

Appendix I – Hydrology



TECHNICAL MEMORANDUM

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TO: Mark Roberts
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RE: Groundwater Feasibility Evaluation – Airport Redevelopment Project
City of Clearlake, CA

DATE: July 8, 2025

This Technical Memorandum (TM) provides a summary evaluation of groundwater feasibility. The purpose is to provide an evaluation of supplying water for the proposed Airport Redevelopment Project via new groundwater well(s).

Background

The proposed Project (Project) is a conceptual development plan that would allow the development of the 49.62-acre site with a mix of uses, potentially including but not limited to healthcare facilities, multifamily housing, retail, restaurants, hotel, and open space within up to 422,000 square feet of commercial and/or medical space, up to 250 new housing units, and 75 hotel rooms.

The Project site is a former airport site located within the southern area of the incorporated limits of the City of Clearlake (City), in Lake County, California. The Project site is bounded by the 18th Avenue extension and Victor Street to the north, State Route (53) to the east, and Old Highway 53 to the south and west (Figure 1).

The projected water demand for the Project was determined by the California Engineering Company, Inc. (2025). The total average demand estimated for the Project is 108,685 gallons per day (gpd).

Purpose

The purpose of this TM is to provide an evaluation of the feasibility of developing a groundwater well or wells to serve all or a portion of the proposed project's water demand by providing a preliminary assessment of the underlying aquifer's ability to provide sufficient capacity to supply the Project. The assessment was conducted using readily available sources of existing geologic and groundwater data.



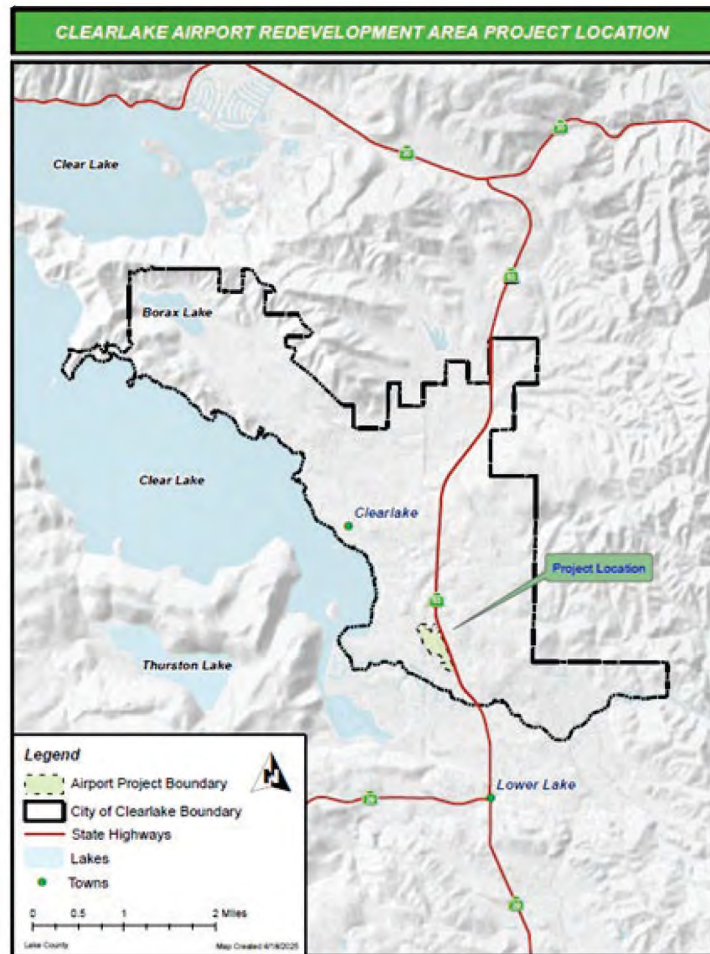


Figure 1. Project Location Map

Geology and Hydrogeology

The Project area is near the southwestern boundary of the Clear Lake Cache Formation (CLCF) Groundwater Basin (Bulletin 118 Basin 5-66¹) (Figure 2). The CLCF Basin has an area of 47 square miles and is bound to the south by Lower Lake Valley Groundwater Basin and Cache Creek and to the west by the Burns Valley Groundwater Basin and Clear Lake. The primary water-bearing formation in this Basin is the Cache Formation ('QTc') largely made up of former lake deposits consisting of tuffaceous and diatomaceous sands and silts, limestone, gravel, and intercalated volcanic rocks. The permeability of the formation is generally low. Hydrogeologic information regarding groundwater level trends and groundwater storage for the aquifer are not available.

¹ [Clear Lake Cache Formation Basin #5-66](#)



Figure 2. Project Location (outlined in black) and Clearlake Cache Formation Groundwater Basin 5-66 (outlined in green)

The City of Clear Lake is within detailed geologic map area of the Clear Lake Volcanics (Hearn et. al., 1995). This map characterizes the predominant geologic formations in the Project area. A portion of the geologic cross-section C-C' crosses the Project area. As shown in Figure 3 and Figure 4, the major geologic formations that occur within the Project location are Alluvium ('al'), Dacite of Cache Creek ('dcc'), Lower Lake Formation ('ll'), Cