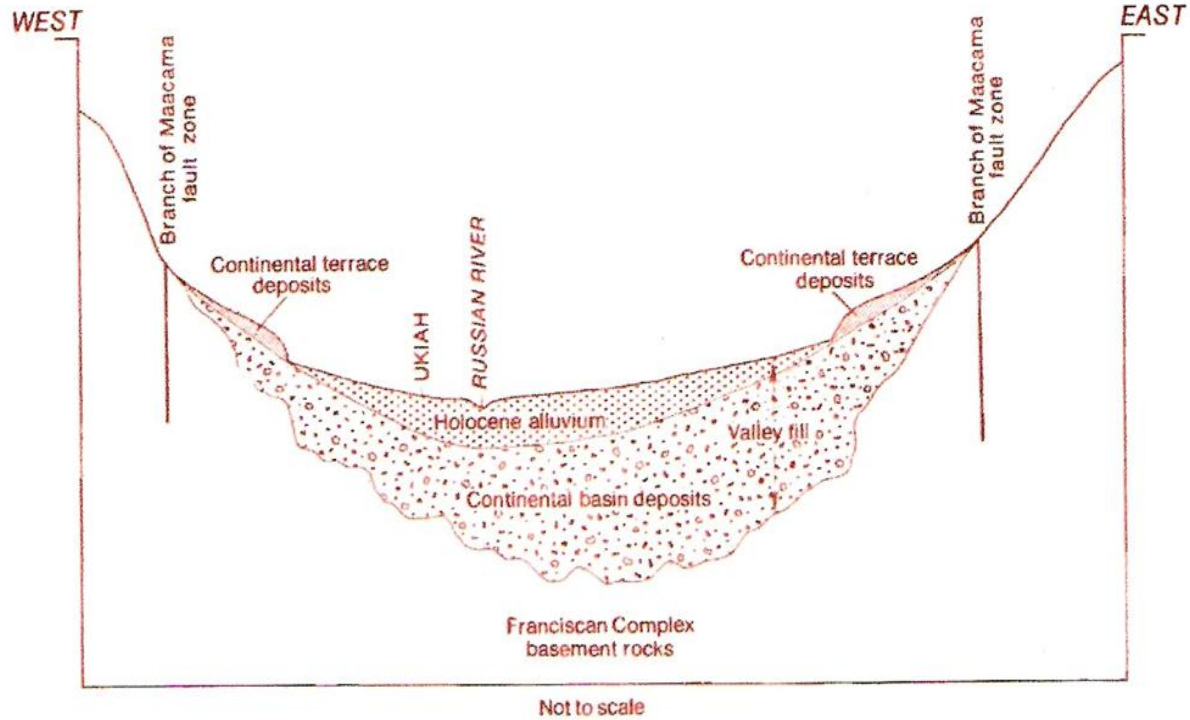


Figure 6.2.4. Illustration of subsurface layers in Ukiah Valley subarea. From: Farrar 1986.

Climate and Rainfall
Based on data from the Ukiah Station (period of record 1893 to present), the Ukiah Valley subarea has average maximum temperatures of 93° F in July and average minimum temperatures of 35.9° F in January. Average annual rainfall recorded at the Ukiah station is 37.3 inches/year (Western Regional Climate Center 2013). The Ukiah 4WSW station (period of record 1951 to present) located in the mountains on the west side of the subarea records annual average rainfall as 50.2 inches. Figure 6.2.8 shows the locations of these stations (Western Regional Climate Center 2013).

Vegetation
Hardwood forest and shrub vegetative cover dominate this subarea (Figure 6.2.9). Shrub cover is concentrated in the eastern mountains. Herbaceous cover primarily occurs along the eastern side of the subarea. Coniferous forest and mixed confer/hardwood forest are distributed as small areas throughout the subarea. Table 6.2.2 outlines the coverage of different vegetation types.

Table 6.2.2. Ukiah Valley subarea vegetative cover.

Cover Type	Total Acres	Percentage of Total Subarea
Hardwood forest/woodland	38,870	46.40%
Shrub	14,730	17.60%
Herbaceous	12,600	15.10%
Mixed Conifer/Hardwood Woodland	6,001	7.20%
Conifer Forest/Woodland	3,742	4.50%
Agriculture	3,042	3.60%
Urban/Residential	2,789	3.30%
Barren	1,807	2.20%
Water	110	0.10%

Channel Types and Surface/Groundwater Interactions
Figure 6.2.10 depicts the channel types mapped for the Ukiah Valley subarea and Figure 6.2.11 depicts channel slope. The main stem regulated Russian River is a low slope (<1%) channel that extends 12.0 miles through this subarea. All of the tributary streams contain bedrock canyon channels of different lengths in their mountain reaches. Throughout these bedrock reaches are short, steep gradients of 4-8% and >8% which could represent low flow fish passage barriers. Morrison and Robinson Creeks also have confined alluvial channels where openings occur in the mountains. McClure and Mill Creeks have dissected alluvium reaches where the channel crosses outcrops of the Loosely Consolidated Deposits. Alluvial fans are present on Orrs, Gibson, Doolin, Morrison, and Howell Creeks where the channel exits the mountain canyon into the Ukiah Valley. Hensley, Ackerman, Doolin, and Robinson Creeks all have semiconfined alluvial channels in their downstream reaches prior to reaching the valley floor. All of the creeks have alluvial unconfined channels which cross the valley floor to meet the Russian River.

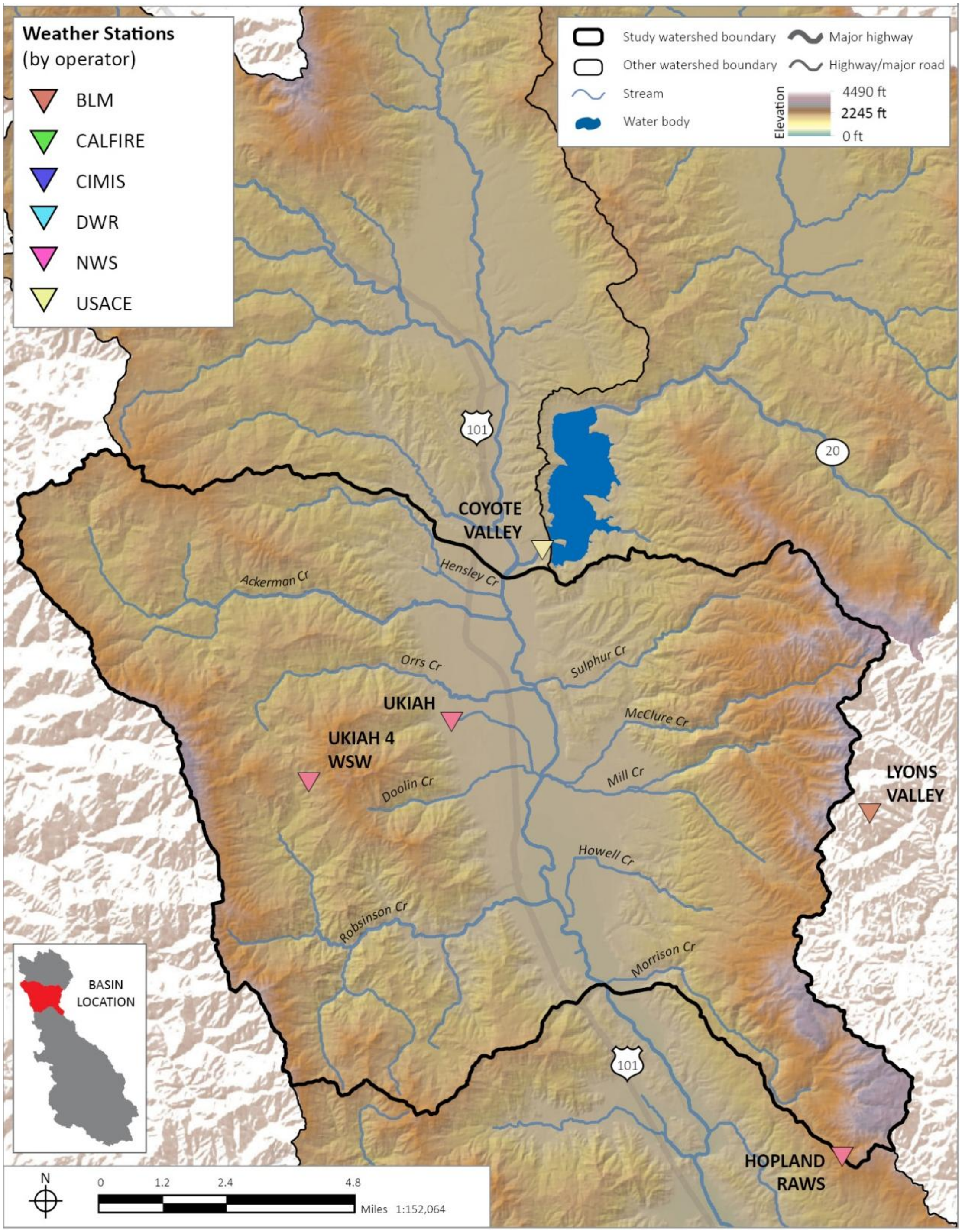


Figure 6.2.8. Elevation and weather stations in the Ukiah Valley subarea.

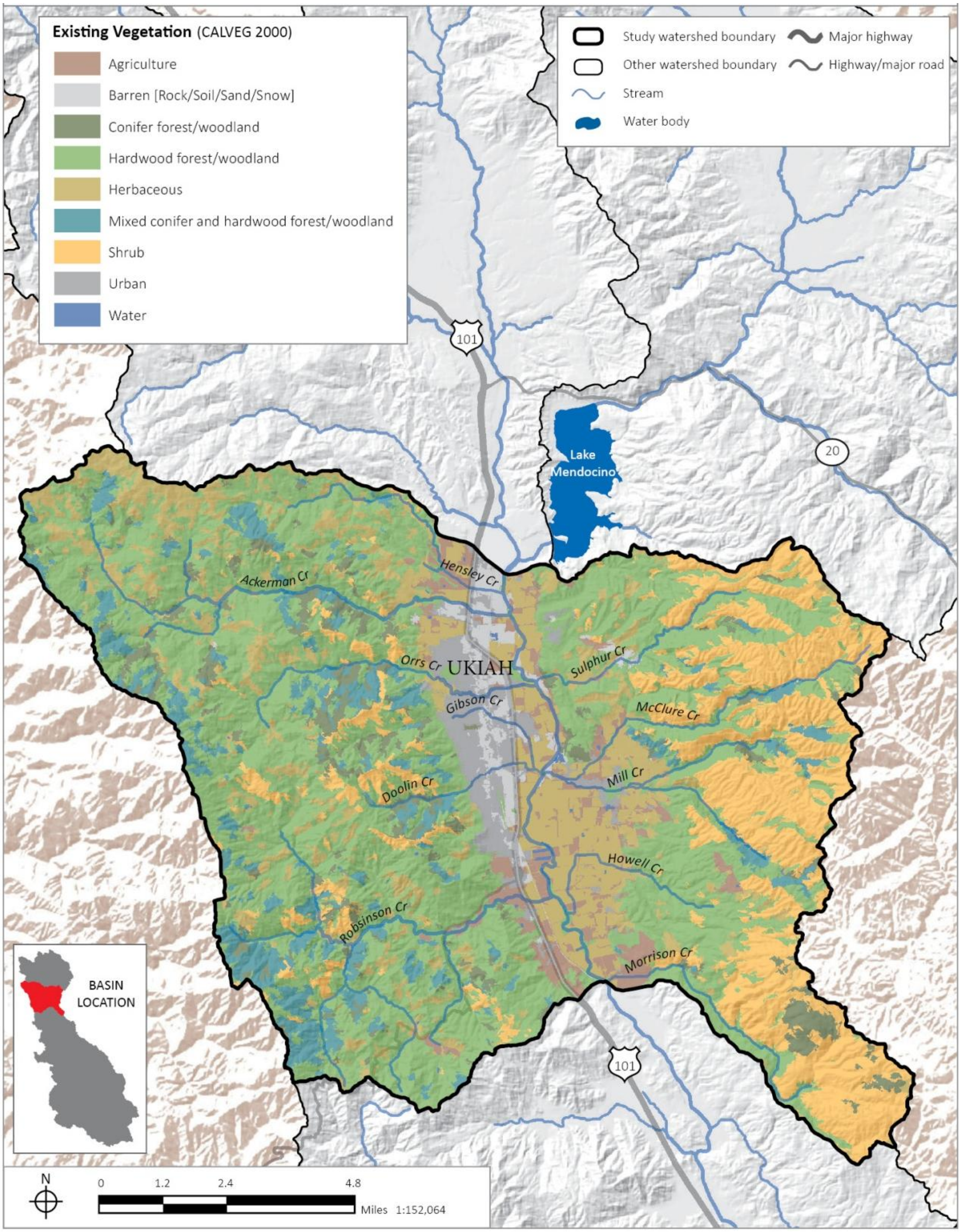


Figure 6.2.9. Existing vegetation of the Ukiah Valley subarea.

Empirical observations, photo-monitoring, and studies (Jackson and Marcus 2004, Walls 2013) have demonstrated that surface flow in several of these alluvial unconfined channels is strongly affected by the regulation of river stage from Coyote Dam. Table 6.2.3 outlines the length of each channel type in the Ukiah Valley subarea for fish-bearing streams only.

Table 6.2.3. Channel types for fish-bearing streams in the Ukiah Valley subarea.

Channel Type	Length (miles)	Percentage of Total Length of Fish-Bearing Streams in Subarea
Bedrock canyon	29.2	40%
Semiconfined alluvial	5.17	7%
Confined alluvial	5.41	8%
Alluvial fan	6.41	9%
Dissected alluvium	2.78	4%
Unconfined alluvial	11.16	15%
Regulated river	12.06	17%

Based on geology, stream gradients, historical photographs and interviews, and channel types, we can speculate on pre-development conditions in this subarea. The Russian River once had a wide, shallow channel with a floodplain covered in riparian forest and wetlands. The channel likely was braided, or several parallel channels existed. Figure 6.2.12 is a photograph of the Perkins St. bridge over the Russian River. Groundwater likely filled the pools in the river in summer during years of average or above average rainfall. The downstream unconfined alluvial reaches of tributary creeks may have had summer pools during high rainfall years, but likely were dry many years.

Discharge measurements made in the East Fork Russian River prior to the Potter Valley Project on 9/21/1905 recorded a 2.2 cfs flow. A discharge measurement on the West Fork on the same day recorded a 1.2 cfs flow. These measurements indicate very low flows (USGS 1913). Discharge measurements on creeks in this subarea were done on Ackerman Creek on 11/2/1911 and it was dry near the confluence with the river and on Orr Creek on 11/2/1911 and it was also dry near the mouth. The Ukiah rainfall gage (049122) shows a total of 34.72 inches for 1911. This is slightly below the average annual rainfall of 37.27 inches at this station.

George Gibbs Journal (1851) describes the Russian River in the Ukiah Valley:
"*Above here the river during the dry season runs chiefly under the sand and water is only to be obtained in occasional pools. We halted for the night at Lyon's encampment...about a mile above the east fork of Russian River comes in... To obtain better grass we passed up the river for about six miles, finding the bottom narrow and worthless. Crossing the now dry bed of the stream...*"
As described in Section 6.1, 1851 was a dry year.

Prior to 1908, when Eel River water was first diverted into the East Fork of the Russian River, the river very nearly dried up in July, August and September. An early flour mill located on the East Fork Russian River in Coyote Valley had to turn its wheel in the summer and fall by means of water diverted from year round Cold Creek through one mile of flume (Kaplan 1979).

Oral histories recorded in the early 1990s of long-time Ukiah Valley residents describe conditions in the river and its floodplain as far back as the 1920s (Chocholak 1992). Agricultural development began between 1850 to 1860 with hay, grain, hops, and livestock. Hops require a large labor force and families came to the area for several months. One resident remembered, *"Everybody would get their chores done in the morning and they would go down to the river and play and dive and swim underwater... Those were great days when we had all these people enjoying the river" (David Sagehorn)* (Chocholak 1992*)*. This account indicates there were deep pools in the river in summer.

Another interview describes the river bed as 8 to 12 feet higher than today, *"we used to be able to drive across it almost any place you wanted" (Morgan Ruddick)*. The floodplain held many sloughs *"...with large bunch grasses and climbing wild grapevines up in the oak trees and ash trees" (Nelson Redding). "The farmers had to farm around the sloughs, they didn't have the machinery to level the land. Even in those years the farmers would work on the river banks. They would cut the trees and make barriers to stop erosion."* However *"there was a lot of land between the agricultural crops and the river" (Nelson Redding). "If you look at it now you'll find the river doesn't have the vegetation it used to have...it's all fast water. There's nothing to bump up against...there used to be holes. They cleaned out the debris that makes those things" (Clarence White)* (Chocholak 1992*).*

It is likely that the bedrock canyon channels along the western side of the Ukiah Valley had flow during the summer due to cooler, fog induced conditions as indicated by the occurrence of redwood forest. The eastern mountain streams may have had summer flows in the bedrock channels. However the eastern mountains are also covered in drought tolerant vegetation and may not have supported perennial flows.

Semiconfined alluvial channels occur on four creeks on the western side of the valley. These channels may have supported year round pools if the alluvial deposit was deep enough to provide groundwater. The confined alluvial channels on Robinson Creek are low in slope in the mountainous area of the watershed and have springs to maintain summer flow. The confined alluvial channel reach on Sulphur Creek is low to moderate slope and cuts through the Loosely Consolidated Deposits. Depending on the depth and composition of this deposit there may have been adequate groundwater for summer pools.

The two dissected alluvium channels on McClure and Mill Creek are both relatively low slope and, like Sulphur Creek, are in the Loosely Consolidated Deposits and could have had summer pools. The unconfined alluvial and alluvial fan channels likely did not support summer pools.

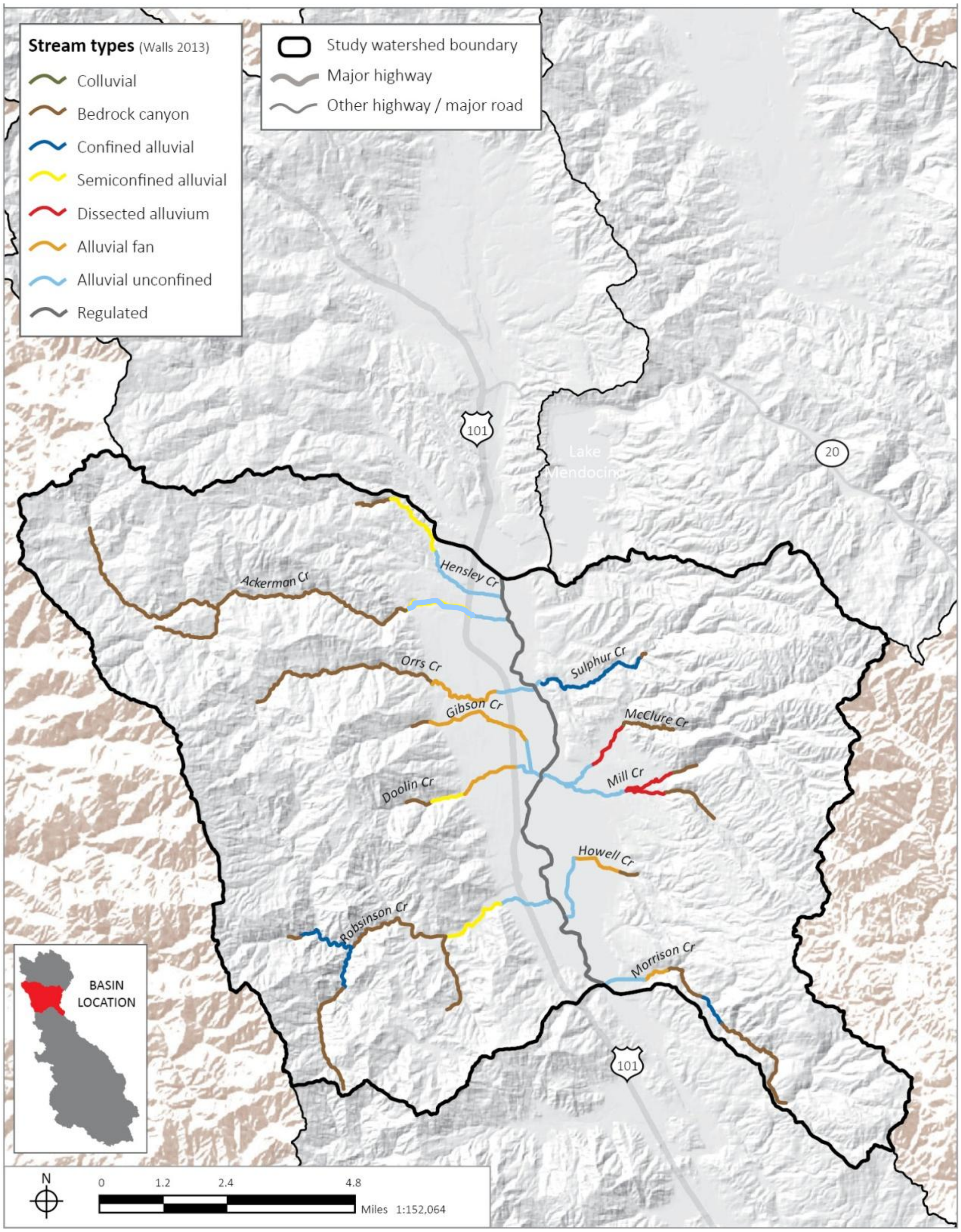


Figure 6.2.10. Stream typology for fish-bearing streams of the Ukiah Valley subarea.

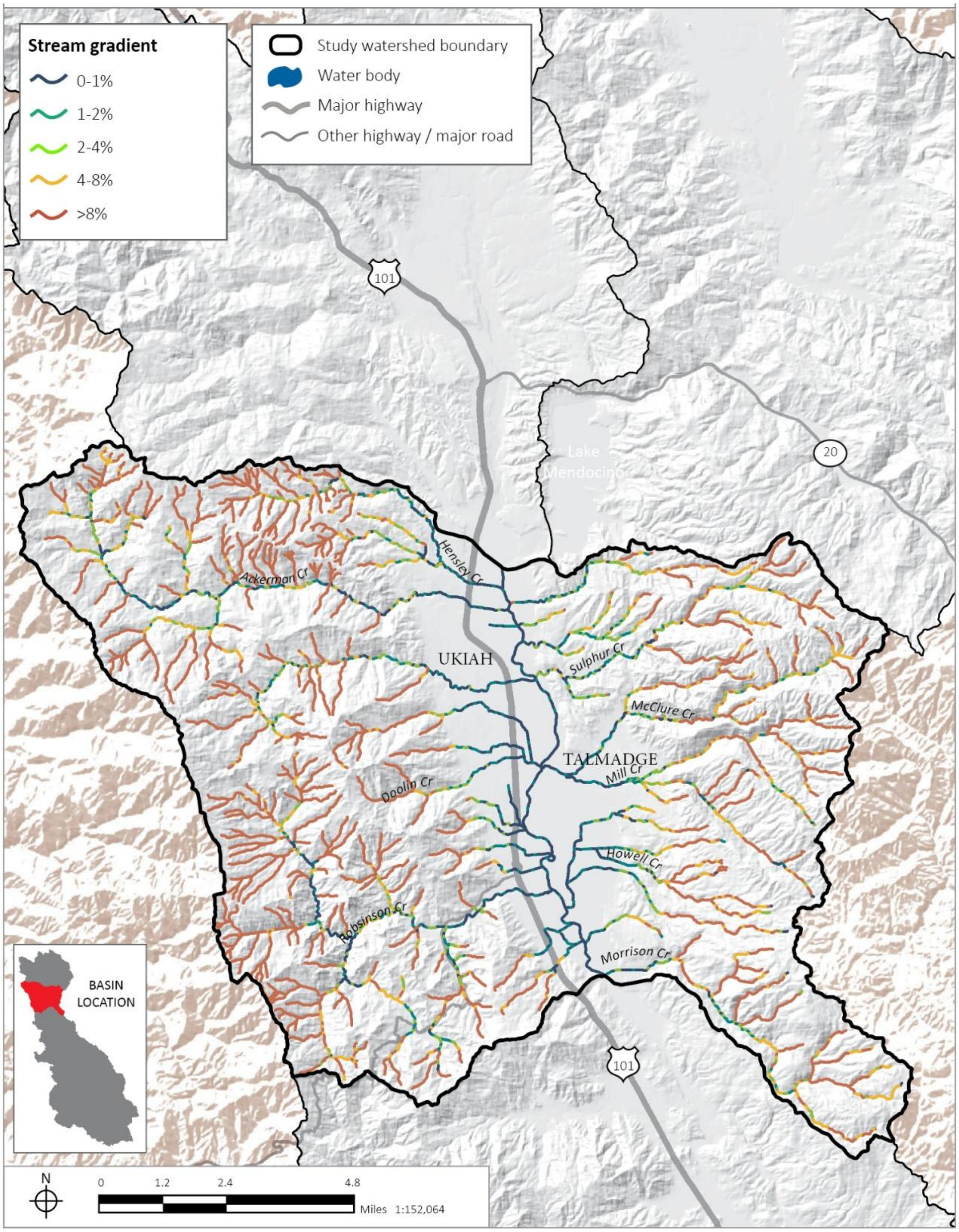


Figure 6.2.11. Stream gradients of Ukiah Valley subarea.

In 1959 Coyote Dam was completed by the Army Corps of Engineers creating Lake Mendocino. The total cost for the dam was $18,325,000 in 1959 ($147,000,000 in 2016 dollars). This reservoir impounds a maximum of 122,500 AF of water. Estimates of steelhead habitat flooded by the reservoir range from 36 to 64 miles (Steiner 1996). In the first fall/winter following construction, over 2,000 adult steelhead were observed in the river below the dam blocked from their spawning grounds (Chocholak 1992).

Another purpose of Lake Mendocino was to increase stream flow in the Russian River in the summer for recreation and to improve fish and wildlife. In the 1960s there was a general recognition that more water in the river was good for sport fish (SWRCB 1986).

Besides Coyote Dam a number of smaller reservoirs were also constructed on tributaries to the Russian River. These included Mill Creek where 3 dams were built in 1913 to provide water supply to the State Hospital in Ukiah. The hospital closed in the 1970s and the reservoirs became County property. The upper reservoir holds 85 AF, the middle reservoir holds 27 AF, and the lower reservoir is completely filled with sediment (County of Mendocino 2008). Smaller agricultural ponds also occur on some tributaries.

In the 1950s the river in Ukiah Valley had three large gravel mining areas. In 1950 243,413 short tons of sand and gravel were extracted largely for use in other counties (Philip Williams and Associates 1997).

The combination of Coyote Dam reducing sediment supply to the river, gravel extraction directly removing bedload, and the clearing, straightening, and stabilization of the river channel brought about significant channel entrenchment.

"Relative to 1965, I am a firm believer that the level of the water course is lower than it was earlier... We've noticed that our gravel bar, we do have a gravel bar which we've never extracted from, it is now scoured very badly in the last few winters. The reason for that is, it was high ground and it is now being cut and deposited someplace downstream" (Malcolm King) (Chocholak 1992*).*

Florsheim & Goodwin (1993) compared surveys of the river channel done by the Army Corps in 1940, a 1979 FEMA survey, and a 1985 Mendocino County survey and concluded that at least 18 ft. of incision in the main river channel and 10 ft. in the West Fork had occurred. Channel entrenchment reduced the bed formations (pools, riffles, gravel bars) in the main stem and created a deep channel with steep vertical banks and limited riparian canopy. The former floodplain, the valley floor, became disconnected from the river channel. The drop in base level in the main stem migrates up alluvial tributary channels causing further incision, loss of bedforms and resulting in impacts to infrastructure and loss of riparian habitat.

The California Department of Water Resources (1984) surveyed a number of tributary streams between 1980 and 1982 and found channel incision in Hensley, Ackerman, and Robinson Creeks. Between 1970 and 1990, the river incised about 5 feet at the City of Ukiah

Table 6.2.5 Major water systems in the Ukiah Valley subarea

Major Water System	Size (million gallons/yr)	Population Served	Size (gpm)	Size (cfs)	Total AF/yr
City of Ukiah	1,300	15,959	2,473	6	3,989.6
Calpella County Water District	37	490	70	0	113.5
Millview County Water District	540	5,500	1,027	2	1,657.2
Rogina Water Company Inc.	210	3,700	400	1	644.5
Willow County Water District	370	3,797	704	2	1,135.5

From: Sonoma County Water Agency 2014.

City of Ukiah

The City of Ukiah Water Department serves a population of about 16,000 from a series of wells and a radial collector well. Table 6.2.5 lists total water use and gallons/minute well production.

Private Water Companies

Several private companies provide water supply in the Ukiah Valley subarea including Rogina Water Company Inc. and River Estates Mutual Water Company.

Water Rights Data

In the Ukiah Valley subarea, the majority of water rights are located in the valley. Table 6.2.6 shows the public and private rights by type. In the Ukiah Valley some landowners applied for appropriative water right permits for their wells as Lake Mendocino was built.

Table 6.2.6 Water rights in the Ukiah Valley subarea.

Type and Status of Right	Number of Rights without Storage	Number of Rights with Storage
Riparian	18	29
Appropriative Licensed	44	41
Appropriative Permitted	7	4
Appropriative Pending	7	7
Total	76	81

From: State Water Resources Control Board database.

Monitoring and Data

Department of Water Resources (DWR) Monitoring Wells

There are three DWR monitoring wells in the Ukiah Valley subarea where groundwater level is measured in spring and fall. Figures 6.2.24-6.2.27 show the measurements from these wells from 1966 to present (well 08L), 1974 to present (well 05K) and 1973 to present (well 34Q). The graphs show recharge of the groundwater level annually except in drought years. The 1976/77 drought is marked by an arrow. The annual variations in groundwater level are less than 1 ft. to over 17 ft. (well 05K); less than 1 ft. to 13 ft. (well 08L) and 3 ft. to 33 ft. (well 34Q) over the period of record. Well 05K shows large annual changes in groundwater levels in the 1970s and early 1980s. However by the late 1980s to present the annual groundwater level change was much smaller. This variation could be based on a change in use of the monitored well, or the prior effects of adjacent wells that are no longer in use.

Well Driller Logs
Figure 6.2.28 depicts the approximate location of 61 wells which have drilling logs filed. Table 6.2.7 lists the information on the wells including rock types and well uses.

Table 6.2.7 Drilling log information for Ukiah Valley subarea.

Surface Rock Type	Number of Wells*	Average Well Depth (ft)	Range of Well Depths (ft)	Type of Well
Quaternary Alluvium (Q)	17	64.2	8 - 206	Monitoring (11), Irrigation (3), Industrial (1), Domestic (2)
Loosely Consolidated Deposits (QPC)	2	135	111 - 160	Domestic
Tertiary-Cretaceous Coastal Belt Rocks (TK)	40	218	72 - 160	Domestic
Franciscan Complex Coast Ranges (KJf)	2	291.5	143 - 440	Domestic

*Abandoned, backfilled, and dry wells were not included.

Stream Flow Gaging
There is a U.S. Geologic Survey stream flow gage 11462080 on the Russian River at Talmage. This gage was installed in August 2009. The short record available does not allow for an analysis of trends at this location. We have included the East Fork Russian River near Ukiah gage 11462000 which is located just downstream from Coyote Dam. Figure 6.2.29 depicts hydrographs of the wettest and driest years at this gage. The driest year was 2009, the second year of the current drought, and releases were at, or below, 100 cfs. The wettest year was 1983. Figure 6.2.30 shows the annual discharge for this stream flow gage and allows comparison between years. Table A-7 in Appendix A lists the highest peak flows for this gage with the highest flow of 13,300 cfs occurring on Dec. 21, 1955 prior to construction of the dam. Tables A-8 and A-9 list mean monthly and mean daily discharge for this gage.

Fisheries
The California Department of Fish and Wildlife completed stream habitat surveys for a number of streams in the Ukiah Valley subarea (CDFG 1995a, 1995d, 1997f, 1998e, 1999a, 1999m, 2001c, 2001f, 2001h, 2001o, 2001q, 2001r, 2001x). Table 6.2.8 summarizes information from these surveys. Steelhead trout were recorded in a number of tributaries. The Sonoma County Water Agency (2003) completed a kayak survey for spawning Chinook salmon in the river. They found an abundance of Chinook redds near Coyote Dam. As part of the Biological Opinion on operation of Coyote Dam a steelhead distribution study was done in 2002 using snorkel surveys between August and September. Randomly selected portions of the Russian River channel were

evaluated. Steelhead trout were recorded in the Russian River Ukiah Valley reach. Most of the habitat types recorded were flatwater (94%) with few riffle or deep pool habitats. The largest number of steelhead were recorded where riffle habitat occurred and in the pool below the grade control structure of the Willow Water District well field (also called Norgard Dam). In entrenched channels bedforms such as riffles, pools, and gravel bars are often eroded out so it is not surprising that the survey found primarily flatwater habitat with few steelhead.

Two of the conditions affecting salmonids have been mapped - migration barriers and riparian shade canopy. Barriers typically occur where a road crosses a creek or where a natural barrier such as a waterfall occurs. Entrenchment of the main stem river and the headcutting this causes in tributaries often creates fish migration barriers. When the tributary headcutting reaches a culverted road crossing the channel will deepen on the downstream side of the crossing creating a migration barrier to steelhead trout. Figure 6.2.31 depicts the mapped barriers in this subarea. Table 6.2.9 describes the features of each barrier. Figure 6.2.32 shows the percentage of riparian canopy density as recorded in CDFW stream surveys. Robinson, Orrs, and Hensley Creeks have relatively good cover at 50-75% for much of their lengths. McClure and Mill Creek have excellent cover at 75-100%.

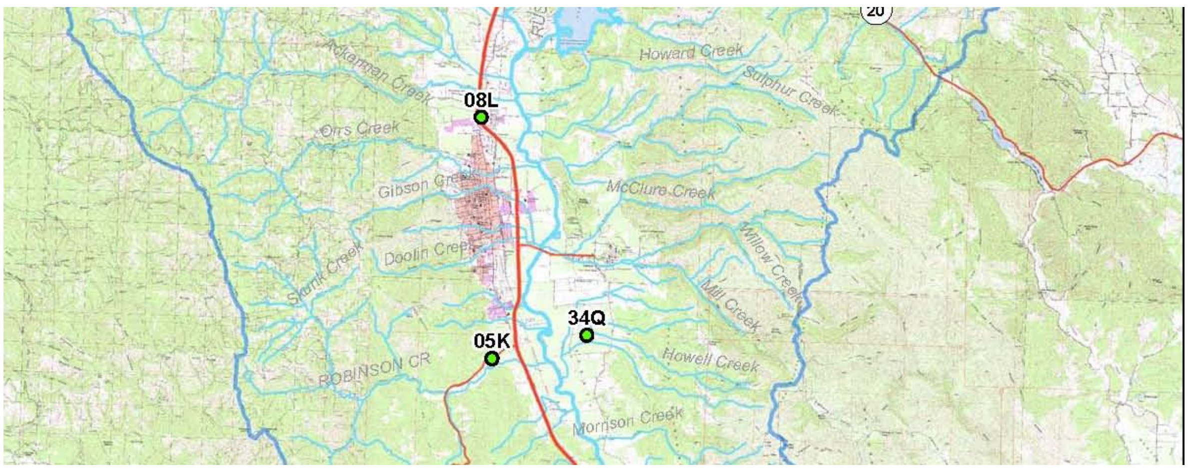


Figure 6.2.24. Locations of Ca. Dept. of Water Resources monitoring wells in the Ukiah Valley subarea.

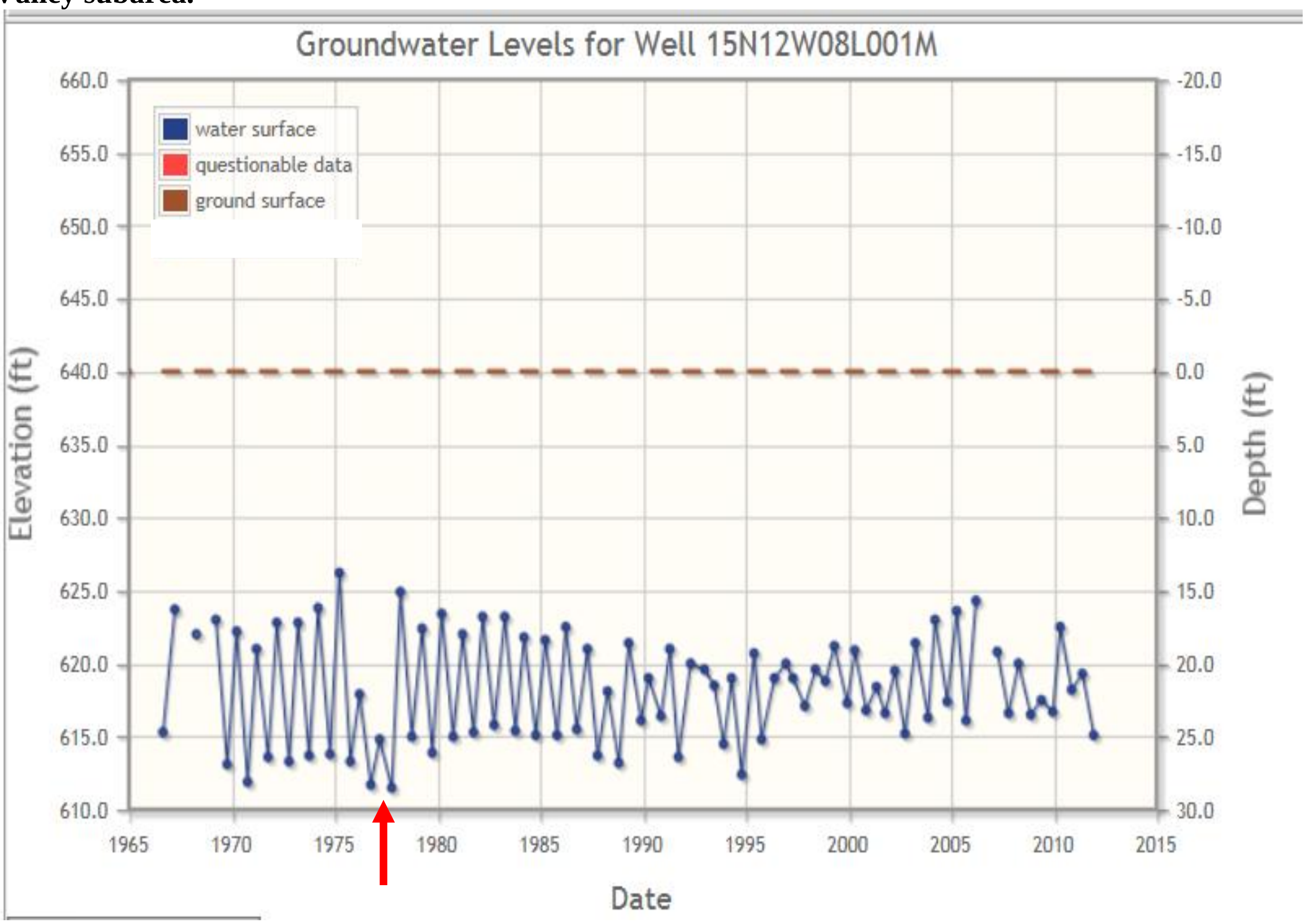


Figure 6.2.25. Groundwater level data for well 08L in the Ukiah Valley subarea. Dashed line indicates ground surface. Arrow indicates the 1976/77 drought.

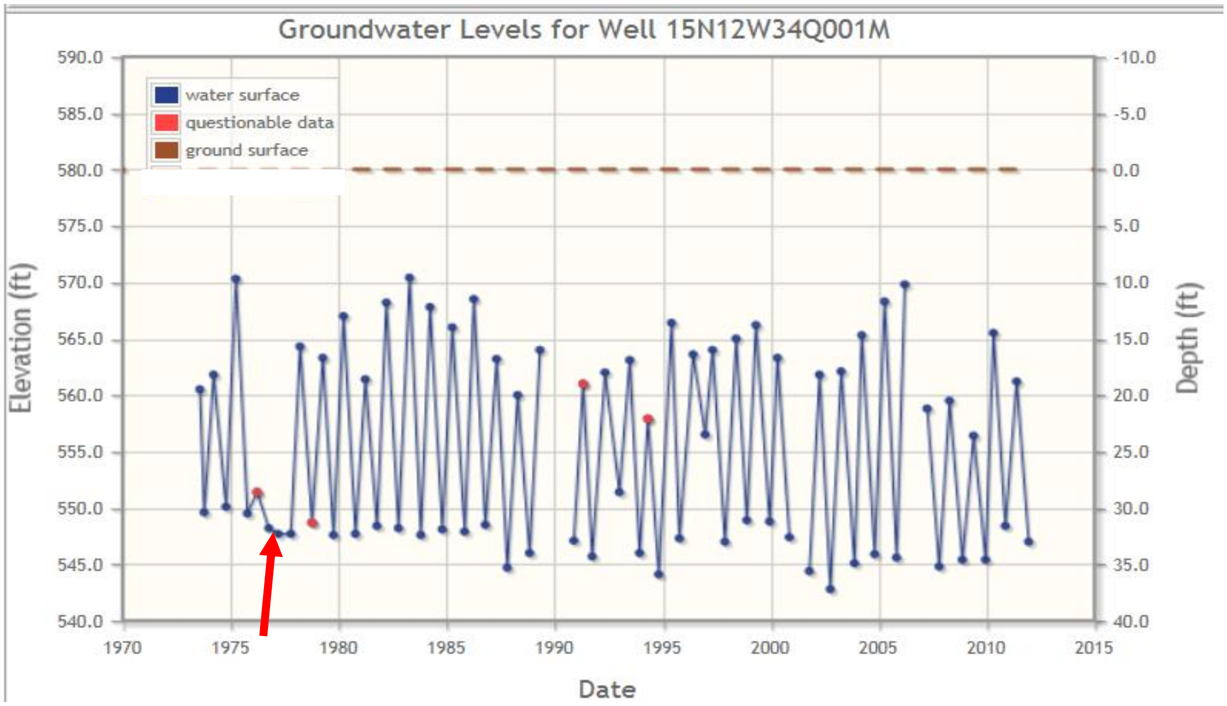


Figure 6.2.26. Groundwater level data for well 34Q in the Ukiah Valley subarea. Dashed line indicates the ground surface. Arrow indicates the 1976/77 drought.

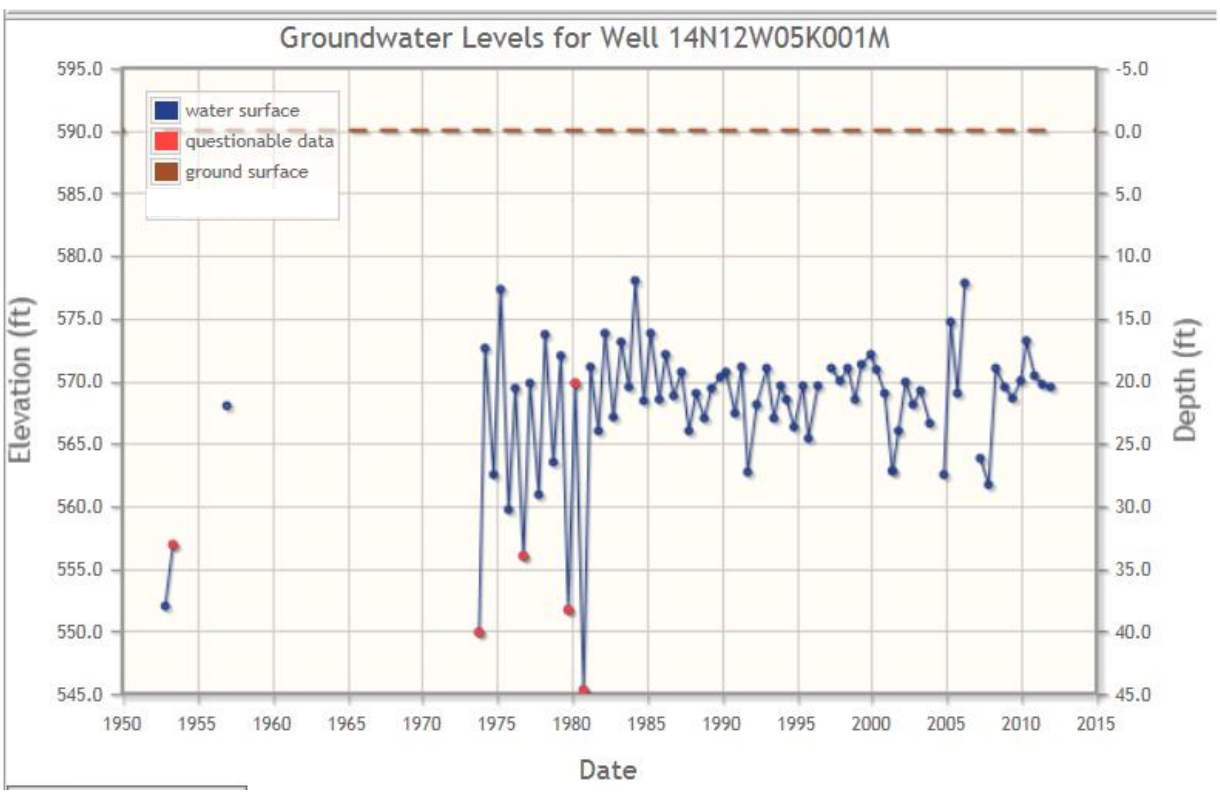


Figure 6.2.27. Groundwater level data for well 05K in the Ukiah Valley subarea. Dashed line indicates the ground surface

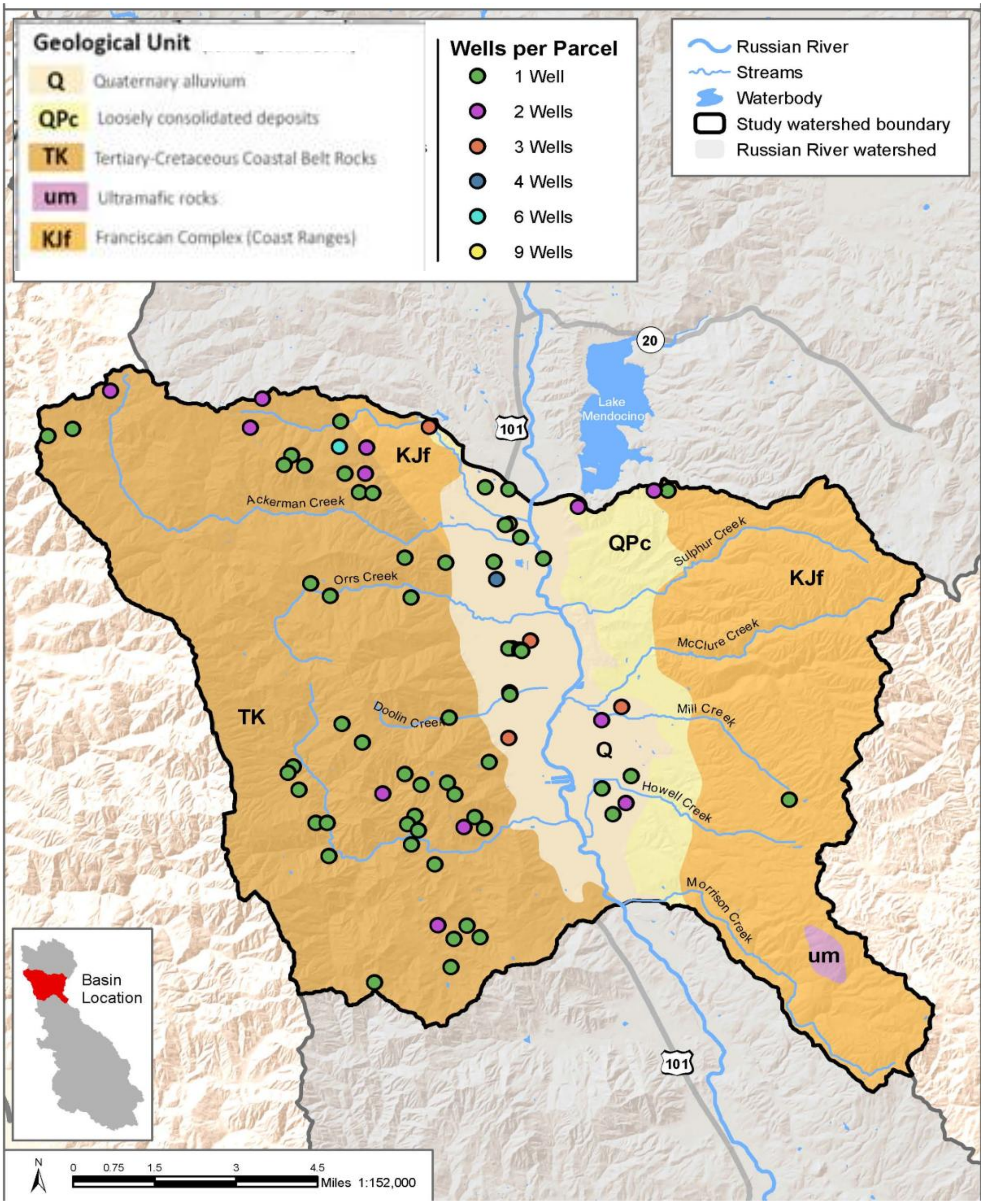


Figure 6.2.28. Locations of wells with drilling logs and geology in Ukiah Valley subarea.

Summary

Historical Conditions
It is unclear from the data available whether the main stem Russian River had salmonid rearing habitat over the dry season. The river channel was once wide and shallow with large meanders. There are discharge measurements that recorded a 2.2 cfs flow on September 21, 1905. This measurement was done prior to the 1908 diversion of Eel River water into the East Fork Russian River from the Potter Valley Project. Measurements on west side tributary streams recorded dry conditions in 1911 in two creeks. Rainfall records for Ukiah (Station 049122) show 1905 had total rainfall of 19.71 inches, about 50% of the average of 37.27 inches. Total rainfall was recorded as 34.72 inches in 1911 at Ukiah. Historic accounts in a dry year (1851) describe a completely dry river channel. This information indicates the Russian River may have had isolated pools connected by hyporheic flows in wet years and dry conditions in dry years. However unconfined alluvial creeks in Ukiah Valley may have had dry conditions even in normal rainfall years.

The bedrock creek channels along the western side of the Ukiah Valley likely had perennial flows most years and supported steelhead trout. It is not clear if semiconfined alluvial, confined alluvial, or dissected alluvium channels had summer rearing habitat. The presence of groundwater-fed pools depends on the permeability and thickness of the alluvial deposit, permeability of the underlying bedrock, the channel slope and condition, riparian canopy and annual rainfall. Many streams in this subarea have alluvial fans between the river and bedrock channels.

Hydrologic and Geomorphic Changes
The East Fork and main stem Russian River channel have been significantly altered. In 1908 a hydropower tunnel shunted water from the Eel River into the East Fork Russian River. Coyote Dam was constructed on the East Fork in 1959 creating Lake Mendocino and releasing water year round into the Russian River. Coyote Dam provides a number of benefits including flood control along the river in Ukiah Valley, water supply, recreation and dry season cold water for 5-10 miles of the river downstream of the dam. Lake Mendocino retains bedload and releases "hungry" water (Kondolf 1997) which has contributed to a highly entrenched river channel. The Russian River Channel Improvement Project was constructed from 1956 to 1963 and channelized the river through excavation and removal of riparian vegetation, installation of miles of bank revetments such as jacklines, rock riprap and flexible fencing. This project removed complex instream habitat and many acres of riparian habitat from the Russian River to create the smallest possible area for the river channel. Sloughs, secondary channels and other floodplain features were removed over the subsequent years. These changes resulted in 20+ feet of channel entrenchment, lowering of the groundwater level, eroding out of bedforms (pools/riffle/bars) and incision moving up into unconfined alluvial tributary channels.

Current Conditions
Irrigated agricultural lands in the Ukiah Valley subarea total about 6,840 acres while urban and rural residential areas total about 6,140 acres. Water supply for agriculture is provided by individual wells and reservoirs as well as main stem diversions through the Mendocino County

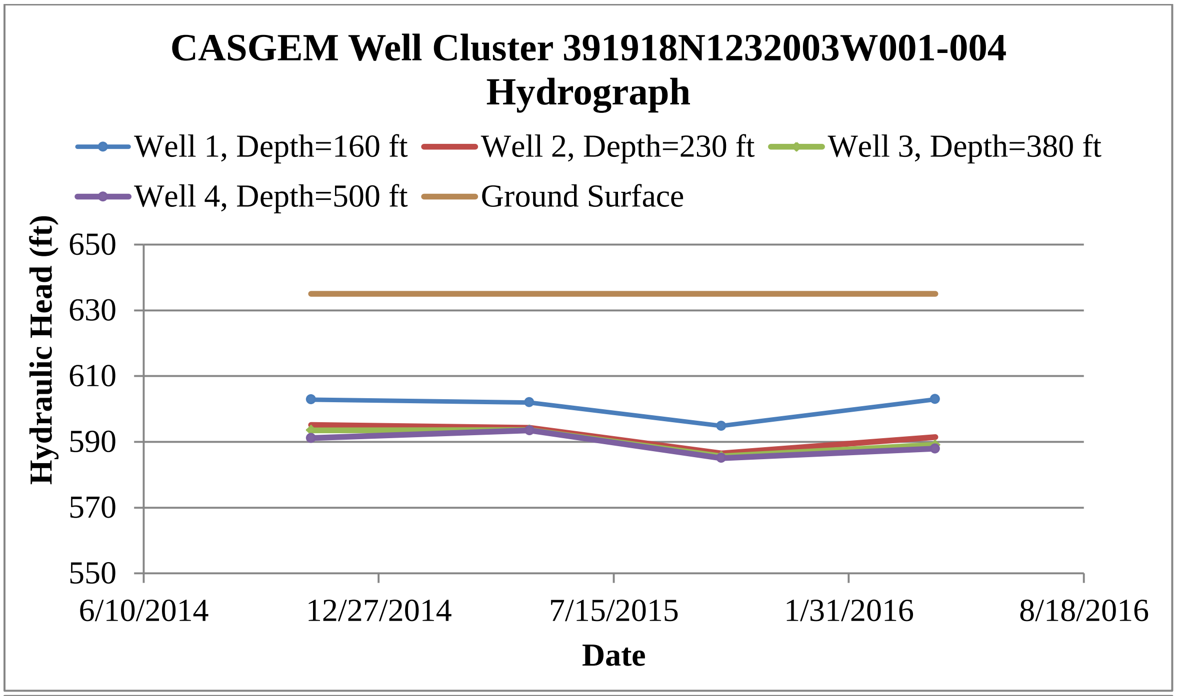
Russian River Flood Control and Water Conservation District (RRFC) which hold rights to 8,000 AF/year in Lake Mendocino. Urban water supply largely comes from wells and contracts between RRFC and smaller water districts. Groundwater level monitoring does not show any long term declines. Rapid drops in river flows in the entrenched channel in the spring can cause tributary stream flow to go subterranean possibly stranding juvenile out-migrating steelhead (see Section 2.13). Steelhead likely rear in the bedrock channels in this subarea, but must successfully reach the river by navigating alluvial fans and unconfined alluvial channels that can rapidly dewater. In its current entrenched, channelized state, the Russian River supports some steelhead trout and Chinook salmon which leave in early March before the river warms up. Entrenchment of the river reduces the groundwater level. This change may limit the amount of cold groundwater reaching the river in late summer/early fall. Due to the entrenchment of the main stem river and its tributaries, there are numerous fish migration barriers where roads cross creeks. Riparian cover is sparse along many creeks.

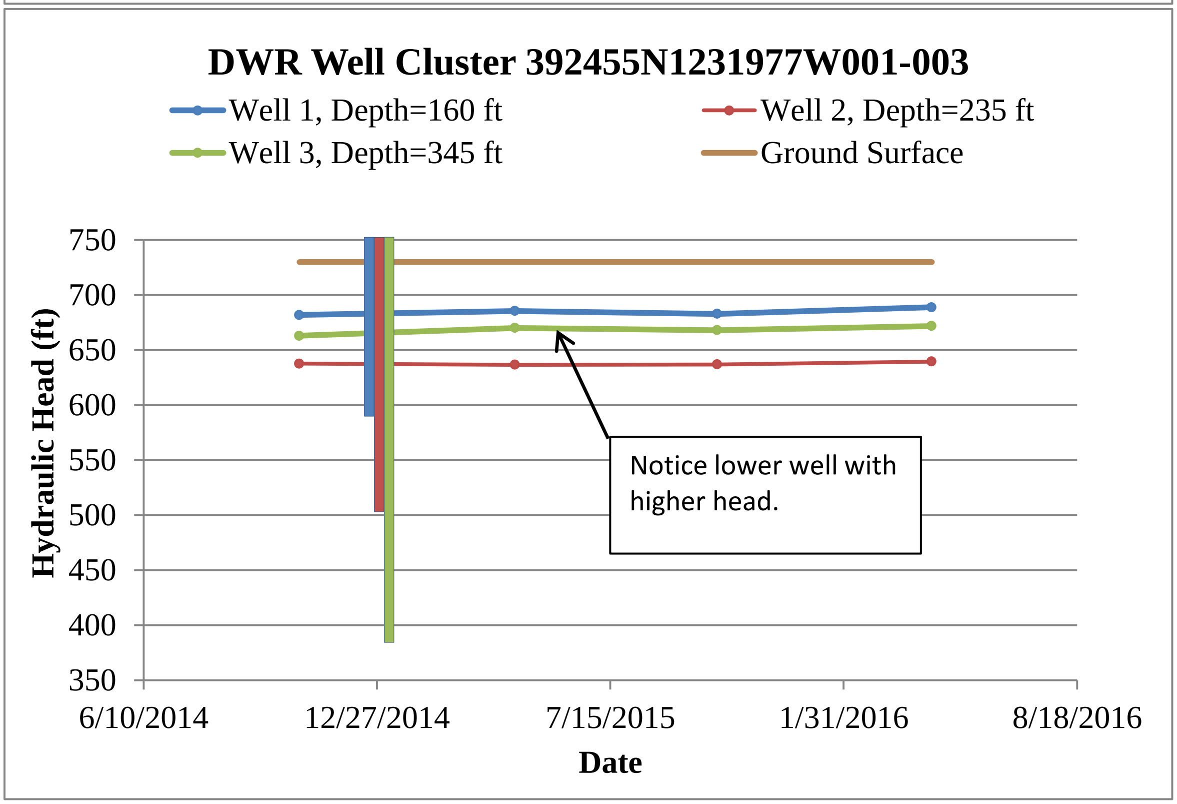
Recommended Monitoring and Studies

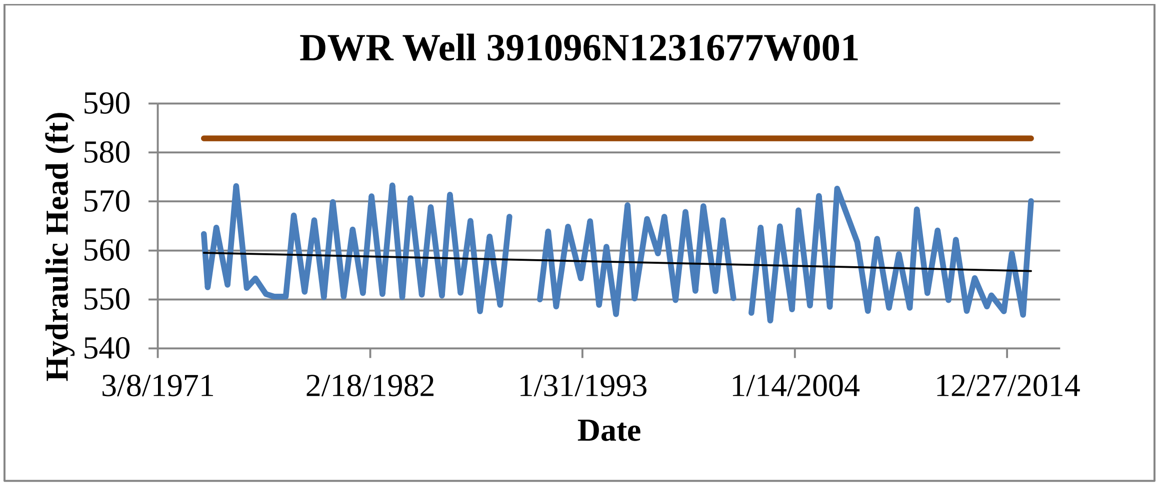
- Stream flow with water temperature monitoring in the dissected alluvium, semiconfined and confined alluvial channels would provide information on whether these channels support salmonid rearing habitats. This information can be used to prioritize restoration/revegetation efforts.
- Topographic surveying of the river channel and lower tributaries should be completed to evaluate ongoing rates of incision and likely future trends.
- All the creek channels need to be assessed for various life stages of salmonids as well as water temperatures and riparian canopy. This information can be used to prioritize restoration/revegetation projects.
- The Biological Opinion on the operation of Coyote Dam requires low summer flows because the Russian River had low flows prior to the dam. However, the channel shape and surface and groundwater interactions were historically very different from current conditions. Water temperatures should be monitored on the Russian River at very frequent intervals starting at the dam release to determine if the low flow releases are producing cold water conditions to support steelhead.
- The effect of flood control releases on river channel erosion need to be evaluated. Additionally the effect of stage changes on tributary flows in the spring needs to be documented and revisions to dam operations evaluated if needed to protect steelhead trout.
- Develop a collaborative groundwater monitoring program with landowners to determine if groundwater use is having a significant effect on creek and river flows. This monitoring will also be useful in completing a Groundwater Sustainability Plan, a requirement of the Sustainable Groundwater Management Act.

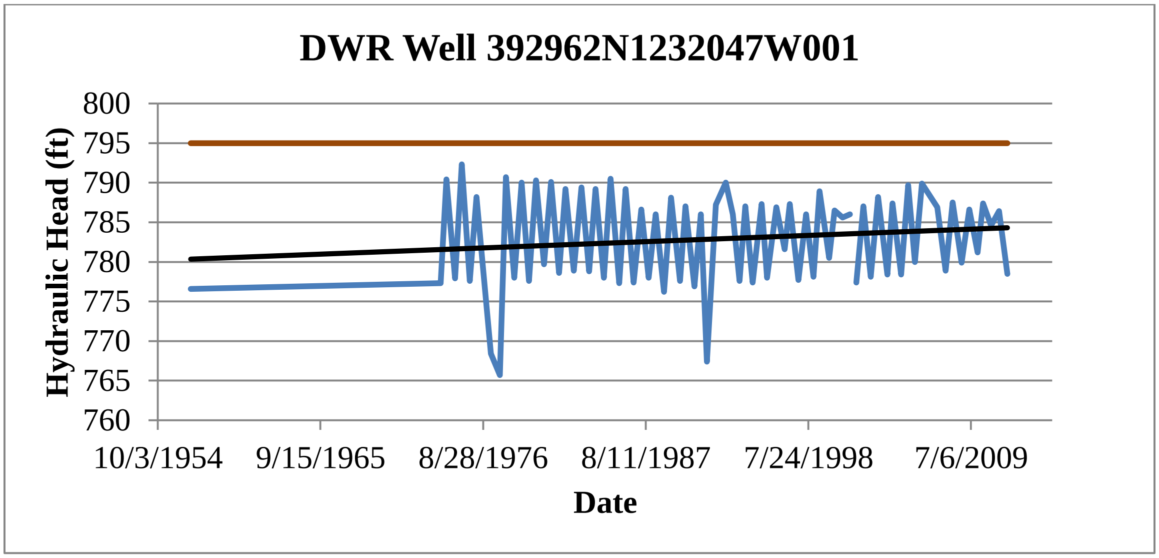
APPENDIX 6

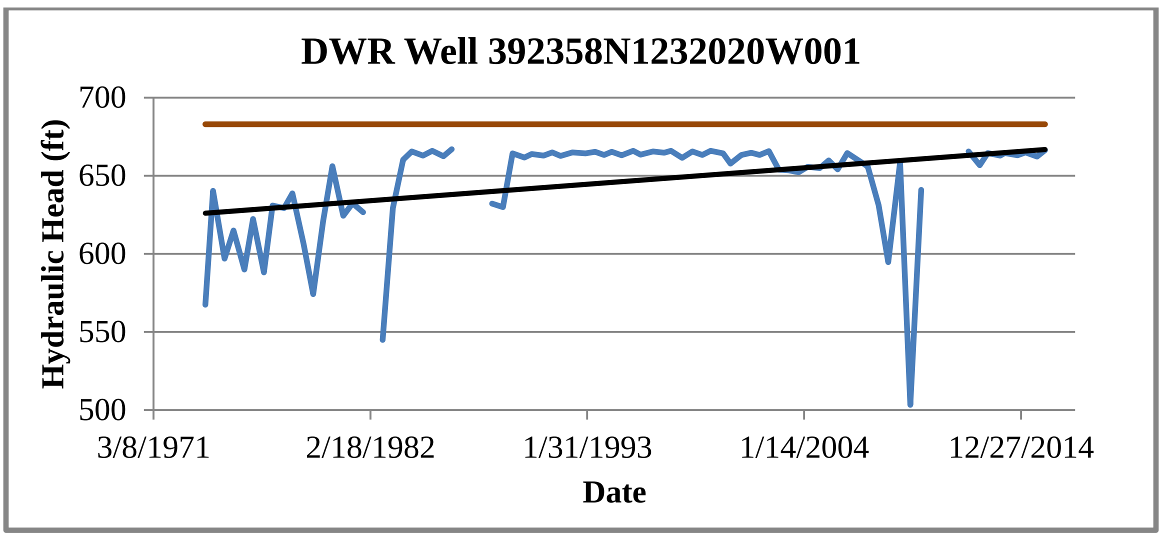
UVGB Hydrographs

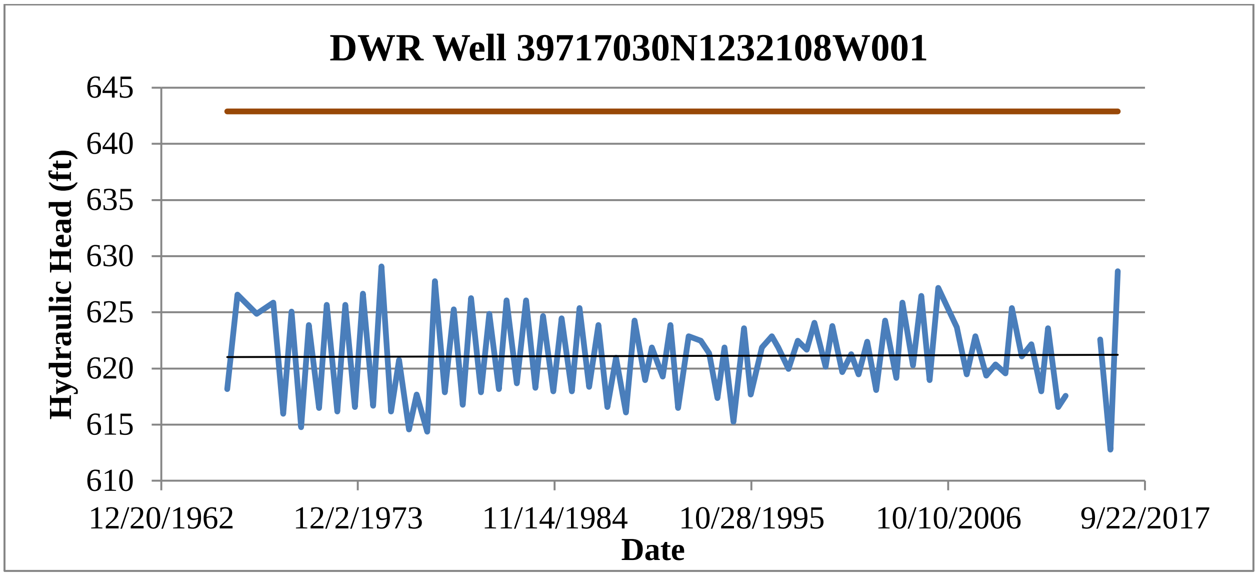

CASGEM Well Cluster 391918N1232003W001-004
Hydrograph
Well 1, Depth=160 ft
Well 2, Depth=230 ft
Well 3, Depth=380 ft
Well 4, Depth=500 ft
Ground Surface
Hydraulic Head (ft)
650
630
610
590
570
550
6/10/2014
12/27/2014
7/15/2015
1/31/2016
8/18/2016
Date

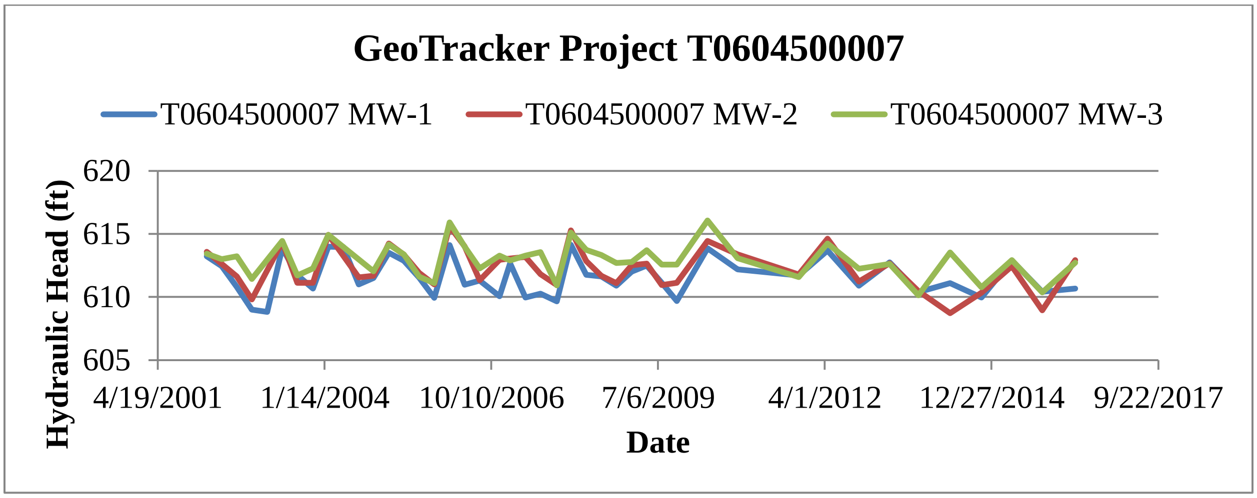

DWR Well Cluster 392455N1231977W001-003
Well 1, Depth=160 ft
Well 2, Depth=235 ft
Well 3, Depth=345 ft
Ground Surface
Hydraulic Head (ft)
750
700
650
600
550
500
450
400
350
Notice lower well with higher head.
6/10/2014
12/27/2014
7/15/2015
1/31/2016
8/18/2016
Date

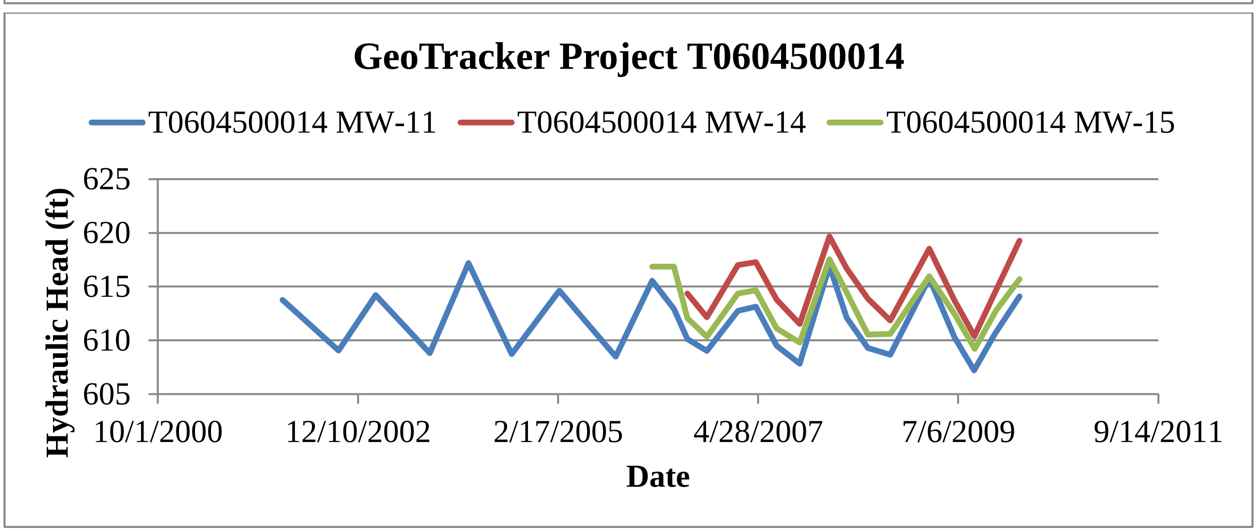

DWR Well 391096N1231677W001
590
580
570
560
550
540
Hydraulic Head (ft)
3/8/1971
2/18/1982
1/31/1993
1/14/2004
12/27/2014
Date

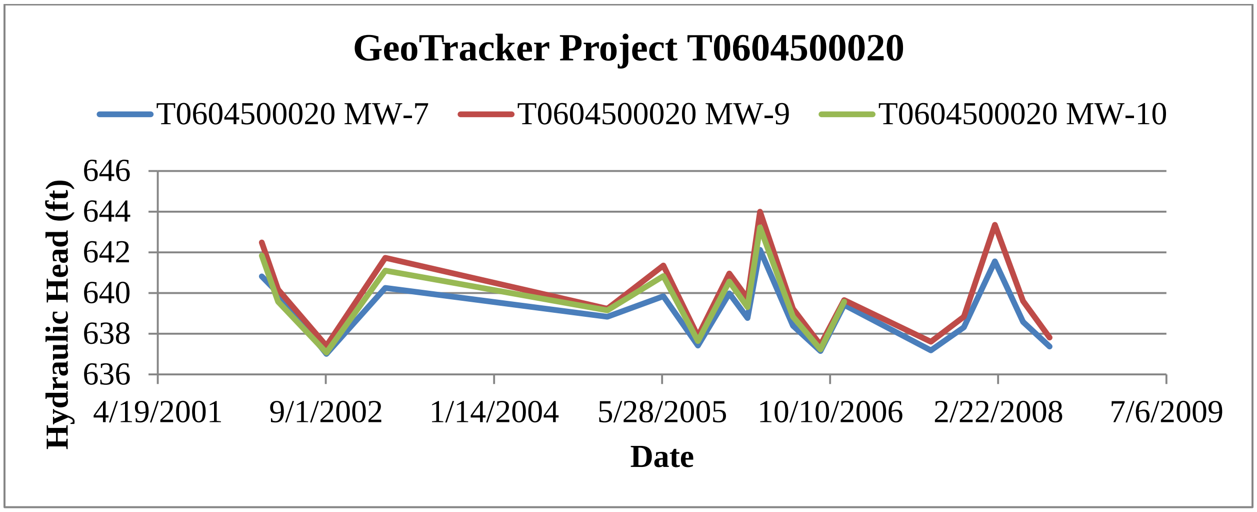

DWR Well 392962N1232047W001
800
795
790
785
780
775
770
765
760
Hydraulic Head (ft)
10/3/1954
9/15/1965
8/28/1976
8/11/1987
7/24/1998
7/6/2009
Date

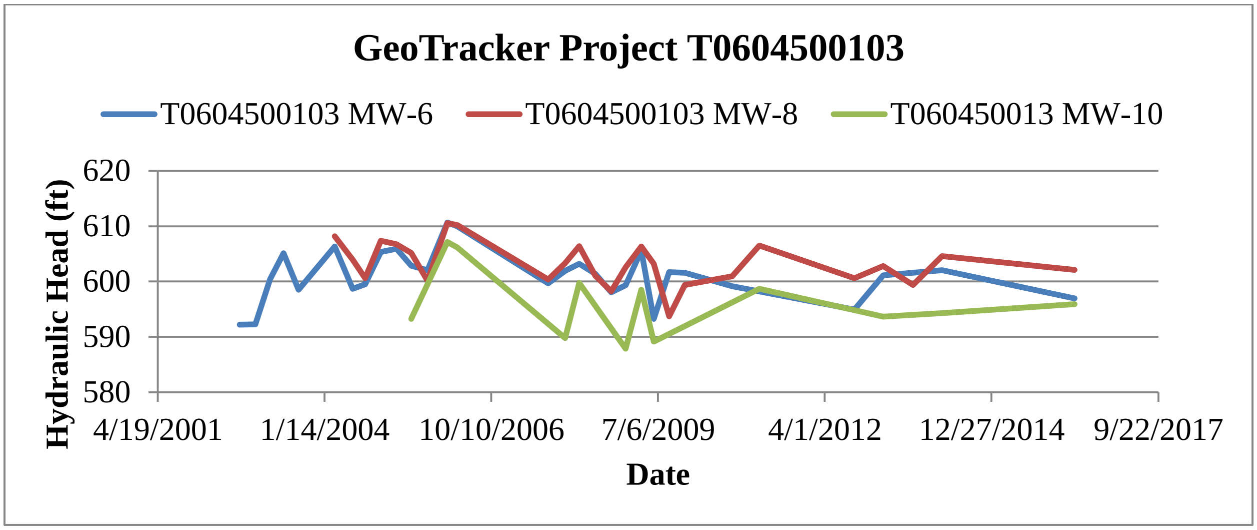

DWR Well 392358N1232020W001
700
650
600
550
500
Hydraulic Head (ft)
3/8/1971
2/18/1982
1/31/1993
1/14/2004
12/27/2014
Date

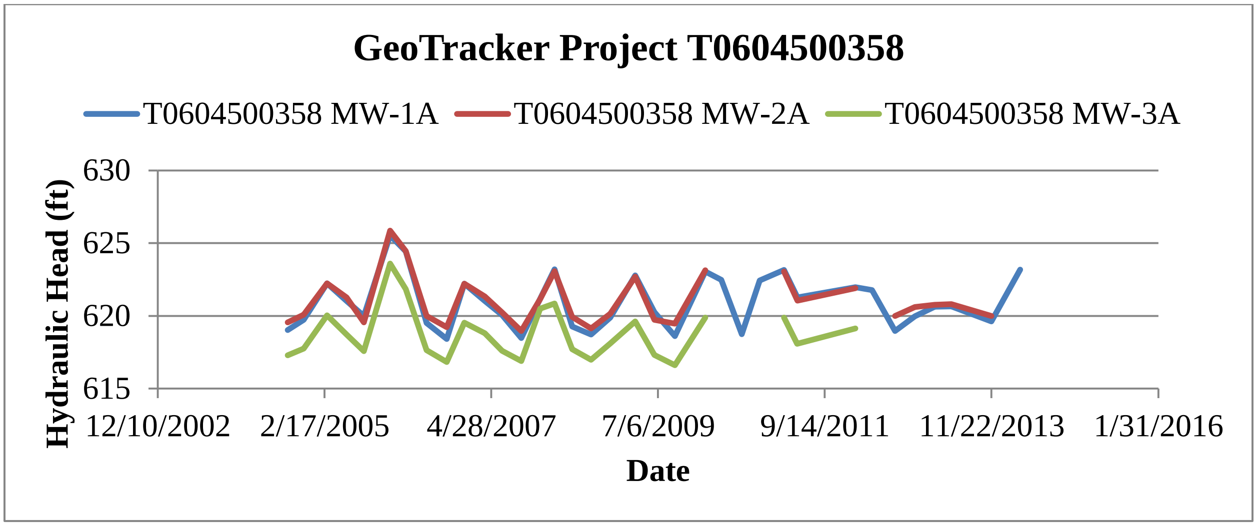

DWR Well 39717030N1232108W001
Hydraulic Head (ft)
645
640
635
630
625
620
615
610
12/20/1962
12/2/1973
11/14/1984
10/28/1995
10/10/2006
9/22/2017
Date

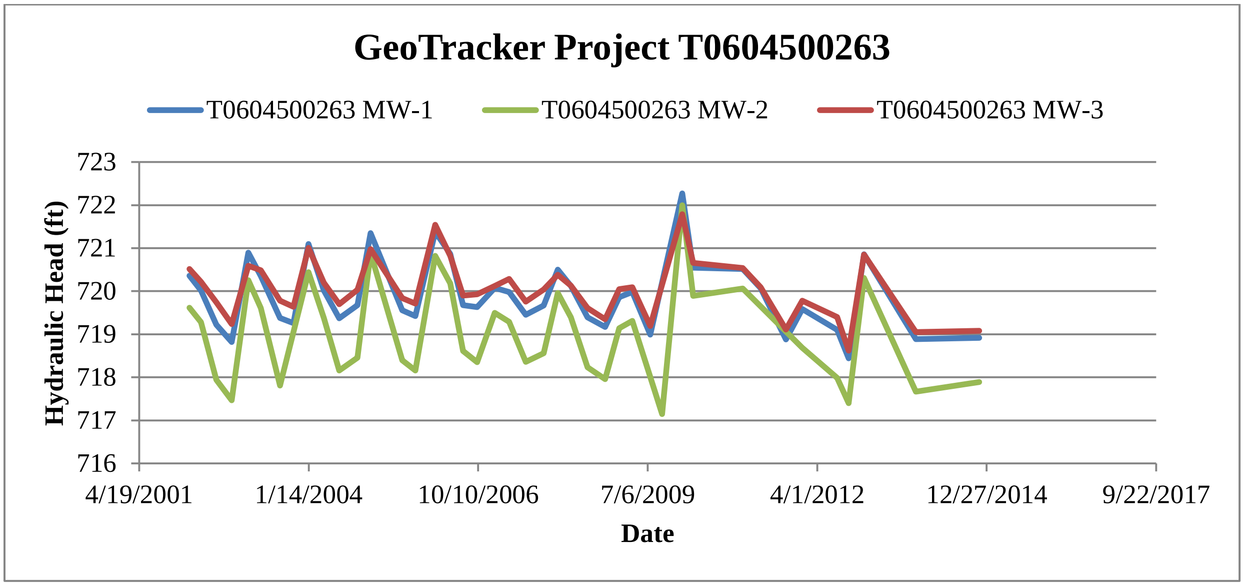

GeoTracker Project T0604500007
T0604500007 MW-1
T0604500007 MW-2
T0604500007 MW-3
Hydraulic Head (ft)
620
615
610
605
4/19/2001
1/14/2004
10/10/2006
7/6/2009
4/1/2012
12/27/2014
9/22/2017
Date

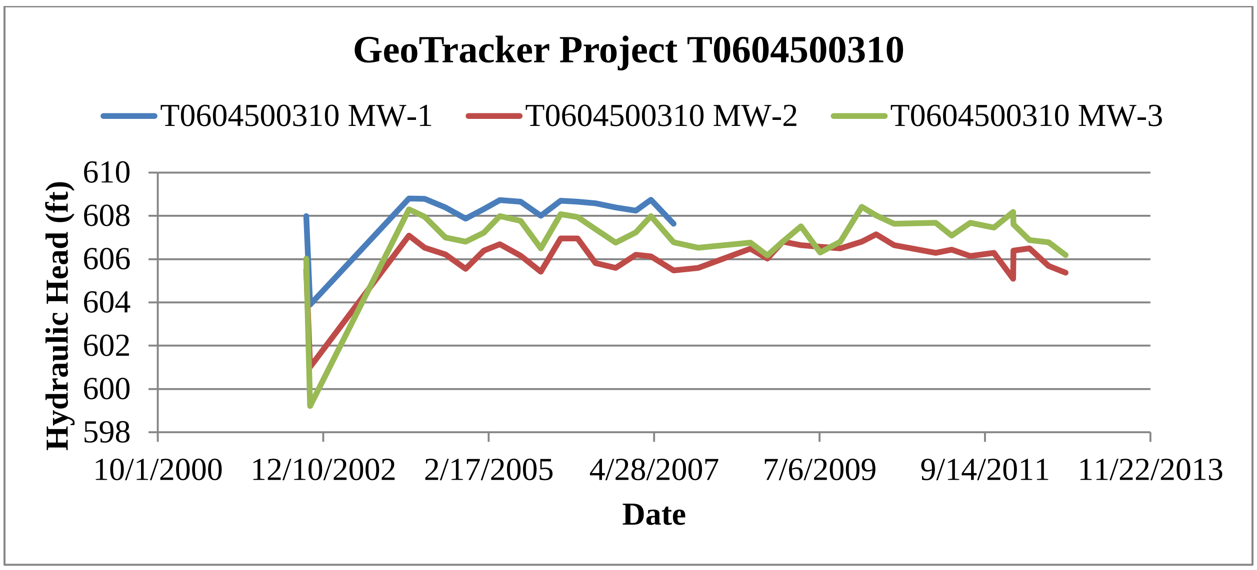

GeoTracker Project T0604500014
T0604500014 MW-11
T0604500014 MW-14
T0604500014 MW-15
Hydraulic Head (ft)
625
620
615
610
605
10/1/2000
12/10/2002
2/17/2005
4/28/2007
7/6/2009
9/14/2011
Date

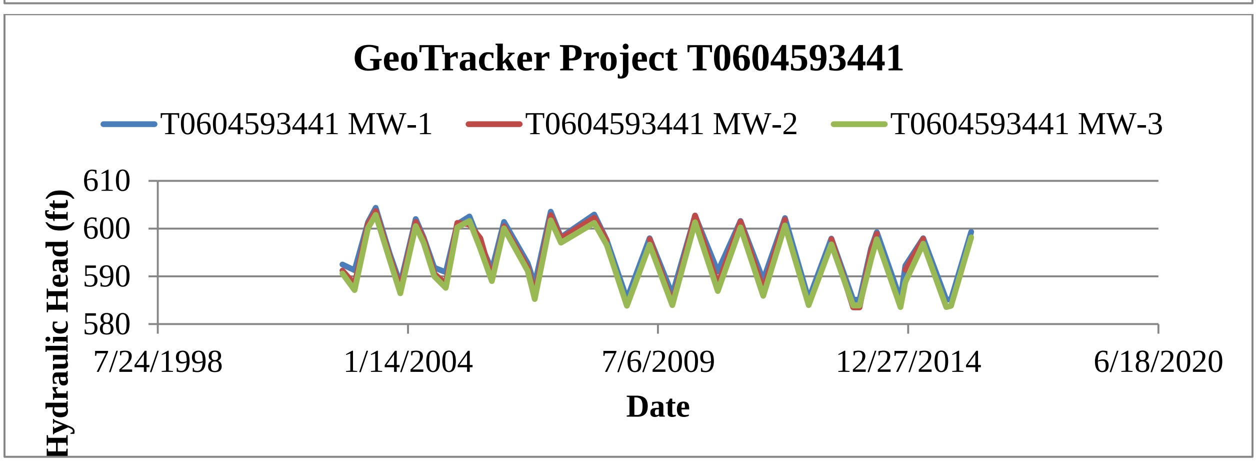

GeoTracker Project T0604500020
T0604500020 MW-7
T0604500020 MW-9
T0604500020 MW-10
Hydraulic Head (ft)
646
644
642
640
638
636
4/19/2001
9/1/2002
1/14/2004
5/28/2005
10/10/2006
2/22/2008
7/6/2009
Date


GeoTracker Project T0604500103
T0604500103 MW-6
T0604500103 MW-8
T060450013 MW-10
Hydraulic Head (ft)
620
610
600
590
580
4/19/2001
1/14/2004
10/10/2006
7/6/2009
4/1/2012
12/27/2014
9/22/2017
Date

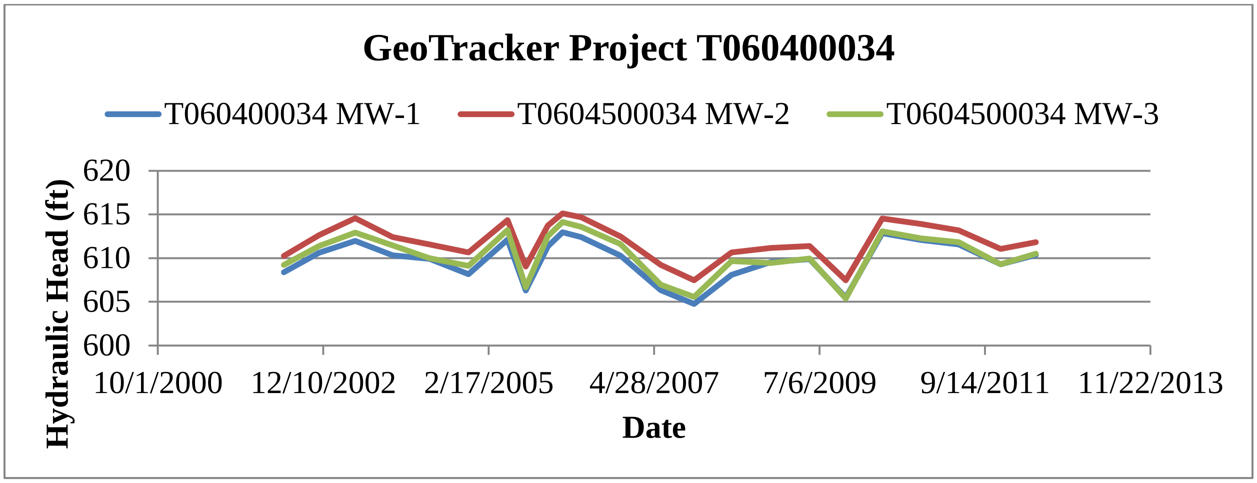

GeoTracker Project T0604500358
T0604500358 MW-1A
T0604500358 MW-2A
T0604500358 MW-3A
Hydraulic Head (ft)
630
625
620
615
12/10/2002
2/17/2005
4/28/2007
7/6/2009
9/14/2011
11/22/2013
1/31/2016
Date


GeoTracker Project T0604500263
T0604500263 MW-1
T0604500263 MW-2
T0604500263 MW-3
Hydraulic Head (ft)
723
722
721
720
719
718
717
716
4/19/2001
1/14/2004
10/10/2006
7/6/2009
4/1/2012
12/27/2014
9/22/2017
Date


GeoTracker Project T0604500310
T0604500310 MW-1
T0604500310 MW-2
T0604500310 MW-3
Hydraulic Head (ft)
610
608
606
604
602
600
598
10/1/2000
12/10/2002
2/17/2005
4/28/2007
7/6/2009
9/14/2011
11/22/2013
Date


GeoTracker Project T0604593441
T0604593441 MW-1
T0604593441 MW-2
T0604593441 MW-3
Hydraulic Head (ft)
610
600
590
580
7/24/1998
1/14/2004
7/6/2009
12/27/2014
6/18/2020
Date

LACO


GeoTracker Project T060400034
T060400034 MW-1
T0604500034 MW-2
T0604500034 MW-3
620
615
610
605
600
Hydraulic Head (ft)
10/1/2000
12/10/2002
2/17/2005
4/28/2007
7/6/2009
9/14/2011
11/22/2013
Date

APPENDIX 7

Well Completion Reports

ORIGINAL
File with DWR

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

162-140-021

Do not fill in
No. 215701

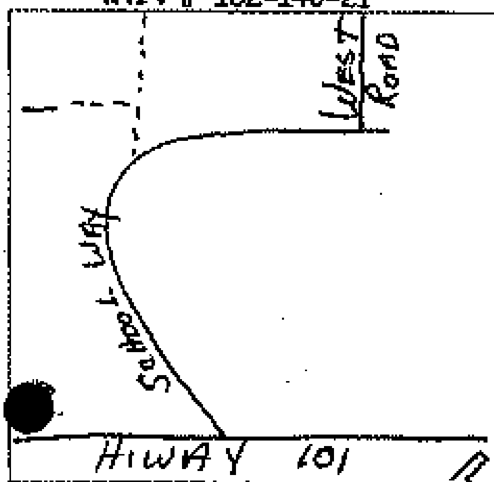
State Well No. ______
Other Well No. 16N12W06

Notice of Intent No. ______
Local Permit No. or Date ownet

[redacted]

(2) LOCATION OF WELL (See instructions):

County Mendocino Owner's Well Number ______
Well address if different from above ______
Township 16N Range 11W Section 6
Distance from cities, roads, railroads, fences, etc.
190 School Way
Redwood Valley
A.P. # 162-140-21



WELL LOCATION SKETCH

(3) TYPE OF WORK:

New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:

Domestic ☒
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

(5) EQUIPMENT:

Rotary ☒ Reverse ☐
Cable ☐ Air ☐
Other ☐ Bucket ☐

(6) GRAVEL PACK:

Yes ☒ No ☐ Size 3/8" pea
Diameter of bore 9 7/8"
Packed from 25 to 173 ft.

(7) CASING INSTALLED:

Steel ☐ Plastic ☒ Concrete ☐

(8) PERFORATIONS: saw cut

Type of perforation or size of screen

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot size
0	156	6"	Cl200	96	156	1/8x3"

(9) WELL SEAL:

Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 25 ft.
Were strata sealed against pollution? Yes ☐ No ☒ Interval ______ ft.
Method of sealing concrete on gravel pack

(10) WATER LEVELS:

Depth of first water, if known ______ ft.
Standing level after well completion 35 ft.

(11) WELL TESTS:

Was well test made? Yes ☒ No ☐ If yes, by whom? Weeks
Type of test Pump ☐ Bailer ☒ Air lift ☐
Depth to water at start of test 35 ft. At end of test 140 ft
Discharge 8 gal/min after 2 hours Water temperature cool
Chemical analyses made? Yes ☐ No ☒ If yes, by whom? ______
Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

(12) WELL LOG:

Total depth 173 ft. Depth of completed well 156 ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
		Well # 2
0	1	Top soil
1	43	Conglomerate boulders and cobbles cemented in brown clay
43	64	Yellow and brown clay
64	72	Small brown gravel
72	76	Brown clay
76	112	Conglomerate cemented gravel
112	129	Brown gravel
129	148	Cemented gravel
148	155	Brown clay with streaks of cemented gravel
155	173	Brown clay

Work started 8/27 1986 Completed 9/2 1986

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

SIGNED Gerald Thompson By: Don Sinclair
(Well Driller)

NAME WEEKS DRILLING AND PUMP COMPANY
(Person, firm, or corporation) (Typed or printed)
Address P.O. Box 176 - 6100 Sebastopol Road
City Sebastopol, California Zip 95472
License No. 057-177681 Date of this report September 3,1986

DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

ORIGINAL
File with DWR

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

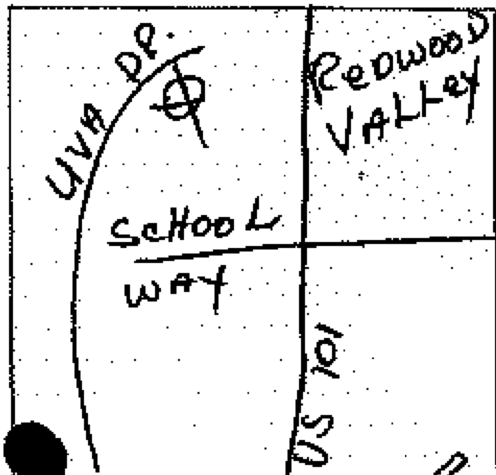
Do not fill in
No. 30670

Notice of Intent No. ______
Local Permit No. or Date ______

State Well No. ______
Other Well No. 16N/2W07A

[redacted]

(2) LOCATION OF WELL (See instructions):
County: Mendocino Owner's Well Number ______
Well address if different from above ______
Township ______ Range ______ Section ______
Distance from cities, roads, railroads, fences, etc. same



WELL LOCATION SKETCH

(3) TYPE OF WORK:
New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:
Domestic ☐
Irrigation ☒
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

(5) EQUIPMENT:
Rotary ☒ Reverse ☐
Cable ☐ Air ☐
Other ☐ Bucket ☐

(6) GRAVEL PACK:
Yes ☒ No ☐ Size ______
Diameter of bore 9 7/8 & 12 3/4
Packed from 0 to 165 ft.

(7) CASING INSTALLED:
Steel ☐ Plastic ☒ Concrete ☐

(8) PERFORATIONS: sawn
Type of perforation or size of screen

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot size
0	158	8	160	79	157	1/8 x 4

(9) WELL SEAL:
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 19' ft.
Were strata sealed against pollution? Yes ☐ No ☒ Interval ______ ft.
Method of sealing cement on gravel pack

(10) WATER LEVELS:
Depth of first water, if known ______ ft.
Standing level after well completion 40' ft.

(11) WELL TESTS:
Was well test made? Yes ☒ No ☐ If yes, by whom? Weeks
Type of test Pump ☐ Bailer ☒ Air lift ☐
Depth to water at start of test 40' ft. At end of test 137' ft.
Discharge 18 gal/min after 1 hours Water temperature cold
Chemical analysis made? Yes ☐ No ☒ If yes, by whom? ______
Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

(12) WELL LOG:
Total depth 165 ft. Depth of completed well 165 ft.

from ft. to ft.	Formation (Describe by color, character, size or material)
0-2	Top soil
2-9	Cemented brown sand & gravel with boulders
9-16	Sandy brown clay w/embedded gravel
16-22	Sandy brown clay
22-29	Sandy brown clay w/streaks embedded gravel
29-55	Cemented brown sand & gravel
55-57	Stiff brown clay
57-67	Stiff gray clay
67-70	Cemented sand & gravel
70-75	Stiff gray clay
75-88	Cemented sand & gravel
88-98	Stiff brown clay
98-115	Cemented brown sand & gravel
115-121	Stiff brown clay
121-123	Sand & gravel
123-127	Stiff brown clay
127-134	Brown clay w/streaks embedded grav
134-146	Cemented sand & gravel
146-149	Stiff brown clay
149-151	Cemented sand & gravel
151-165	Sandy brown clay w/streaks cemented sand & gravel

CONFIDENTIAL
DO NOT MAKE PUBLIC
WATER CODE SECTION 13752

Work started 1/6 1977 Completed 1/9 1977

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

SIGNED Gerald Thompson By: Mary E. Thompson
(Well Driller)
NAME Weeks Drilling and Pump Co.
(Person, firm, or corporation) (Typed or printed)
Address Sebastopol Road
City Sebastopol, California 95472
License No. 177681 Date of this report January 14, 1977

Mary E. Thompson

ORIGINAL
File with DWR

Page 1 of 1

Owner's Well No. ______

Date Work Began 11-21-94, Ended 11-21-94

Local Permit Agency Mendocino County

Permit No. 9906 Permit Date 5-24-94

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 548153

DWR USE ONLY — DO NOT FILL IN

16N12W07B M

STATE WELL NO./STATION NO.

LATITUDE | LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DEPTH TO FIRST WATER ______ (Ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION Describe material, grain size, color, etc.
0	2	topsoil
2	60	brown clay w/ boulders
60	180	blue clay w/ gravel

TOTAL DEPTH OF BORING 180 (Feet)

TOTAL DEPTH OF COMPLETED WELL 180 (Feet)

WELL OWNER

[redacted]

WELL LOCATION

Address 275 Terra Verde Court #5

City Redwood Valley, CA

County Mendocino

APN Book 16 2 Page 171 Parcel 27

Township ______ Range ______ Section ______

Latitude ___ ___ ___ NORTH (DEG. MIN. SEC.) Longitude ___ ___ ___ WEST (DEG. MIN. SEC.)

LOCATION SKETCH

NORTH / WEST / EAST / SOUTH

Illustrate or Describe Distance of Well from Landmarks such as Roads, Buildings, Fences, Rivers, etc. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

X NEW WELL

MODIFICATION/REPAIR

___ Deepen

___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USE(S) (✓)

___ MONITORING

WATER SUPPLY

X Domestic

___ Public

___ Irrigation

___ Industrial

___ "TEST WELL"

___ CATHODIC PROTECTION

___ OTHER (Specify)

DRILLING METHOD Rotary Air FLUID ______

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL 25 (Ft.) & DATE MEASURED 11-21-94

ESTIMATED YIELD* 10 (GPM) & TEST TYPE airlift

TEST LENGTH 3 (Hrs.) TOTAL DRAWDOWN 180 (Ft.)

* May not be representative of a well's long-term yield.

CASING(S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE: BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	80	10	x				F480PVC	5	c200	
80	180	"		X			"	"	"	1/8

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	20		X		
20				X	fine pea

ATTACHMENTS (✓)

___ Geologic Log

___ Well Construction Diagram

___ Geophysical Log(s)

___ Soil/Water Chemical Analyses

___ Other ______

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME FISCH BROS. DRILLING INC. (PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED) 941

5001 Gravenstein Hiway N., Sebastopol, CA 95472 (ADDRESS, CITY, STATE, ZIP)

Signed Dale Theiss by djf (WELL DRILLER/AUTHORIZED REPRESENTATIVE) 11-29-94 (DATE SIGNED) 399226 (C-57 LICENSE NUMBER)

ORIGINAL
File with DWR

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

165-010-014

Do Not Fill In

No 141122

State Well No.

Other Well No. 16N/12W 7J

[redacted]

(2) LOCATION OF WELL:
County Mendocino Owner's number, if any
Township, Range, and Section
Distance from cities, roads, railroads, etc. same

(3) TYPE OF WORK (check):
New Well [X] Deepening [ ] Reconditioning [ ] Destroying [ ]
If destruction, describe material and procedure in Item 11.

(4) PROPOSED USE (check):
Domestic [X] Industrial [ ] Municipal [ ]
Irrigation [ ] Test Well [ ] Other [ ]

(5) EQUIPMENT:
Rotary [ ]
Cable [ ]
Other Bucket [X]

(6) CASING INSTALLED:
STEEL: SINGLE [ ] DOUBLE [ ] (OTHER:) Plastic

If gravel packed

From ft.	To ft.	Diam.	Gage or Wall	Diameter of Bore	From ft.	To ft.
0	81	8"	160	30	0	80

Type of shoe or well ring: none Size of gravel: pea
Describe joint bell & glue joint

(7) PERFORATIONS OR SCREEN:
Type of perforation or name of screen sawn

From ft.	To ft.	Perf. per row	Rows per ft.	Size in. x in.
40	80	9	2	1/8 x 4

(8) CONSTRUCTION:
Was a surface sanitary seal provided? Yes [X] No [ ] To what depth 16 ft.
Were any strata sealed against pollution? Yes [ ] No [X] If yes, note depth of strata
From ft. to ft.
From ft. to ft.
Method of sealing concrete on gravel pack

(9) WATER LEVELS:
Depth at which water was first found, if known ft.
Standing level before perforating, if known ft.
Standing level after perforating and developing 38 ft.

(10) WELL TESTS:
Was pump test made? Yes [ ] No [X] If yes, by whom? bail
Yield: 30 gal./min. with 62 ft. drawdown after hrs.
Temperature of water cold Was a chemical analysis made? Yes [ ] No [X]
Was electric log made of well? Yes [ ] No [X] If yes, attach copy

(11) WELL LOG:
Total depth 80 ft. Depth of completed well 80 ft.
Formation: Describe by color, character, size of material, and structure
ft. to ft.

0 - 1	Brown top soil
1 - 11	Brown clay
11 - 13	Brown clay w/embedded rock
13 - 18	Gray clay
18 - 20	Brown sand
20 - 38	Brown clay
38 - 42	Brown sand gravel
42 - 48	Blue sandy clay
48 - 50	Blue sand gravel
50 - 55	Blue sandy clay
55 - 57	Coarse brown sand
57 - 77	Brown cemented gravel
77 - 80	Brown clay

Work started 8/4/76 19 , Completed 8/4/76 19

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Weeks Drilling and Pump Co.
(Person, firm, or corporation) (Typed or printed)
Address Sebastopol Road
Sebastopol, California 95472
[SIGNED] Gerald Thompson (Well Driller)
By: Mary E. Thompson
License No. 177681 Dated August 6, 1976

CONFIDENTIAL LOG
Water Code Sec. 13752

SKETCH LOCATION OF WELL ON REVERSE SIDE

CONFIDENTIAL LOG
Water Code Sec. 13752

ORIGINAL

File with DWR

Notice of Intent No. ______

Local Permit No. or Date 9359

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
WATER WELL DRILLERS REPORT

162-232-006

Do not fill in

No. 211626

State Well No. ______

Other Well No. 16N12W07K

[redacted]

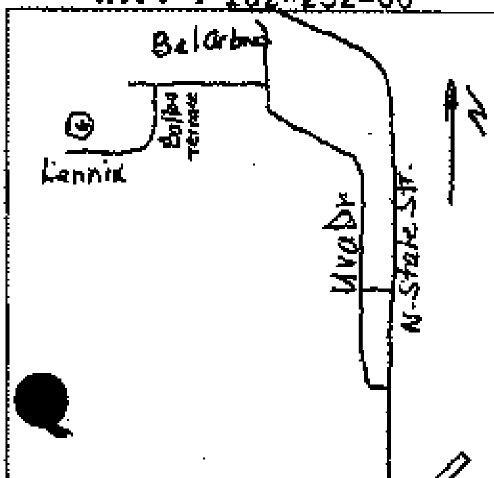
(2) LOCATION OF WELL (See instructions):

County MENDOCINO Owner's Well Number ______

Well address if different from above ______

Township 16N Range 12W Section 7

Distance from cities, roads, railroads, fences, etc.
800 Lennix Drive
Redwood Valley
A.P. # 162-232-06



WELL LOCATION SKETCH

(3) TYPE OF WORK:
New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:
Domestic ☒
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

(5) EQUIPMENT:
Rotary ☒ Reverse ☐
Cable ☐ Air ☒
Other ☐ Bucket ☐

(6) GRAVEL PACK:
Yes ☒ No ☐ Size Pea
Diameter of bore 16"
Packed from 21 to 200 ft.

(7) CASING INSTALLED:
Steel ☐ Plastic ☒ Concrete ☐

(8) PERFORATIONS:
Type of perforation or size of screen micro

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot size
0	201	5"	CL200	60	120	.032
				160	200	"

(9) WELL SEAL:
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 21 ft.
Were strata sealed against pollution? Yes ☐ No ☒ Interval ______ ft.
Method of sealing cement on gravel pack

(10) WATER LEVELS:
Depth of first water, if known ______ ft.
Standing level after well completion 30' ft.

(11) WELL TESTS:
Was well test made? Yes ☒ No ☐ If yes, by whom? Weeks
Type of test Pump ☐ Bailer ☐ Air lift ☒
Depth to water at start of test 30 ft. At end of test 195 ft
Discharge 60 gal/min after 1½ hours Water temperature cool
Chemical analysis made? Yes ☐ No ☒ If yes, by whom? ______
Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

(12) WELL LOG: Total depth 200 ft. Depth of completed well 200 ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
0	1	Top soil
1	12	Brown clayee sands
12	20	Brown clayee sands with streaks of coarse sand and small gravels
20	30	Brown clayee sand with streaks of gravel
30	35	Blue clay
35	45	Blue clay with streaks of gravel
45	52	Blue clay
52	54	Gravels
54	60	Blue clay with small streaks of gravels
60	95	Gravel cemented with small streaks of loose gravels
95	120	Gravel cemented with streaks of blue clay
120	125	Blue clay with streaks of gravel
125	130	Blue clay with streaks of cemented gravels
130	155	Blue clay
155	175	Cemented gravels
175	200	Blue and brown clay with streaks of gravel

Work started 10-21 1992 Completed 10-24 1992

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

SIGNED Ward Thompson By: Don Sinclair
(Well Driller)

NAME WEEKS DRILLING AND PUMP COMPANY
(Person, firm, or corporation) (Typed or printed)

Address P.O. Box 176-6100 Sebastopol Road

City Sebastopol, California Zip 95473

License No. C57-177681 Date of this report Oct. 27,1992

DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

~041 7921
~0427919

ORIGINAL
File with DWR

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
WATER WELL DRILLERS REPORT

Q(R

Do not fill in

No. 341678

Notice of Intent No. ______
Local Permit No. or Date 6374

162-240-022

State Well No. ______
Other Well No. 16N12W07Q

[redacted]

(2) LOCATION OF WELL (See instructions):
County ~~Mendocino~~ Owner's Well Number ______
Well address if different from above ~~7921 Oman Rd., Redwood Valley~~
Township ______ Range ______ Section ______
Distance from cities, roads, railroads, fences, etc. ______

A.P.#162-240-22

WELL LOCATION SKETCH

(3) TYPE OF WORK:
New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:
Domestic ☒
Irrigation ☐
Industrial ☐
Test Well ☐
Municipal ☐
Other ☒
(Describe)

(5) EQUIPMENT:
Rotary ☒ Reverse ☐
Cable ☐ Air ☒
Other ☐ Bucket ☐

(6) GRAVEL PACK:
Yes ☒ No ☐ Size 3/8 pea
Diameter of bore 10"
Packed from 20 to 270 ft.

(7) CASING INSTALLED:
Steel ☐ Plastic ☒ Concrete ☐

(8) PERFORATIONS:
Type of perforation or size of screen

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot size
0	270	5"	c160	90	270	1/8"

(9) WELL SEAL:
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 20 ft.
Were strata sealed against pollution? Yes ☐ No ☒ Interval ______ ft.
Method of sealing grout

(10) WATER LEVELS:
Depth of first water, if known ______ ft.
Standing level after well completion 83 ft.

(11) WELL TESTS:
Was well test made? Yes ☒ No ☐ If yes, by whom? driller
Type of test Pump ☐ Bailer ☐ Air lift ☒
Depth to water at start of test 83 ft. At end of test 205 ft.
Discharge 35 gal/min after 2 hours Water temperature ______
Chemical analysis made? Yes ☐ No ☒ If yes, by whom? ______
Was electric log made Yes ☐ No ☒ If yes, attach copy to this report

(12) WELL LOG: Total depth 270 ft. Completed depth 270 ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
0	80	brown clay & cemented gravels
80	82	gravel w fine sand
82	138	blue clay
138	140	gravel
140	212	stickey blu clay
212	270	blu clay w gravel

CONFIDENTIAL
NOT FOR PUBLIC USE
WATER CODE SEC. 13752

Work started May 1990 Completed May 1990

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Signed Dale Theiss by c.j.usher
(Well Driller)
NAME FISCH BROS DRILLING INC.
(Person, firm, or corporation) (Typed or printed)
Address 5001 Gravenstein Hwy. No.
City Sebastopol Ca ZIP 95472
License No. 399226 Date of this report 5-11-90

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

DWR 188 (REV. 12-86)

16N/12W-07M

ORIGINAL -043

File with DWR

162-240-

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
WATER WELL DRILLERS REPORT

J/R

Do not fill in

No. 211166

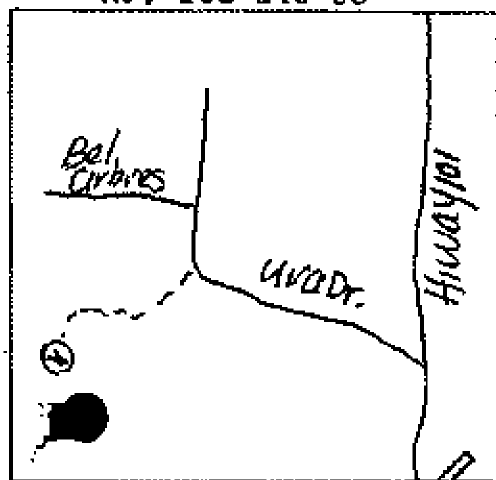
State Well No.
Other Well No. 16N12W07R

[redacted] No.
[redacted] No. or Date 5693

162-240-033

[redacted]

(2) LOCATION OF WELL (See instructions):
County MENDOCINO Owner's Well Number
Well address if different from above
Township 16N Range 12W Section 7
Distance from cities, roads, railroads, fences, etc.
8100 Uva Drive
Redwood Valley
AP# 162-240-33



WELL LOCATION SKETCH

(3) TYPE OF WORK:
New Well [X] Deepening [ ]
Reconstruction [ ]
Reconditioning [ ]
Horizontal Well [ ]
Destruction [ ] (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:
Domestic [ ]
Irrigation [ ]
Industrial [ ]
Test Well [ ]
Stock [ ]
Municipal [ ]
Other [ ]

(5) EQUIPMENT:
Rotary [ ] Reverse [ ]
Cable [ ] Air [X]
Other [ ] Bucket [ ]

(6) GRAVEL PACK:
Yes [X] No [ ] Size pea
Diameter of bore 8 7/8
Packed from 20 to 162 ft.

(7) CASING INSTALLED:
Steel [ ] Plastic [X] Concrete [ ]

(8) PERFORATIONS:
Type of perforation or size of screen micro

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot size
0	160	5"	CL200	29'	76'	.030
				96'	156'	

(9) WELL SEAL:
Was surface sanitary seal provided? Yes [X] No [ ] If yes, to depth 20 ft.
Were strata sealed against pollution? Yes [ ] No [X] Interval ft.
Method of sealing cement on gravel pack

(10) WATER LEVELS:
Depth of first water, if known 80 ft.
Standing level after well completion 60 ft.

(11) WELL TESTS:
Was well test made? Yes [X] No [ ] If yes, by whom? Weeks
Type of test Pump [ ] Bailer [ ] Air lift [X]
Depth to water at start of test 60 ft. At end of test 90 ft.
Discharge 20 gal/min after 3 hours Water temperature cool
[redacted] analysis made? Yes [ ] No [X] If yes, by whom?
Was [redacted] log made? Yes [ ] No [X] If yes, attach copy to this report

(12) WELL LOG: Total depth 162 ft. Depth of completed well 160 ft.

from ft. to ft.	Formation (Describe by color, character, size or material)
0-6	Brown clay and embedded grave
6-22	Stiff tan clay
22-39	Clay with embedded gravel and
-	sand & gravel
39-40	Clay
40-41	Sand and gravel
41-42	Blue clay
42-50	Brown clayee sand
50-54	Blue clay
54-62	Clayee sand & coarse sand and
	gravel
62-85	Sand and gravel
85-87	Clay
87-112	Blue clay with embedded grave
112-126	Sand and gravel
126-143	Stiff blue clay
143-157	Sand and gravel
157-162	Clay with embedded gravel

MAY 31 1990

Work started 5-1 19 90 Completed 5-3 19 90

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

SIGNED Ward Thompson By: Don Sinclair
(Well Driller)

NAME Weeks Drilling and Pump Company
(Person, firm, or corporation) (Typed or printed)
Address P.O.Box 176- 6100 Sebastopol Road
City Sebastopol, California Zip 95473
License No. C57-177681 Date of this report May 8, 1990

DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

ORIGINAL
File with DWR

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
WATER WELL DRILLERS REPORT

Do not fill i

No. 03003

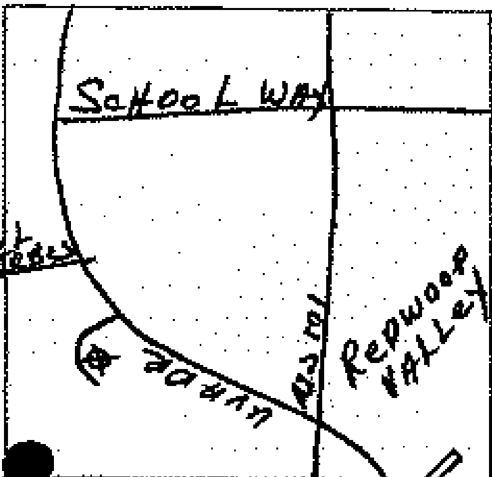
Notice of Intent No. ________
Local Permit No. or Date ________

165-020-011

State Well No. ________
Other Well No. 16N/12W-7

[redacted]

(2) LOCATION OF WELL (See instructions):
County Mendocino Owner's Well Number ________
Well address if different from above ________
Township ________ Range ________ Section ________
Distance from cities, roads, railroads, fences, etc. 8000 Uva Dr
Redwood Valley



WELL LOCATION SKETCH

(3) TYPE OF WORK:
New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:
Domestic ☒
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

(5) EQUIPMENT:
Rotary ☒ Reverse ☐
Cable ☐ Air ☐
Other ☐ Bucket ☐

(6) GRAVEL PACK:
Yes ☒ No ☐ Size pea
Diameter of bore 9 7/8 & 8 3/4
Packed from 20 to 226

(7) CASING INSTALLED:
Steel ☐ Plastic ☒ Concrete ☐

(8) PERFORATIONS: sawn
Type of perforation or size of screen

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot size
0	228	6	160	146	206	1/8 x 4

(9) WELL SEAL:
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 20' ft.
Were strata sealed against pollution? Yes ☐ No ☒ Interval ________ ft.
Method of sealing cement on gravel pack

(10) WATER LEVELS:
Depth of first water, if known ________ ft.
Standing level after well completion 85' ft.

(11) WELL TESTS:
Was well test made? Yes ☒ No ☐ If yes, by whom? Weeks
Type of test Pump ☐ Bailer ☒ Air lift ☐
Depth to water at start of test 85' ft. At end of test 220' ft.
Discharge 7 gal/min after 3 hours Water temperature cold
Chemical analysis made? Yes ☐ No ☒ If yes, by whom? ________
Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

(12) WELL LOG: Total depth 226 ft. Depth of completed well 226 ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
0	7	Brown clay w/cemented gravel & sa
7	9	Hard sand base rock
9	12	Hard conglomerate rock w/streaks
		of brown clay
12	14	Brown clay w/green rock & quartz
14	18	Brown sticky clay w/embedded grav
18	30	Brown sticky clay
30	44	Blue sticky clay
44	46	Washed blue & brown gravels
46	66	Washed birdseye gravel
66	72	Blue clay
72	75	Blue sandy clay w/embedded
		birdseye gravel
75	82	Brown gravel w/streaks of brown
		clay
82	95	Blue & brown clay
95	102	Brown clay w/cemented gravel
102	110	Brown sand & gravel w/streaks of
		clay
110	120	Brown clay w/cemented gravel
120	125	Black rock
125	136	Brown clay w/embedded gravel
136	156	Blue clay w/streaks of cemented
		gravel
156	166	Coarse sand w/blue clay
166	186	Soft conglomerate rock & gravel
186	214	Gray brown clay
214	222	Brown gravel w/streaks of brown
		sand
222	226	Blue clay

Work started 5/25 1977 Completed 5/31 19 77

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

SIGNED Gerald Thompson By: Mary E. Thompson
(Well Driller)
NAME Weeks Drilling and Pump Company
(Person, firm, or corporation) (Typed or printed)
Address Sebastopol Road
City Sebastopol, California 95472
License No. 177681 Date of this report June 9, 1977

ORIGINAL
File Original, Duplicate and Triplicate with the
REGIONAL WATER POLLUTION
CONTROL BOARD No. 1
(Insert appropriate number)

WATER WELL DRILLERS REPORT

(Sections 7674, 7677, 7678, Water Code) 3-768

THE RESOURCES AGENCY OF CALIFORNIA

Do Not Fill In
No 113514

State Well No.
Other Well No. 16/12-8B

[redacted]

(2) LOCATION OF WELL:

County Mendocino Owner's number, if any—

R. F. D. or Street No.

Approximately 1,000 feet south of School Way on east side of Pinecrest Drive, Redwood Valley, California

(3) TYPE OF WORK (check):

New well XX Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 11.

(4) PROPOSED USE (check):

Domestic XX Industrial ☐ Municipal ☐
Irrigation XX Test Well ☐ Other ☐

(5) EQUIPMENT:

Rotary XX
Cable ☐
Dug Well ☐

(6) CASING INSTALLED:

SINGLE XX DOUBLE ☐

From (ft.)	to (ft.)	Diam. (in.)	Gage or wall
0	267	6 5/8"	12

If gravel packed

Diameter of bore	from (ft.)	to (ft.)
12½	0	267

Type and size of shoe or well ring None

Size of gravel: Pea

Describe joint Welded

(7) PERFORATIONS:

Type of perforator used Torch

Size of perforations 6 in., length, by 3/16 in.

From (ft.)	to (ft.)	Perf. per row	Rows per ft.
47	87	4	1
107	127	4	1
147	187	4	1
207	267	4	1

(8) CONSTRUCTION:

Was a surface sanitary seal provided? XX Yes ☐ No To what depth 20 ft.

Were any strata sealed against pollution? ☐ Yes ☐ No If yes, note depth of strata

From ft. to ft.

Method of Sealing Cement on Pack

(9) WATER LEVELS:

Depth at which water was first found ft.

Standing level before perforating ft.

Standing level after perforating 60 ft.

(10) WELL TESTS:

Was a pump test made? ☐ Yes XX No If yes, by whom? Bail

Yield: 28 gal./min. with 50 ft. draw down after hrs.

Temperature of water cool Was a chemical analysis made? ☐ Yes ☐ No

(11) WELL LOG:

Total depth 267 ft. Depth of completed well 267 ft.

Formation: Describe by color, character, size of material, and structure.

From (ft.)	to (ft.)	Formation
0	3	Top Soil
3	8	Brown Sandy Clay
8	52	Brown Cemented Sand & Gravel
52	64	Stiff Blue Clay
64	121	Brown Cemented Gravel
121	151	Stiff Blue Clay
151	168	Stiff Blue Clay with Streaks of Sandy Blue Clay
168	172	Hard Brown Sandy Clay
172	198	Hard Brown Clay with Streaks of Sand & Gravel
198	202	Blue Clay
202	212	Multi-colored Cemented Sand
212	242	Blue Clay with Streaks of Sand
242	253	Cemented Coarse Sand
253	267	Hard Blue Clay with Soft Gritty Streaks

Plotted and Coded
As Well 16N/12W-8B80

FOR OFFICIAL USE ONLY

Work started 9/22/ 65. Completed 10/1/ 65

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME WEEKS DRILLING & PUMP COMPANY
(Person, firm, or corporation) (Typed or printed)

Address 6100 Sebastopol Road
Sebastopol, California

[Signed] Mary E. Thompson
GERALD THOMPSON-By: MARY E. THOMPSON

License No. 177681 Dated 10/8/65 Pres.

ORIGINAL
File with DWR

Page 1 of 1

Owner's Well No. 94-3216

Date Work Began Oct 94, Ended Oct 94

Local Permit Agency Mendocino Cty

Permit No. 9980 Permit Date

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. 548137

DWR USE ONLY — DO NOT FILL IN —
16N12W02E M
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION Describe material, grain size, color, etc.
0	2	topsoil
2	80	brown clay w/gravel stringers
80	180	blue clay
180	260	blue clay w/cemented gravel

TOTAL DEPTH OF BORING 260 (Feet)

TOTAL DEPTH OF COMPLETED WELL 260 (Feet)

WELL OWNER

[redacted]

Address 8150 Vineyard Oaks Dr.

City Redwood Valley Ca.

County Mendocino Ca.

APN Book 162 Page 210 Parcel 37

Township ___ Range ___ Section ___

Latitude ___ DEG. MIN. SEC. NORTH Longitude ___ DEG. MIN. SEC. WEST

LOCATION SKETCH

NORTH

WEST EAST

SOUTH

Illustrate or Describe Distance of Well from Landmarks such as Roads, Buildings, Fences, Rivers, etc. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

X NEW WELL

MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USE(S) (✓)

___ MONITORING

WATER SUPPLY
X Domestic
___ Public
___ Irrigation
___ Industrial

___ "TEST WELL"

___ CATHODIC PROTECTION

___ OTHER (Specify)

DRILLING METHOD Rotary Mud FLUID Mud

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL 60 (Ft.) & DATE MEASURED

ESTIMATED YIELD* 6 (GPM) & TEST TYPE airlift

TEST LENGTH 4 (Hrs.) TOTAL DRAWDOWN 250 (Ft.)

* *May not be representative of a well's long-term yield.*

CASING(S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE: BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL/GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	60	8.75	X				F480PVC	5	c200	
60	260	"		X			"	"	"	1/8

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	20		X		
XXXXXXXXXX					
20	260			X	fine pea

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME FISCH BROS. DRILLING INC. 941
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

5001 GRAVENSTEIN HWY NO. SEBASTOPOL CA. 95472
ADDRESS CITY STATE ZIP

Signed Dale Theiss by c. j. usher 10-31-94 399226
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

ORIGINAL
File with DWR
Page X of 1
Owner's Well No. 92-2797
Date Work Began August 92 Ended August 92
Local Permit Agency Mendocino Cty
Permit No. 9113 Permit Date 7-8-92

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet
No. 398391

DWR USE ONLY — DO NOT FILL IN
16N12W08 M
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION Describe material, grain size, color, etc.
0	1	topsoil
1	23	gravel
23	150	blue clay
150	153	blue sand
153	200	brown clay
200	280	blue clay
280	285	coarse & loose sand
285	310	brown clay
310	320	birdseye gravel
320	330	clay
330	332	sand
332	340	clay

TOTAL DEPTH OF BORING 340 (Feet)
TOTAL DEPTH OF COMPLETED WELL X 340 (Feet)

WELL OWNER
[redacted]

WELL LOCATION
Address 7935 Bva Dr.
City Redwood Valley Ca.
County Mendocino Ca.
APN Book 165 Page 010 Parcel 08
Township ___ Range ___ Section ___
Latitude ___ DEG. MIN. SEC. NORTH Longitude ___ DEG. MIN. SEC. WEST

LOCATION SKETCH
NORTH / WEST / EAST / SOUTH
Illustrate or Describe Distance of Well from Landmarks such as Roads, Buildings, Fences, Rivers, etc. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)
X NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USE(S) (✓)
___ MONITORING
WATER SUPPLY
X Domestic
___ Public
___ Irrigation
___ Industrial
___ "TEST WELL"
___ CATHODIC PROTECTION
___ OTHER (Specify)

DRILLING METHOD Rotary Mud FLUID Mud

WATER LEVEL & YIELD OF COMPLETED WELL
DEPTH OF STATIC WATER LEVEL 15 (Ft.) & DATE MEASURED ___
ESTIMATED YIELD* 20+ (GPM) & TEST TYPE airlift
TEST LENGTH 2 (Hrs.) TOTAL DRAWDOWN 200 (Ft.)
* May not be representative of a well's long-term yield.

CASING(S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	200	10 5/8	X				F480 PVC	5	.200	
200	340	"		X			"	"	"	.032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	22	X			
22	340			X	fine pea

ATTACHMENTS (✓)
___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other
ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT
I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.
NAME FISCH BROS DRILLING INC.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
5001 Gravenstein Hwy No. Sebastopol Ca. 95472
ADDRESS CITY STATE ZIP
Signed Brian Burnham By c.j.usher 8-10-92 399226
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

ORIGINAL
File with DWR

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

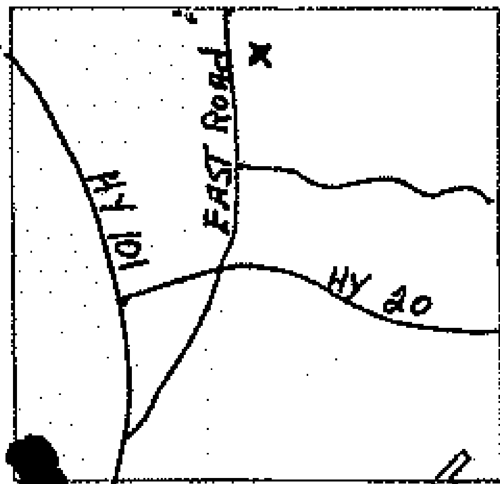
16N/12W-16 Do not fill in
No. 18702

Notice of Intent No. ____
Local Permit No. or Date ____

State Well No. ____
Other Well No. 16N12W16C01M

[redacted]

(2) LOCATION OF WELL (See instructions):
County Mendo Owner's Well Number ____
Well address if different from above ____
Township 16 N Range 12 W Section 16
Distance from cities, roads, railroads, fences, etc. 1/4 M North Rd A
100 FT EAST OF EAST Rd Redwood Valley



WELL LOCATION SKETCH

(3) TYPE OF WORK:
New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:
Domestic ☐
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☒
Other ☐

(5) EQUIPMENT:
Rotary ☐ Reverse ☐
Cable ☒ Air ☐
Other ☐ Bucket ☐

(6) GRAVEL PACK:
Yes ☒ No ☐ Size pea
Diameter of bore 12"
Packed from 100 to 400

(7) CASING INSTALLED:
Steel ☒ Plastic ☐ Concrete ☐

From ft.	To ft.	Dia. in.	Gage or Wall
0	400	8	.188

(8) PERFORATIONS:
Type of perforation or size of screen Sawed Slot

From ft.	To ft.	Slot size
148	400	1/8 X 3

(9) WELL SEAL:
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 100 ft.
Were strata sealed against pollution? Yes ☐ No ☒ Interval ____ ft.
Method of sealing Grout

(10) WATER LEVELS:
Depth of first water, if known 40' ft.
Standing level after well completion 5 ft.

(11) WELL TESTS:
Was well test made? Yes ☒ No ☐ If yes, by whom? Neil Dunken
Type of test Pump ☒ Bailer ☐ Air lift ☐
Depth to water at start of test 5 ft. At end of test 115 ft.
Discharge 215 gal/min after ____ hours Water temperature Cool
Chemical analysis made? Yes ☐ No ☒ If yes, by whom? ____
Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

(12) WELL LOG: Total depth 400 ft. Depth of completed well 400 ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
0	3	soil
3	17	Dirty sand + Gravel
17	79	Brown clay + Gravel mix
79	93	Blue clay
93	143	Brown clay + Gravel mix
143	154	Blue clay
154	172	Brown clay + Gravel MIX
172	203	Blue clay
203	236	Brown clay + Gravel MIX
236	240	Blue clay
240	260	Brown clay + Gravel MIX
260	280	Blue clay
280	400	Brown clay + Gravel MIX

Perforations: 1/8 X 3 8 slots per Row 8 Rows per Foot. "Double Perf"

Note: Recommended pump setting 140 Feet Including Bowls No Tail Pipe.

Pumping Rate 100 GPM.

For Engineering Data use 100 Feet A pumping level when pumping 100 GPM

Work started 2-15 1977. Completed 4-1 1977

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Signed Dave Giese (Well Driller)
NAME Dave Giese Well Drilling (Person, firm, or corporation) (Typed or printed)
Address 200 Gobalet LN
City Ukiah Zip ____
License No. 304165 Date of this report 4-4-77

DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

ORIGINAL

File with DWR

[redacted] of Intent No.______

[redacted] Permit No. or Date 8925

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

Do not fill in

No. 210813

State Well No.______

Other Well No. 16N12W20K

[redacted]

(2) LOCATION OF WELL (See instructions):

County Mendocino Owner's Well Number______

Well address if different from above______

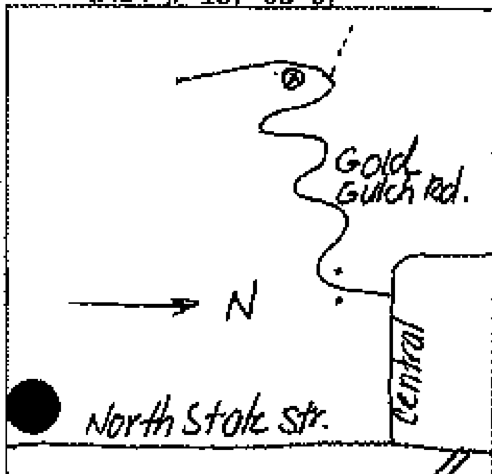
Township 16N Range 12W Section 20

Distance from cities, roads, railroads, fences, etc.

1000 Gold Gulch Road

Ukiah

A.P. # 167-08-07



WELL LOCATION SKETCH

(3) TYPE OF WORK:

New Well ☒ Deepening ☐

Reconstruction ☐

Reconditioning ☐

Horizontal Well ☐

Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:

Domestic ☒

Irrigation ☐

Industrial ☐

Test Well ☐

Stock ☐

Municipal ☐

Other ☐

(5) EQUIPMENT:

Rotary ☐ Reverse ☐

Cable ☐ Air ☒

Other ☐ Bucket ☐

(6) GRAVEL PACK:

Yes ☒ No ☐ Size 3/8 pea

Diameter of bore 7 7/8"

Packed from 20' to 338'

(7) CASING INSTALLED:

Steel ☐ Plastic ☒ Concrete ☐

(8) PERFORATIONS:

Type of perforation or size of screen saw cut

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot size
0	339	5"	CL200	278	338	1/8x3

(9) WELL SEAL:

Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 20' ft.

Were strata sealed against pollution? Yes ☐ No ☒ Interval______ ft.

Method of sealing cement on gravel pack

(10) WATER LEVELS:

Depth of first water, if known______ ft.

Standing level after well completion 100' ft.

(11) WELL TESTS:

Was well test made? Yes ☒ No ☐ If yes, by whom? Weeks

Type of test Pump ☐ Bailer ☐ Air lift ☒

Depth to water at start of test 100 ft. At end of test 320 ft

[redacted]harge 8 gal/min after 2 hours Water temperature cool

[redacted]ical analysis made? Yes ☐ No ☒ If yes, by whom?

Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

(12) WELL LOG: Total depth 338 ft. Depth of completed well 339 ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
0	10	Clayee brown sand and sandy clay
10	26	Brown clay
26	45	Brown cemented conglomerate
45	47	Blue clay
47	55	Brown cemented conglomerate
55	76	Gray clay
76	80	Gray conglomerate rock and clay
80	97	Gray clay
97	105	Conglomerate rock
105	118	Brown clay with gray streaks
118	160	Conglomerate rock and clay
160	179	Gray clay
179	192	Conglomerate rock
192	201	Gray clay
201	338	Grey clay with streaks of conglomerate rock

Work started 3/30 1987 Completed 3/31 1987

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

SIGNED Gerald Thompson By: Don Sinclair
(Well Driller)

NAME WEEKS DRILLING AND PUMP COMPANY
(Person, firm, or corporation) (Typed or printed)

Address P.O. Box 176 - 6100 Sebastopol Road

City Sebastopol, California Zip 95472

License No. C57-177681 Date of this report April 1,1987

DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

ORIGINAL

File with DWR

[redacted] of Intent No.

[redacted] Permit No. or Date 8926

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

Do not fill in

No. 210815

State Well No.

Other Well No. 16N12W20R

[redacted]

(2) LOCATION OF WELL (See instructions):

County Mendocino Owner's Well Number

Well address if different from above

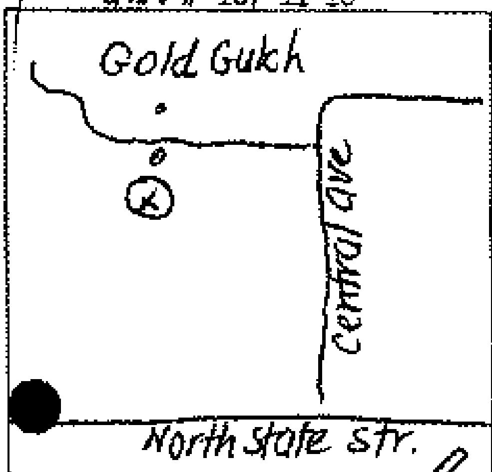
Township 16N Range 12W Section Yokaya Rancho

Distance from cities, roads, railroads, fences, etc.

300 Gold Gulch Road

Ukiah

A.P. # 167-11-18



WELL LOCATION SKETCH

(3) TYPE OF WORK:

New Well ☒ Deepening ☐

Reconstruction ☐

Reconditioning ☐

Horizontal Well ☐

Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:

Domestic ☒

Irrigation ☐

Industrial ☐

Test Well ☐

Stock ☐

Municipal ☐

Other ☐

(5) EQUIPMENT:

Rotary ☐ Reverse ☐

Cable ☐ Air ☒

Other ☐ Bucket ☐

(6) GRAVEL PACK:

Yes ☒ No ☐ Size 3/8" pea

Diameter of bore 7 7/8 & 9 3/4"

Packed from 20 to 292 ft.

(7) CASING INSTALLED:

Steel ☐ Plastic ☒ Concrete ☐

(8) PERFORATIONS:

Type of perforation or size of screen saw cut

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot size
0	287	4	CL200	186	286	1/8

(9) WELL SEAL:

Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 20 ft.

Were strata sealed against pollution? Yes ☐ No ☒ Interval ft.

Method of sealing cement on gravel pack

(10) WATER LEVELS:

Depth of first water, if known ft.

Standing level after well completion 160 ft.

(11) WELL TESTS:

Was well test made? Yes ☒ No ☐ If yes, by whom? Weeks

Type of test Pump ☐ Bailer ☐ Air lift ☒

Depth to water at start of test 160 ft. At end of test 250 ft

Discharge 2 gal/min after 1 hours Water temperature cool

Chemical analysis made? Yes ☐ No ☒ If yes, by whom?

Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

(12) WELL LOG: Total depth 292 ft. Depth of completed well 287 ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
0	6	Brown clay
6	10	Gray and brown rock
10	46	Conglomerate rock and clay
46	65	Brown clays
65	70	Brown conglomerate
70	83	Sandy blue clay
83	109	Blue clay with streaks of conglomerate
109	122	Conglomerate
122	137	Brown and gray clay
137	212	Conglomerate
212	216	Blue clay
216	292	Conglomerate

Work started 4/10 19 87 Completed 4/13/ 19 87

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Signed Gerald Thompson By: Don Sinclair (Well Driller)

NAME WEEKS DRILLING AND PUMP COMPANY (Person, firm, or corporation) (Typed or printed)

Address P.O. Box 176 - 6100 Sebastopol Road

City Sebastopol, California Zip 95472

License No. 057-177681 Date of this report April 14,1987

ORIGINAL
File with DWR
Page 1 of 1

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. e0236816

Owner's Well No. DRY HOLE #1
Date Work Began 10/6/2014, Ended 10/8/2014
Local Permit Agency Mendocino County Environmental
Permit No. WW22482 Permit Date 8/19/2014

DWR USE ONLY — DO NOT FILL IN
17N 12W 28
STATE WELL NO./STATION NO.
39 17 47 N 123 11 47 W
LATITUDE LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD AIR FLUID N/A

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION Describe material, grain, size, color, etc.
		DRY HOLE
0	15	Tan clay
15	20	Tan clay with gravel
20	135	Tan stiff clay
135	165	Blue clay
165	180	Tan clay with rock
180	220	Stiff blue clay
220	245	Shale rock
245	265	Shale with sandstone
265	290	Shale rock
290	310	Stiff blue clay
310	360	Shale
		Dry hole backfilled and abandoned
		per Mendocino County requirements

TOTAL DEPTH OF BORING 360 (Feet)
TOTAL DEPTH OF COMPLETED WELL N/A (Feet)

WELL OWNER

Name [redacted]
Mailing Address [redacted]
CITY STATE ZIP

WELL LOCATION

Address 3555 Road J
City Redwood Valley CA
County Mendocino
APN Book 161 Page 060 Parcel 11
Township ___ Range ___ Section ___
Latitude ___ DEG. MIN. SEC. Longitude ___ DEG. MIN. SEC.

LOCATION SKETCH

NORTH
WEST
EAST
SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL
MODIFICATION/REPAIR
— Deepen
— Other (Specify)
— DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
✓ Irrigation ___ Industrial
MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

1

DEPTH TO FIRST WATER N/A (Ft.) BELOW SURFACE
DEPTH OF STATIC WATER LEVEL N/A (Ft.) & DATE MEASURED
ESTIMATED YIELD * N/A (GPM) & TEST TYPE N/A
TEST LENGTH N/A (Hrs.) TOTAL DRAWDOWN N/A (Ft.)
May not be representative of a well's long-term yield.

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	25	11								
25	360	7 7/8								

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	TYPE CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analysis
___ Other ___
ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.
NAME Weeks Drilling & Pump
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
P.O. Box 176 Sebastopol CA 95473
ADDRESS CITY STATE ZIP
Signed [signature] 10/22/14 177681
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 11-97 IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

ORIGINAL
File with DWR

Page 1 of 1

Owner's Well No. DRY HOLE #1

Date Work Began 9/8/2014, Ended 9/9/2014

Local Permit Agency Mendocino County Environmental

Permit No. WW22412 Permit Date 5/16/2014

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. e0235834

DWR USE ONLY — DO NOT FILL IN

15N 12W 6

STATE WELL NO./STATION NO.

39 09152 N | 123 10 60 W

LATITUDE | LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD AIR FLUID N/A

DEPTH FROM SURFACE Ft. to	Ft.	DESCRIPTION Describe material, grain, size, color, etc.
		DRY HOLE
0	23	Loose clay with gravel
23	75	Stiff tan clay
75	125	Stiff gray clay
125	130	Gray clay with rock
130	160	Stiff gray clay
160	300	Sandy gray clay
		Dry hole backfilled and abandoned per Mendocino County requirements

TOTAL DEPTH OF BORING 300 (Feet)

TOTAL DEPTH OF COMPLETED WELL N/A (Feet)

WELL OWNER

Name [redacted]

Mailing Address [redacted]

CITY STATE ZIP

WELL LOCATION

Address 1960 Vichy Springs Road

City Ukiah CA

County Mendocino

APN Book 178 Page 190 Parcel 06

Township ___ Range ___ Section ___

Latitude ___ DEG. MIN. SEC. Longitude ___ DEG. MIN. SEC.

LOCATION SKETCH

NORTH / WEST / EAST / SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR
— Deepen
— Other (Specify)

— DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial

MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER N/A (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL N/A (Ft.) & DATE MEASURED

ESTIMATED YIELD * N/A (GPM) & TEST TYPE N/A

TEST LENGTH N/A (Hrs.) TOTAL DRAWDOWN N/A (Ft.)

* May not be representative of a well's long-term yield.

CASING (S)

DEPTH FROM SURFACE Ft. to	Ft.	BORE-HOLE DIA. (Inches)	TYPE: BLANK	SCREEN	CONDUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	25	11								
25	300	8								

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft. to	Ft.	CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)

ATTACHMENTS (✓)

— Geologic Log
— Well Construction Diagram
— Geophysical Log(s)
— Soil/Water Chemical Analyses
— Other

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Weeks Drilling & Pump
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

P.O. Box 176 Sebastopol CA 95473
ADDRESS CITY STATE ZIP

Signed [signature] 10/09/14 177681
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 11-97 IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

ORIGINAL
File with DWR

Page 1 of 1

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. e0235595

DWR USE ONLY — DO NOT FILL IN

17N12W33

STATE WELL NO./STATION NO.

39.17.39 N 123.11.52 W

LATITUDE LONGITUDE

APN/TRS/OTHER

Owner's Well No. DRY HOLE #1

Date Work Began 8/7/2014 Ended 8/8/2014

Local Permit Agency Mendocino County Environmental

Permit No. WW22439 Permit Date 6/19/2014

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD AIR FLUID N/A

DEPTH FROM SURFACE Ft. to Ft.		DESCRIPTION *Describe material, grain, size, color, etc*
		DRY HOLE
0	24	Sandy tan silt
24	33	Gray shale
33	37	Sticky green clay
37	216	Sticky blue clay
216	231	Blue green sandstone
231	340	Sticky blue clay
		Dry hole backfilled and abandoned
		per Mendocino County requirements

TOTAL DEPTH OF BORING 340 (Feet)

TOTAL DEPTH OF COMPLETED WELL N/A (Feet)

WELL OWNER

Name [redacted]

Mailing Address [redacted]

CITY STATE ZIP

WELL LOCATION

Address 3465 Road J

City Redwood Valley CA

County Mendocino

APN Book 161 Page 060 Parcel 12

Township ___ Range ___ Section ___

Latitude ___ DEG. MIN. SEC. Longitude ___ DEG. MIN. SEC.

LOCATION SKETCH

NORTH / WEST / EAST / SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial

MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER N/A (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL N/A (Ft.) & DATE MEASURED ___

ESTIMATED YIELD * N/A (GPM) & TEST TYPE N/A

TEST LENGTH N/A (Hrs.) TOTAL DRAWDOWN N/A (Ft.)

** May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	22	11								
22	340	8								

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other ___

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Weeks Drilling & Pump
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

P.O. Box 176 Sebastopol CA 95473
ADDRESS CITY STATE ZIP

Signed [signature] 10/09/14 177681
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 11-97

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

ORIGINAL
File with DWR

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. e0235571

Owner's Well No. WELL #1

Date Work Began 9/4/2014, Ended 9/16/2014

Local Permit Agency Mendocino County Environmental

Permit No. WW22481 Permit Date 8/19/2014

DWR USE ONLY — DO NOT FILL IN
14N12W28
STATE WELL NO./STATION NO.
39 02 31 N 123 11 40 W
LATITUDE LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD AIR FLUID N/A

DEPTH FROM SURFACE Ft. to	Ft.	DESCRIPTION Describe material, grain, size, color, etc.
0	30	Tan clay with rock
30	50	Gray rock
50	65	Gray clay
65	105	Sandstone
105	115	Gray clay
115	135	Sandstone
135	230	Shale
230	245	Gray rock
245	360	Gray shale

TOTAL DEPTH OF BORING 360 (Feet)

TOTAL DEPTH OF COMPLETED WELL 89 (Feet)

WELL OWNER

Name Bob & Donna Meier

Mailing Address 5909 Highway 175

Hopland CA
CITY STATE ZIP

WELL LOCATION

Address 2401 McNab Ranch Road

City Ukiah CA

County Mendocino

APN Book 047 Page 110 Parcel 17

Township ___ Range ___ Section ___

Latitude ___ DEG. MIN. SEC. Longitude ___ DEG. MIN. SEC.

LOCATION SKETCH

NORTH / WEST / EAST / SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial

MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER N/A (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 20 (Ft.) & DATE MEASURED 9/16/2014

ESTIMATED YIELD * 1 (GPM) & TEST TYPE Air Developed

TEST LENGTH 2 (Hrs.) TOTAL DRAWDOWN 84 (Ft.)

** May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft. to	Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
79	81		✓				PVC	5	SDR21	

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft. to	Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	1	✓			
1	14		✓		
14	89			✓	3/8 Pea Gravel
89	91		✓		
91	360			✓	Native

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Weeks Drilling & Pump
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

P.O. Box 176 Sebastopol CA 95473
ADDRESS CITY STATE ZIP

Signed [signature] 10/08/14 177681
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 11-97

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

ORIGINAL
File with DWR
Page 1 of 2

Owner's Well No. WELL #1
Date Work Began 9/4/2014, Ended 9/16/2014
Local Permit Agency Mendocino County Environmental
Permit No. WW22481 Permit Date 8/19/2014

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. e0235571

DWR USE ONLY – DO NOT FILL IN
14N12W23
STATE WELL NO./STATION NO.
39 02 31 N 123 11 40 W
LATITUDE LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD AIR FLUID N/A

DEPTH FROM SURFACE Ft. to	Ft.	DESCRIPTION *Describe material, grain, size, color, etc.*
0	30	Tan clay with rock
30	50	Gray rock
50	65	Gray clay
65	105	Sandstone
105	115	Gray clay
115	135	Sandstone
135	230	Shale
230	245	Gray rock
245	360	Gray shale

TOTAL DEPTH OF BORING 360 (Feet)
TOTAL DEPTH OF COMPLETED WELL 89 (Feet)

WELL OWNER

Name [redacted]
Mailing [redacted]
CITY STATE ZIP

WELL LOCATION

Address 2401 McNab Ranch Road
City Ukiah CA
County Mendocino
APN Book 047 Page 110 Parcel 17
Township ___ Range ___ Section ___
Latitude ___ DEG. MIN. SEC. Longitude ___ DEG. MIN. SEC.

LOCATION SKETCH

NORTH / WEST / EAST / SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER N/A (Ft.) BELOW SURFACE 1
DEPTH OF STATIC WATER LEVEL 20 (Ft.) & DATE MEASURED 9/16/2014
ESTIMATED YIELD * 1 (GPM) & TEST TYPE Air Developed
TEST LENGTH 2 (Hrs.) TOTAL DRAWDOWN 84 (Ft.)
** May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft. to	Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CONDUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	25	11								
25	360	8								
+2	19		✓				PVC	5	SDR21	
19	39			✓			PVC	5	SDR21	.032
39	59		✓				PVC	5	SDR21	
59	79			✓			PVC	5	SDR21	.032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft. to	Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	1	✓			
1	14		✓		
14	89			✓	3/8 Pea Gravel
89	91		✓		
91	360			✓	Native

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other
ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.
NAME Weeks Drilling & Pump
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
P.O. Box 176 Sebastopol CA 95473
ADDRESS CITY STATE ZIP
Signed June Ancholm
WELL DRILLER/AUTHORIZED REPRESENTATIVE
10/08/14 DATE SIGNED
177681 C-57 LICENSE NUMBER

DWR 188 REV. 11-97 IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

ORIGINAL
File with DWR

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. e0231794

DWR USE ONLY — DO NOT FILL IN	
15N12W31	STATE WELL NO./STATION NO.
39 06 60 N	LATITUDE
123 12 21 W	LONGITUDE
184 023 05	APN/TRS/OTHER

Owner's Well No. WELL #1

Date Work Began 8/4/2014, Ended 8/5/2014

Local Permit Agency Mendocino County Environmental

Permit No. WW22400 Permit Date 5/9/2014

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD Mud Rotary FLUID Bentonite

DEPTH FROM SURFACE Ft. to	Ft.	DESCRIPTION *Describe material, grain, size, color, etc.*
0	14	Sandy tan soil and gravel
14	22	Stiff tan clay
22	33	Clayee green serpentine
33	41	Gray shale
41	46	Serpentine
46	57	Gray shale
57	69	Black shale
69	73	Serpentine
73	82	Gray shale
82	87	Black shale
87	93	Sandy gray rock (damp)
93	140	Gray sandstone fractured and lots of water

TOTAL DEPTH OF BORING 140 (Feet)

TOTAL DEPTH OF COMPLETED WELL 127 (Feet)

WELL OWNER

Name [redacted]

Mailing Address [redacted]

[redacted] CITY [redacted] STATE ZIP

WELL LOCATION

Address 298 Valley View Road

City Ukiah CA

County Mendocino

APN Book 184 Page 023 Parcel 05

Township ___ Range ___ Section ___

Latitude ___ DEG. MIN. SEC. Longitude ___ DEG. MIN. SEC.

LOCATION SKETCH

NORTH

WEST EAST

SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR

___ Deepen

___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)

WATER SUPPLY

✓ Domestic ___ Public

___ Irrigation ___ Industrial

MONITORING ___

TEST WELL ___

CATHODIC PROTECTION ___

HEAT EXCHANGE ___

DIRECT PUSH ___

INJECTION ___

VAPOR EXTRACTION ___

SPARGING ___

REMEDIATION ___

OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER N/A (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 11 (Ft.) & DATE MEASURED 8/5/2014

ESTIMATED YIELD * 50+ (GPM) & TEST TYPE Air Developed

TEST LENGTH 2 (Hrs.) TOTAL DRAWDOWN 105 (Ft.)

** May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft. to	Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	58	11								
58	140	8								
+2	87		✓				PVC	5	SDR21	
87	127			✓			PVC	5	SDR21	.032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft. to	Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	50		✓		
50	127			✓	3/8 Pea Gravel

ATTACHMENTS (✓)

___ Geologic Log

___ Well Construction Diagram

___ Geophysical Log(s)

___ Soil/Water Chemical Analyses

___ Other

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Weeks Drilling & Pump
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

P.O. Box 178 Sebastopol CA 95473
ADDRESS CITY STATE ZIP

Signed [signature] 09/12/14 177681
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

ORIGINAL
File with DWR

Page 1 of 1

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. e0209535

DWR USE ONLY — DO NOT FILL IN
15N12W08
STATE WELL NO./STATION NO.
391008 | 1231200
LATITUDE | LONGITUDE
APN/TRS/OTHER

Owner's Well No. WELL #2
Date Work Began 3/4/2014, Ended 3/12/2014
Local Permit Agency Mendocino County Environmental
Permit No. WW22350 Permit Date 3/4/2014

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD Mud Rotary FLUID Bentonite

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain, size, color, etc.*
0	3	Brown silty clayee sand
3	7	Brown silty gravel
7	25	Multi-colored sand and gravel
25	28	Larger diameter rocks, sand and gravels
28	54	Reddish brown clayee sand and gravel
54	58	Clayee sand and gravel, loose volcanic
58	73	Tighter sand and gravel
73	81	Loose sand and gravel
81	95	Tight multi-colored sand and gravel, brownish
95	103	Clayee sand and gravel
103	121	Becomes more clayeee
121	138	Brown clay, becomes grayish
138	144	Greenish gray clay
144	153	Greenish gray clay, sandy
153	170	Reddish brown sand and gravel
170	173	Larger diameter rocks
173	177	Clayee sand
177	185	Sand and gravel brown, multi
185	197	Sandy gravelly clay
197	202	Tight clayee sand and gravel
202	207	Blue green clay
207	213	Blue multi sand and gravel
213	220	Blue clay

TOTAL DEPTH OF BORING 220 (Feet)
TOTAL DEPTH OF COMPLETED WELL 220 (Feet)

WELL OWNER

Name [redacted]
Mailing Address [redacted]
CITY STATE ZIP

WELL LOCATION

Address 700 Ford Road
City Ukiah CA
County Mendocino
APN Book 170 Page 200 Parcel 14
Township ___ Range ___ Section ___
Latitude ___ DEG. MIN. SEC. Longitude ___ DEG. MIN. SEC.

LOCATION SKETCH

NORTH / WEST / EAST / SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)
✓ NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)
WATER SUPPLY
___ Domestic ___ Public
✓ Irrigation ___ Industrial
MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER N/A (Ft.) BELOW SURFACE
DEPTH OF STATIC WATER LEVEL 25 (Ft.) & DATE MEASURED 3/12/2014
ESTIMATED YIELD * 90 (GPM) & TEST TYPE Air Devel/Pump
TEST LENGTH 5 (Hrs.) TOTAL DRAWDOWN 200 (Ft.)
** May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	220	8								
0	220	18								
11	150		✓				PVC	10	SDR17	
150	210			✓			PVC	10	SDR17	.032
210	220		✓				PVC	10	SDR17	

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	0	✓			CONCRETE
0	50	✓			
50	120		✓		
120	220			✓	1/8x1/4 Gravel

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other ___

ATTACH ADDITIONAL INFORMATION IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.
NAME Weeks Drilling & Pump
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
P.O. Box 176 Sebastopol CA 95473
ADDRESS CITY STATE ZIP
Signed [signature] 04/16/14 177681
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV 11-97 IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

STATE OF CALIFORNIA

WELL COMPLETION REPORT

No. e0206623

DWR USE ONLY -- DO NOT FILL IN

15N12W28 | STATE WELL NO. STATION NO.

39.4765 N 123.1119 W | LATITUDE LONGITUDE

180-060-67 | APN / TRS / OTHER

OWNER'S WELL No. 8405

Date Work Began 5/12/14 Ended 5/14/14

Local Permit Agency MENDOCINO

Permit No. WW22318 Permit Date 02-05-2014

GEOLOGIC LOG

ORIENTATION Vertical Degree of Angle ____

DEPTH TO FIRST WATER ____ (ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft.	Ft.	DESCRIPTION
0	10	brown clay
10	40	gravels and cemented gravels
40	90	gravels and sand
90	97	brown clay
97	180	cemented gravels
		recommended pump setting of 100'
		* 200 ? gpm

TOTAL DEPTH OF BORING 180 (Feet)

TOTAL DEPTH OF COMPLETED WELL 120 (Feet)

WELL OWNER

[redacted]

WELL LOCATION

Address 725 TALMAGE ROAD

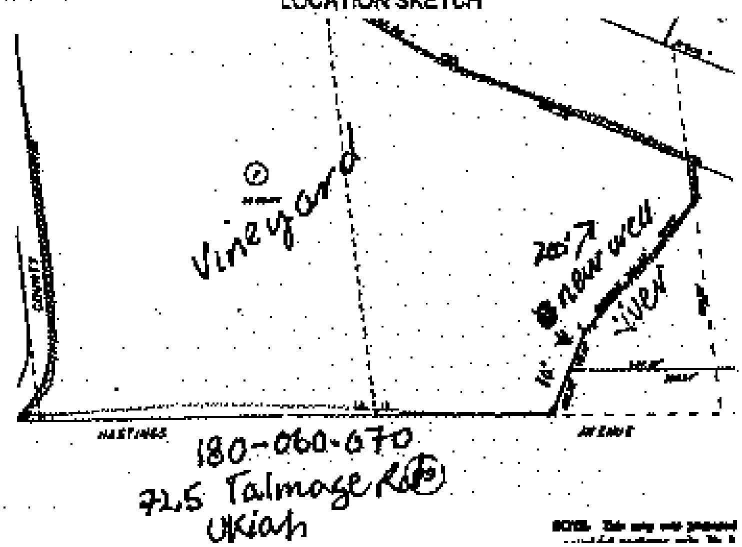
City UKIAH County MENDOCINO

Apn Book 180 Page 060 Parcel 070

or Township ____ Range ____ Section ____ 1/4 ____ 1/4

or Latitude ____ ____ ____ NORTH Longitude ____ ____ ____ WEST
Deg. Min. Sec. Deg. Min. Sec.

LOCATION SKETCH



ACTIVITY NEW WELL PLANNED USE(S) IRRIGATION WATER

DRILLING METHOD ROTARY MUD FLUID

DEPTH OF STATIC WATER LEVEL 25 (Ft.) & DATE MEASURED May 15 2014

ESTIMATED YIELD * ★ (G.P.M.) & TEST TYPE Airlift

TEST LENGTH 2 (Hrs.) TOTAL DRAWDOWN ____ (FT.)

*May not be representative of a well's long-term yield.

CASING

DEPTH FROM SURFACE Ft.	To Ft.	BORE-HOLE DIA.	TYPE	Material / Grade	Dia.	Gauge	Slot size
0	40	20	Blank	F480 PVC	12	200	
40	120	20	Perfs	F480 PVC	12	200	.032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	To Ft.	Seal Material	Filter Pack (Type / Size)
0	20	BENTONITE	
20	120		8 X 16 SAND

Attachments

- no Geologic Log
- no Well Construction Diagram
- _ Geophysical Logs
- no Soil Water Chemical Analyses
- no Other

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME FISCH BROS. DRILLING, INC.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

5001 Gravenstein Hwy No. Sebastopol CA 95472

Signed Steve Unterseher 5-15-14 399226
WELL DRILLER / AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

STATE OF CALIFORNIA

WELL COMPLETION REPORT

No. e0196458

OWNER'S WELL No. 8162

Date Work Began 1/13/14 Ended 1/16/14

Local Permit Agency MENDOCINO

Pe No. WW22283 Permit Date 12-06-2013

DWR USE ONLY -- DO NOT FILL IN

14N12W10

STATE WELL NO. STATION NO.

390504 1230936

LATITUDE LONGITUDE

APN / TRS / OTHER

GEOLOGIC LOG

ORIENTATION Vertical Degree of Angle ____

DEPTH TO FIRST WATER ____ (ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft.	Ft.	DESCRIPTION
0	40	brown clay with cemented gravels
40	55	brown clay
55	130	brown clay and cemented gravels
130	150	brown clay
150	200	weathered sandstone
200	210	weathered sandstone and shale
210	225	shale and clay

recommended pump setting of 200'

TOTAL DEPTH OF BORING 225 (Feet)

TOTAL DEPTH OF COMPLETED WELL 220 (Feet)

WELL OWNER

[redacted]

WELL LOCATION

Address 5700 OLD RIVER ROAD

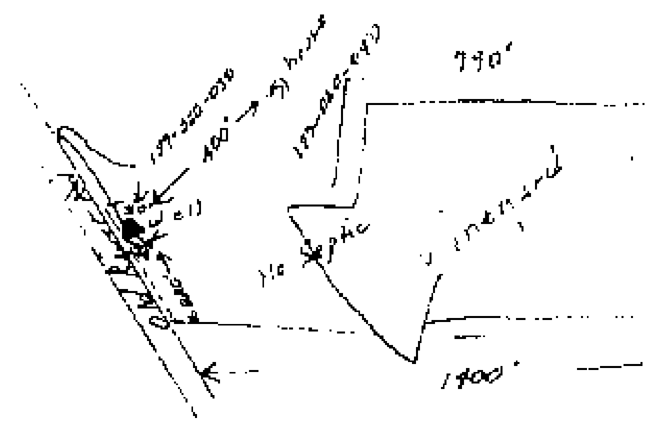
City UKIAH County MENDOCINO

Apn Book 187 Page 080 Parcel 05

or Township ____ Range ____ Section ____ 1/4 ____ 1/4

or Latitude ____ ____ ____ NORTH Longitude ____ ____ ____ WEST
Deg. Min. Sec. Deg. Min. Sec.

LOCATION SKETCH



ACTIVITY NEW WELL PLANNED USE(S) Irrigation Water

DRILLING METHOD ROTARY MUD FLUID

DEPTH OF STATIC WATER LEVEL 50 (Ft.) & DATE MEASURED Jan 16, 2014

ESTIMATED YIELD * 30 (G.P.M.) & TEST TYPE Airlift

TEST LENGTH 2 (Hrs.) TOTAL DRAWDOWN ____ (FT.)

*May not be representative of a well's long-term yield

CASING

DEPTH FROM SURFACE Ft. To	Ft.	BORE-HOLE DIA.	TYPE	Material / Grade	Dia.	Gauge	Slot size
0	80	13	Blank	F480 PVC	8	200	
80	220	13	Perfs	F480 PVC	8	200	.032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft. To	Ft.	Seal Material	Filter Pack (Type / Size)
0	20	BENTONITE	
20	220		8 X 16

Attachments

no Geologic Log

no Well Construction Diagram

r Geophysical Logs

no Soil Water Chemical Analyses

no Other

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME FISCH BROS. DRILLING, INC.

(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

5001 Gravenstein Hwy No Sebastopol CA 95472

Signed Steve Untersaher 01-17-14 399226

WELL DRILLER / AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

ORIGINAL
File with DWR

Page 1 of 1

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. e0183573

DWR USE ONLY — DO NOT FILL IN
16N12W09
STATE WELL NO./STATION NO.
391532 LATITUDE 1231143 LONGITUDE
APN/TRS/OTHER

Owner's Well No. WELL #1
Date Work Began 7/12/2013, Ended 7/18/2013
Local Permit Agency Mendocino County Environmental
Permit No. WW22201 Permit Date 7/18/2013

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD Mud Rotary FLUID Bentonite

DEPTH FROM SURFACE Ft. to	Ft.	DESCRIPTION (Describe material, grain size, color, etc.)
0	17	Brown clay with some rock
17	26	Sticky green clay
26	29	Blue green sand
29	45	Stiff gray clay
45	57	Multi-colored gravel
57	90	Very stiff green and gray clay
90	100	Blue clay
100	105	Sandy blue clay
105	120	Multi-colored gravel
120	150	(Dirty) Blue sand and gravel with streaks of blue clay
150	152	Stiff blue clay

TOTAL DEPTH OF BORING 152 (Feet)
TOTAL DEPTH OF COMPLETED WELL 150 (Feet)

WELL OWNER

[redacted]

CITY STATE ZIP

WELL LOCATION

Address 1300 Road B
City Redwood Valley CA
County Mendocino
APN Book 163 Page 230 Parcel 02
Township ___ Range ___ Section ___
Latitude ___ DEG. MIN. SEC. Longitude ___ DEG. MIN. SEC.

LOCATION SKETCH

NORTH / WEST / EAST / SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER N/A (Ft.) BELOW SURFACE
DEPTH OF STATIC WATER LEVEL 80 (Ft.) & DATE MEASURED 7/18/2013
ESTIMATED YIELD * 10 (GPM) & TEST TYPE Bailed
TEST LENGTH 2 (Hrs.) TOTAL DRAWDOWN 8lm (Ft.)
* May not be representative of a well's long-term yield.

CASING (S)

DEPTH FROM SURFACE Ft. to	Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	152	9 7/8"								
+3	40		✓				PVC	5	SDR21	
40	60			✓			PVC	5	SDR21	.032
60	80		✓				PVC	5	SDR21	
80	140			✓			PVC	5	SDR21	.032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft. to	Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	2	✓			CONCRETE
2	24		✓		
24	44			✓	8x16 Sand
44	150			✓	1/8x1/4" Gravel

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other
ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.
NAME Weeks Drilling & Pump
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
P.O. Box 178, Sebastopol, CA 95473
ADDRESS CITY STATE ZIP
Signed [signature] WELL DRILLER/AUTHORIZED REPRESENTATIVE
08/01/13 DATE SIGNED
177681 C-57 LICENSE NUMBER

DWR 188 REV. 11-97

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

STATE OF CALIFORNIA

WELL COMPLETION REPORT

No E0182651

OWNER'S WELL No. 8060

Date Work Began 10/1/13 Ended 10/1/13

Local Permit Agency MENDOCINO

Pe[redacted]No. WW22243 Permit Date 09-19-2013

DWR USE ONLY — DO NOT FILL IN

16N12W03

STATE WELL NO. STATION NO.

39.1634 123.1026

LATITUDE LONGITUDE

APN / TRS / OTHER

GEOLOGIC LOG

ORIENTATION Vertical Degree of Angle ____

DEPTH TO FIRST WATER ____ (ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft.	Ft.	DESCRIPTION
0	30	brown clay
30	50	brown clay with weathered sandstone
50	130	blue clay, shale and sandstone
130	170	greenstone
170	200	greenstone with clay
[redacted]		recommend setting pump at 180'

TOTAL DEPTH OF BORING 200 (Feet)

TOTAL DEPTH OF COMPLETED WELL 200 (Feet)

WELL OWNER

[redacted]

WELL LOCATION

Address 2800 WEBB RANCH ROAD

City REDWOOD VALLEY County MENDOCINO

Apn Book 161 Page 280 Parcel 05

or

Township ____ Range ____ Section ____ 1/4 ____ 1/4

or

Latitude ___ ___ ___ NORTH Longitude ___ ___ ___ WEST

Deg. Min. Sec. Deg. Min. Sec.

LOCATION SKETCH

ACTIVITY NEW WELL PLANNED USE(S) Domestic Water

DRILLING METHOD ROTARY AIR FLUID

DEPTH OF STATIC WATER LEVEL 100 (Ft) & DATE MEASURED Oct 1 2013

ESTIMATED YIELD * 5 (G.P.M) & TEST TYPE Airlift

TEST LENGTH 2 (Hrs) TOTAL DRAWDOWN ____ (FT.)

*May not be representative of a well's long-term yield

CASING

DEPTH FROM SURFACE Ft.	To Ft.	BORE-HOLE DIA.	TYPE	Material / Grade	Dia.	Gauge	Slot size
0	100	10	Blank	F480 PVC	5	200	
100	200	7 3/4	Perfs	F480 PVC	5	200	.032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	To Ft.	Seal Material	Filter Pack (Type / Size)	
0	20	Bentonite		
20	200		Pea Gravel	3/8

Attachments

no Geologic Log

no Well Construction Diagram

[redacted] Geophysical Logs

no Soil Water Chemical Analyses

no Other

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Bach Bros. Drilling, Inc.

(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

5001 Gravenstein Hwy No. Sebastopol CA 95472

Signed Steve Untersener 399226

WELL DRILLER / AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

ORIGINAL
File with DWR
Page 1 of 4
Owner's Well No. ______
Date Work Began 10/18/2000 Ended 10/24/2000
Local Permit Agency Mendocino County Environmental Health
Permit No. 10/18/2000 Permit Date 11771

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet
No. 722640

DWR USE ONLY — DO NOT FILL IN
14M/12W28
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD Air Rotary FLUID ______

DEPTH FROM SURFACE Ft. to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0 : 160	Gray Rock (MED)
160 : 330	Gray Rock (VERY HARD)

TOTAL DEPTH OF BORING 330 (Feet)
TOTAL DEPTH OF COMPLETED WELL 0 (Feet)

WELL OWNER

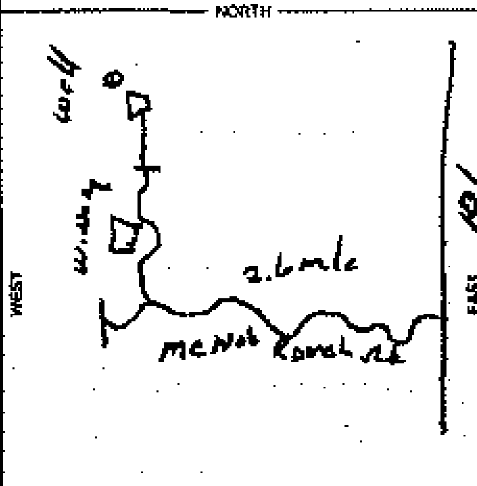
[redacted]

WELL LOCATION

Address 3300 McNab Ranch Road
City Ukiah, CA. 95482
County Mendocino
APN Book 47 Page 11 Parcel 14
Township ______ Range ______ Section ______
Latitude ______ NORTH Longitude ______ WEST
DEG. MIN. SEC. DEG. MIN. SEC.

LOCATION SKETCH

NORTH



WEST EAST
SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

X NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)

WATER SUPPLY
X Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER DRY (Ft.) BELOW SURFACE
DEPTH OF STATIC WATER LEVEL DRY (Ft.) & DATE MEASURED None
ESTIMATED YIELD * DRY (GPM) & TEST TYPE None
TEST LENGTH None (Hrs.) TOTAL DRAWDOWN ______ (Ft.)
* May not be representative of a well's long-term yield.

CASING (S)

DEPTH FROM SURFACE Ft. to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0 330	9"	None				None	None	None	None

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft. to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
None	None			None

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other
ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME R & B DRILLING
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

580 Milani Drive, Ukiah, CA. 95482
ADDRESS CITY STATE ZIP

Signed [signature] 11/07/2000 482117
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 11-97 IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

SW 1/4, 29
SE 1/4, 30

ORIGINAL
File with DWR

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

Do not fill in

No. 378261

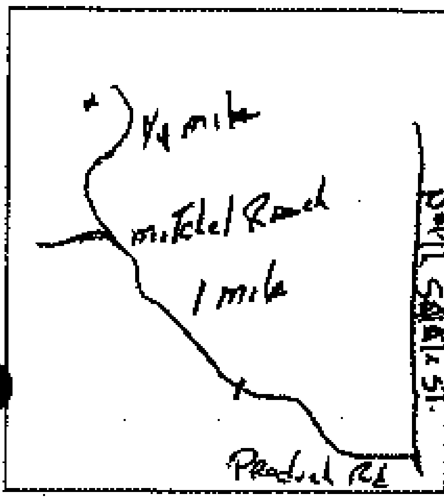
Notice of Intent No. ______
Local Permit No. or Date 9013 6/5/91

167 210 005

State Well No.
Other Well No. 16N12W29M

[redacted]

(2) LOCATION OF WELL (See instructions):
County Mendocino Owner's Well Number
Well address if different from above 1201 Parducci Rd.
Township 16 North Range 12 West Section 30
Distance from cities, roads, railroads, fences, etc. 1 1/2 miles on Parducci Road right turn after Lake 1/4 mile



WELL LOCATION SKETCH

(3) TYPE OF WORK:
New Well XX Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:
Domestic ☒
Irrigation ☐
Industrial ☐
Test Well ☐
Municipal ☐
Other ☒
(Describe)

(12) WELL LOG: Total depth 400 ft. Completed depth 0 ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
0	3	Top Soil
3	32	Yellow Clay
32	67	Blue Clay
67	73	Yellow Clay
73	85	Gray Clay
85	110	Yellow Clay
110	122	Blue Clay & Gravel
122	139	Yellow Clay & Gravel
139	165	Blue Clay
165	180	Rock Sandstone
180	208	Blue Clay & Gravel
208	228	Yellow Clay
228	400	Yellow Clay & Gravel

(5) EQUIPMENT:
Rotary ☒ Reverse ☐
Cable ☐ Air XX
Other ☐ Bucket ☐

(6) GRAVEL PACK:
Yes ☐ No ☒ Size
Diameter of bore 9 INCH
Packed from 0 to 0
DRY

(7) CASING INSTALLED:
Steel ☐ DRY Plastic ☐ Concrete ☐

(8) PERFORATIONS:
Type of perforation or size of screen

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot size
	DRY	DRY	DRY	DRY	DRY	

(9) WELL SEAL:
Was surface sanitary seal provided? Yes ☐ No ☐ If yes, to depth ______ ft.
Were strata sealed against pollution? Yes ☐ No ☐ Interval DRY DRY DRY ft.
Method of sealing DRY

(10) WATER LEVELS:
Depth of first water, if known DRY DRY DRY ft.
Standing level after well completion DRY DRY DRY DRY ft.

(11) WELL TESTS:
Was well test made? Yes ☐ DRY DRY DRY If yes, by whom?
Type of test Pump ☐ Bailer ☐ Air lift ☐
Depth to water at start of test ______ ft. DRY DRY DRY At end of test ______ ft.
Discharge ______ gal/min after ______ hours Water temperature ______
Chemical analysis made? Yes ☐ No ☐ If yes, by whom?
Was electric log made? Yes ☐ DRY DRY DRY If yes, attach copy to this report

Work started 6/5 1991 Completed 6/6 1991

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Signed ______ (Well Driller)
NAME R & B Drilling
(Person, firm, or corporation) (Typed or printed)
Address 580 Milani Drive
City Ukiah, CA. ZIP 95482
License No. 482117 Date of this report 6/13/91

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

ORIGINAL

File with DWR

Notice of Intent No. ____

Local Permit No. or Date 6727

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

Do not fill in

No. 210920

State Well No. ____

Other Well No. 16N12W20R

[redacted]

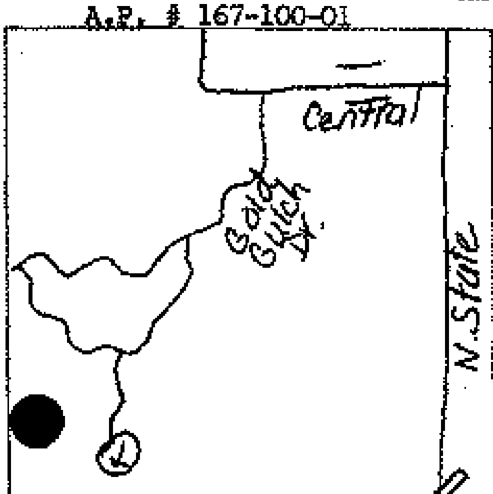
(2) LOCATION OF WELL (See instructions):

County Mendocino Owner's Well Number ____

Well address if different from above ____

Township 16N Range 12W Section 20

Distance from cities, roads, railroads, fences, etc.
757 Gold Gulch Road
Ukiah
A.P. # 167-100-01



WELL LOCATION SKETCH

(3) TYPE OF WORK:

New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:

Domestic ☒
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

(5) EQUIPMENT:

Rotary ☐ Reverse ☐
Cable ☐ Air ☒
Other ☐ Bucket ☐

(6) GRAVEL PACK:

Yes ☐ No ☒ Size ____

Diameter of bore 11 & 6 3/4"

Packed from ____ to ____ ft.

(7) CASING INSTALLED:

Steel ☐ Plastic ☐ Concrete ☐

(8) PERFORATIONS:

Type of perforation or size of screen ____

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot size

(9) WELL SEAL:

Was surface sanitary seal provided? Yes ☐ No ☐ If yes, to depth ____ ft.

Were strata sealed against pollution? Yes ☐ No ☐ Interval ____ ft.

Method of sealing ____

(10) WATER LEVELS:

Depth of first water, if known ____ ft.

Standing level after well completion ____ ft.

(11) WELL TESTS:

Was well test made? Yes ☐ No ☐ If yes, by whom? ____

Type of test Pump ☐ Bailer ☐ Air lift ☐

Depth to water at start of test ____ ft. At end of test ____ ft.

Discharge ____ gal/min after ____ hours Water temperature ____

Chemical analysis made? Yes ☐ No ☐ If yes, by whom? ____

Was electric log made? Yes ☐ No ☐ If yes, attach copy to this report

(12) WELL LOG: Total depth 420 ft. Depth of completed well ____ ft.

from ft. to ft. Formation (Describe by color, character, size or material)

LOG OF UNCASED DRY HOLE

from ft.	to ft.	Formation
0	3	Sandy brown clay
3	4	Clayee brown sand
4	6	Clayee brown sand embedded with weathered brown and gray rock
6	67	Firm clayee brown sand and gravel with streaks of stiff brown clay
67	106	Firm clayee blue sand and sandy blue clay
106	127	Firm sandy gray clay
127	154	Firm sandy blue clay
154	197	Firm clayee blue sand and stiff sandy blue clay
197	420	Stiff blue clay and clayee blue sand embedded with multicolored gravels

Work started 3-17 19 88 Completed 3-22 19 88

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

SIGNED Gerald Thompson By: Don Sinclair
(Well Driller)

NAME WEEKS DRILLING AND PUMP COMPANY
(Person, firm, or corporation) (Typed or printed)

Address P.O. Box 176 - 6100 Sebastopol Road

City Sebastopol, California Zip 95472

License No. C57-177681 Date of this report March 22, 1988

DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

STATE OF CALIFORNIA

WELL COMPLETION REPORT

No. e0255737

DWR USE ONLY -- DO NOT FILL IN

17N12W29

STATE WELL NO. STATION NO.

391757N 1231259W

LATITUDE LONGITUDE

160080140

APN / TRS / OTHER

OWNER'S WELL No 9017

Date Work Began 4/20/15 Ended 4/23/15

Local Permit Agency MENDOCINO

Pt No. WW22485 Permit Date 08-12-2014

GEOLOGIC LOG

ORIENTATION Vertical Degree of Angle ____

DEPTH TO FIRST WATER ____ (ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft.	Ft.	DESCRIPTION
0	2	topsoil
2	22	brown clay with big cemented gravels
22	40	brown clay
40	220	blue clay with cemented gravel

TOTAL DEPTH OF BORING 220 (Feet)

TOTAL DEPTH OF COMPLETED WELL 220 (Feet)

WELL OWNER

[redacted]

WELL LOCATION

Address 2240 GREEN ACRE DRIVE

City REDWOOD VALLEY County MENDOCINO

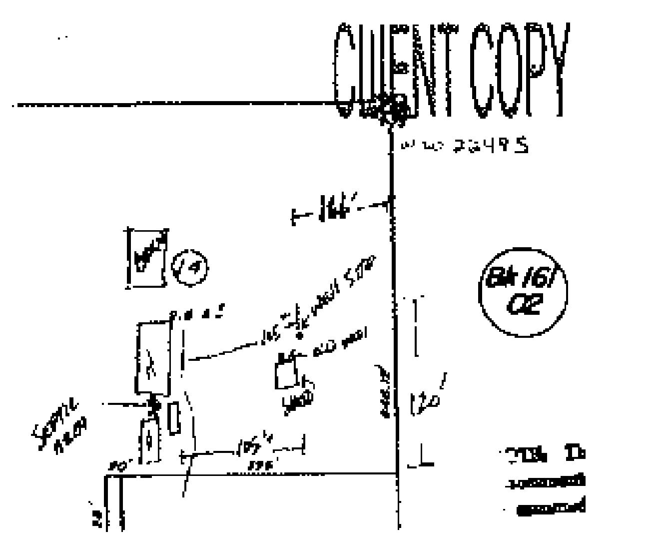
Apn Book 160 Page 080 Parcel 140

or Township ____ Range ____ Section ____ 1/4 ____ 1/4

or Latitude ___ ___ ___ NORTH Longitude ___ ___ ___ WEST

Deg. Min. Sec. Deg. Min. Sec.

LOCATION SKETCH



ACTIVITY NEW WELL PLANNED USE(S) DOMESTIC WATER

DRILLING METHOD ROTARY MUD FLUID

DEPTH OF STATIC WATER LEVEL 25 (Ft.) & DATE MEASURED Apr 23, 2015

ESTIMATED YIELD * 15 (G.P.M.) & TEST TYPE Airlift

TEST LENGTH 2 (Hrs.) TOTAL DRAWDOWN 210 (FT.)

*May not be representative of a well's long-term yield.

CASING

DEPTH FROM SURFACE Ft.	To Ft.	BORE-HOLE DIA.	TYPE	Material / Grade	Dia.	Gauge	Slot size
0	20	10 5/8	BLANK	F480 PVC	5	200	
20	60	8 3/4	BLANK	F480 PVC	5	200	
60	220	8 3/4	PERF	F480 PVC	5	200	.032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	To Ft.	Seal Material	Filter Pack (Type / Size)
0	20	BENTONITE	
20	220		12/20 SAND

Attachments

no Geologic Log

no Well Construction Diagram

1 Geophysical Logs

no Soil Water Chemical Analyses

no Other

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME FISCH BROS. DRILLING, INC.

(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

5001 Gravenstein Hwy No Sebastopol CA 95472

Signed Dale Theiss 042415 399226

WELL DRILLER / AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

ORIGINAL
File with DWR

Page 1 of 1

Owner's Well No. DRY HOLE #1

Date Work Began 10/3/2014, Ended 10/6/2014

Local Permit Agency Mendocino County Environmental

Permit No. WW22480 Permit Date 8/12/2014

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. e0236817

DWR USE ONLY – DO NOT FILL IN

17N12W33

STATE WELL NO./STATION NO.

39 16 47 N 123 1 136 W

LATITUDE LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD AIR FLUID N/A

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION Describe material, grain, size, color, etc.
		DRY HOLE
0	35	Brown clay with gravel
35	60	Tan clay
60	85	Blue clay with gravel
85	125	Stiff gray clay
125	145	Brown stiff clay
145	200	Gray clay / Shale
		Dry hole backfilled and abandoned
		per Mendocino County requirements

TOTAL DEPTH OF BORING 200 (Feet)

TOTAL DEPTH OF COMPLETED WELL N/A (Feet)

WELL OWNER

Name [redacted]

Mailing Address [redacted]

CITY STATE ZIP

WELL LOCATION

Address 2730 Road E

City Redwood Valley CA

County Mendocino

APN Book 161 Page 240 Parcel 02

Township Range Section

Latitude DEG. MIN. SEC. Longitude DEG. MIN. SEC.

LOCATION SKETCH

NORTH / WEST / EAST / SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR
- ___ Deepen
- ___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)

WATER SUPPLY
- ✓ Domestic ___ Public
- ✓ Irrigation ___ Industrial

MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

1

DEPTH TO FIRST WATER N/A (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL NA (Ft.) & DATE MEASURED

ESTIMATED YIELD * N/A (GPM) & TEST TYPE N/A

TEST LENGTH N/A (Hrs.) TOTAL DRAWDOWN N/A (Ft.)

** May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	25	11								
25	200	7 7/8								

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)

ATTACHMENTS (✓)

- ___ Geologic Log
- ___ Well Construction Diagram
- ___ Geophysical Log(s)
- ___ Soil/Water Chemical Analyses
- ___ Other

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Weeks Drilling & Pump
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

P.O. Box 176 Sebastopol CA 95473
ADDRESS CITY STATE ZIP

Signed [signature] 10/22/14 177681
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV 11-97

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

ORIGINAL
File with DWR

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
WATER WELL DRILLERS REPORT

Do not fill in
No. 066952

Notice of Intent No. ____
Local Permit No. or Date ____

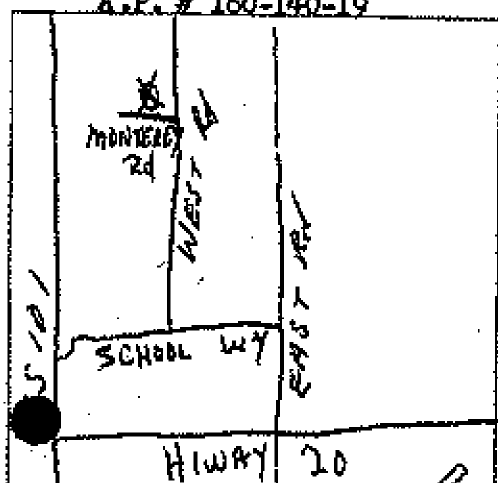
160-140-019

State Well No. ____
Other Well No. 17N12W29M

[redacted]

(2) LOCATION OF WELL (See instructions):
County Mendocino Owner's Well Number ____
Well address if different from above ____
Township 17N Range 12W Section 29
Distance from cities, roads, railroads, fences, etc.
same as above

A.P. # 160-140-19



WELL LOCATION SKETCH

(3) TYPE OF WORK:
New Well ■ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:
Domestic ■
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

(5) EQUIPMENT:
Rotary ■ Reverse ☐
Cable ☐ Air ☐
Other ☐ Bucket ☐

(6) GRAVEL PACK:
Yes ■ No ☐ Size pea
Diameter of bore 9 7/8 & 13 7/8"
Packed from 25' to 130' ft.

(7) CASING INSTALLED:
Steel ☐ Plastic ■ Concrete ☐

(8) PERFORATIONS:
Type of perforation or size of screen sawn

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot size
0	134	5	160PVC	50	70	
				90	130	1/8x3

(9) WELL SEAL:
Was surface sanitary seal provided? Yes ■ No ☐ If yes, to depth 25' ft.
Were strata sealed against pollution? Yes ☐ No ■ Interval ____ ft.
Method of sealing cement on gravel pack

(10) WATER LEVELS:
Depth of first water, if known ____ ft.
Standing level after well completion ? ft.

(11) WELL TESTS:
Was well test made? Yes ■ No ☐ If yes, by whom? Weeks
Type of test Pump ☐ Bailer ■ Air lift ☐
Depth to water at start of test ? ft. At end of test 100' ft
Discharge 1.5 gal/min after 2 hours Water temperature cold
Chemical analysis made? Yes ☐ No ■ If yes, by whom? ____
Was electric log made? Yes ☐ No ■ If yes, attach copy to this report

(12) WELL LOG: Total depth 130 ft. Depth of completed well 130 ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
0	1	Top soil
1	19	Cemented gravels
19	42	Brown clay
42	90	Gravel
90	94	Cemented gravel
94	100	Brown shale & clay
100	112	Brown sandy clay
112	123	Gray rock & clay
123	130	Gray clay w/streaks of rock

Work started March 8, 1979 Completed March 14, 1979

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

SIGNED Gerald Thompson By: Mary E. Thompson
(Well Driller)
NAME WEEKS DRILLING AND PUMP COMPANY
(Person, firm, or corporation) (Typed or printed)
Address Sebastopol Road
City Sebastopol, California Zip 95472
License No. C57-177681 Date of this report March 19, 1979

DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

ORIGINAL
File with DWR

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
WATER WELL DRILLERS REPORT

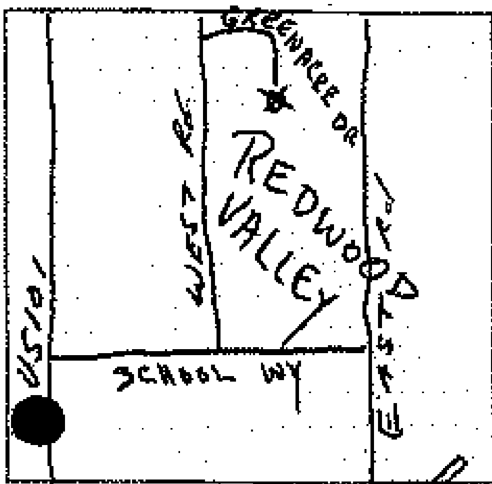
Do not fill in
No. 105700

State Well No.
Other Well No. 17N12W29L

Notice of Intent No.
[redacted] Permit No. or Date
160-090

[redacted]

(2) LOCATION OF WELL (See instructions):
County: Mendocino Owner's Well Number:
Well address if different from above:
Township: 17N Range: 12W Section: 29
Distance from cities, roads, railroads, fences, etc.
End of Greenacre Drive
Redwood Valley



WELL LOCATION SKETCH

(3) TYPE OF WORK:
New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:
Domestic ☒
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

(5) EQUIPMENT:
Rotary ☐ Reverse ☐
Cable ☐ Air ☐
Other ☐ Bucket ☒

(6) GRAVEL PACK:
Yes ☒ No ☐ Size: pea
Diameter of bore: 30"
Packed from 20' to 83'

(7) CASING INSTALLED:
Steel ☐ Plastic ☒ Concrete ☐

(8) PERFORATIONS:
Type of perforation or size of screen: sawn

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot size
0	84	8"	160PVC	43	83	1/8x4

(9) WELL SEAL:
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 20' ft.
Were strata sealed against pollution? Yes ☐ No ☒ Interval ft.
Method of sealing: concrete on gravel pack

(10) WATER LEVELS:
Depth of first water, if known ft.
Standing level after well completion 30' ft.

(11) WELL TESTS:
Was well test made? Yes ☒ No ☐ If yes, by whom? Weeks
Type of test: Pump ☐ Bailer ☒ Air lift ☐
Depth to water at start of test 30' ft. At end of test 70' ft
Discharge 5 gal/min after 3/4 hours Water temperature cold
[redacted]al analysis made? Yes ☐ No ☒ If yes, by whom?
[redacted] electric log made? Yes ☐ No ☒ If yes, attach copy to this report

(12) WELL LOG: Total depth 83 ft. Depth of completed well 83 ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
0	1	Brown top soil
1	3	Brown dirt
3	10	Brown clay
10	25	Embedded gravels & clay
25	26	Brown gravel w/little seep
26	65	Blue embedded gravels
65	70	Embedded gravel w/little seep
70	75	Blue clay
75	77	Boulders & water bearing gravel
77	83	Boulders & clay

Work started Aug. 15, 1978 Completed Aug. 15, 1978

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

SIGNED: Gerald Thompson By: Mary E. Thompson (Well Driller)
NAME: WEEKS DRILLING AND PUMP COMPANY (Person, firm, or corporation) (Typed or printed)
Address: Sebastopol Road
City: Sebastopol, California Zip 95472
License No. 057-177681 Date of this report August 21, 1978

DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

CONFIDENTIAL LOG
Water Code Sec. 13752

ORIGINAL
File with DWR

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

Do Not Fill In

№ 116376

State Well No.

Other Well No. 17N/12W-23

[redacted]

(2) LOCATION OF WELL:

County Mendocino Owner's number, if any

Township, Range, and Section

Distance from cities, roads, railroads, etc. end of Road "J"
Redwood Valley

(3) TYPE OF WORK (check):

New Well ☒ Deepening ☐ Reconditioning ☐ Destroying ☐

If destruction, describe material and procedure in Item 11.

(4) PROPOSED USE (check):

Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) EQUIPMENT:

Rotary ☒
Cable ☐
Other ☐

(6) CASING INSTALLED:

(STEEL) OTHER:

SINGLE ☐ DOUBLE ☐

From ft.	To ft.	Diam.	Gage or Wall	Diameter of Bore (If gravel packed)	From ft.	To ft.
0	296	6"	10	9 7/8	0	153
				7 7/8	153	295

Size of shoe or well ring: none Size of gravel: pea

Describe joint weld

(7) PERFORATIONS OR SCREEN:

Type of perforation or name of screen slots

From ft.	To ft.	Perf. per row	Rows per ft.	Size in. x in.
206	276	4	1	1/8 X 10

(8) CONSTRUCTION:

Was a surface sanitary seal provided? Yes ☒ No ☐ To what depth ft.

Were any strata sealed against pollution? Yes ☐ No ☒ If yes, note depth of strata

From ft. to ft.

From ft. to ft.

Method of sealing cement on gravel pack

(9) WATER LEVELS:

Depth at which water was first found, if known ft.

Standing level before perforating, if known ft.

Standing level after perforating and developing unknown ft.

(10) WELL TESTS:

Was pump test made? Yes ☐ No ☒ If yes, by whom?

Yield: 44 gal./min. with 295 ft. drawdown after hrs.

Temperature of water cold Was a chemical analysis made? Yes ☐ No ☒

Was electric log made of well? Yes ☐ No ☒ If yes, attach copy

(11) WELL LOG:

Total depth 295 ft. Depth of completed well 295 ft.

Formation: Describe by color, character, size of material, and structure

ft. to ft.	
0 - 1	Top soil
1 - 50	Brown sandy clay w/embedded gravel
50 - 74	Blue sandy clay
74 - 96	Stiff blue clay
96 - 147	Blue sandy clay, some embedded gravel
147 - 165	Smokie gray clay w/black shale
165 - 173	Smokie gray clay & black & green rock
173 - 190	Gray rock w/gray clay
190 - 239	Very hard gray & green rock, some gray clay, some fractures
239 - 245	Smokie gray clay w/gray rock
245 - 249	Green clay w/multi colored rock
249 - 262	Smokie gray clay w/gray & black rock
262 - 285	Hard gray rock w/some gray clay
285 - 295	Smokie gray clay & hard gray rock

Work started 9-26-73 19 , Completed 9-26-73 19
10-

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Weeks Drilling and Pump Co.
(Person, firm, or corporation) (Typed or printed)

Address Sebastopol Road
Sebastopol, California 95472

[SIGNED] Gerald Thompson (Well Driller)
By Mary E. Thompson

License No. 177681 Dated 10-15-73, 19

SKETCH LOCATION OF WELL ON REVERSE SIDE

CONFIDENTIAL LOG
Water Code ...

ORIGINAL
File with DWR

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
WATER WELL DRILLERS REPORT

Do not fill in

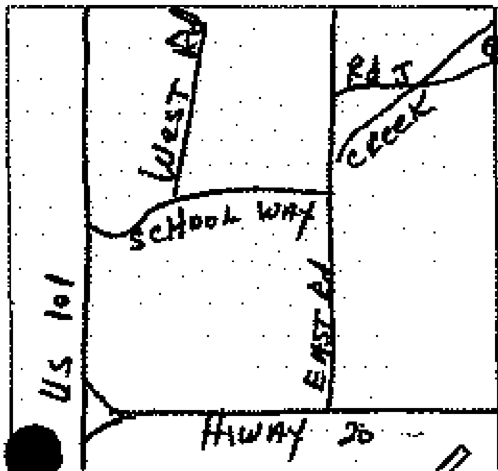
No. 03049

Notice of Intent No. ______
Local Permit No. or Date ______

State Well No. ______
Other Well No. 17N/12W-28

[redacted]

(2) LOCATION OF WELL (See instructions):
County Mendocino Owner's Well Number ______
Well address if different from above ______
Township ______ Range ______ Section ______
Distance from cities, roads, railroads, fences, etc. on Manzanita Road
Redwood Valley



WELL LOCATION SKETCH

(3) TYPE OF WORK:
New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:
Domestic ☒
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

(5) EQUIPMENT:
Rotary ☒ Reverse ☐
Cable ☐ Air ☐
Other ☐ Bucket ☐

(6) GRAVEL PACK:
Yes ☒ No ☐ Size pea
Diameter of bore 9 7/8 & 8 3/4
Packed from 20' to 250'

(7) CASING INSTALLED:
Steel ☐ Plastic ☒ Concrete ☐

(8) PERFORATIONS:
Type of perforation or size of screen sawn

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot size
0	252	6"	160PSI	150'	210'	1/8 x 4
				230'	250'	1/8 x 4

(9) WELL SEAL:
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 20' ft.
Were strata sealed against pollution? Yes ☐ No ☒ Interval ______ ft.
Method of sealing cement on gravel pack

(10) WATER LEVELS:
Depth of first water, if known ______ ft.
Standing level after well completion 60' ft.

(11) WELL TESTS:
Was well test made? Yes ☒ No ☐ If yes, by whom? WEEKS
Type of test Pump ☐ Bailer ☒ Air lift ☐
Depth to water at start of test 60' ft. At end of test 240' ft.
Discharge 1 gal/min after 2 hours Water temperature cold
Chemical analysis made? Yes ☐ No ☒ If yes, by whom? ______
Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

(12) WELL LOG: Total depth 250 ft. Depth of completed well 250 ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
0	12	Tight brown clay w/sandstone
12	25	Tight brown sticky clay w/embedded coarse sand
25	35	Blue clay embedded w/coarse sand
35	80	Blue clay w/embedded conglomerate gravels
80	85	Blue clay
85	87	Soft conglomerate rock
87	209	Blue clay w/embedded blue rock
209	223	Stiff gray clay embedded w/blue rock
223	225	Gray rock w/clay seams
225	230	Gray clay
230	232	Gray & green serpentine rock w/seams of clay
232	250	Serpentine clay & gray clay embedded w/rock

Work started August 18, 19 77 Completed August 22, 19 77

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

SIGNED Gerald Thompson By: Mary E. Thompson
(Well Driller)
NAME WEEKS DRILLING AND PUMP COMPANY
(Person, firm, or corporation) (Typed or printed)
Address Sebastopol Road
City Sebastopol, California Zip 95472
License No. 177681 Date of this report August 25, 19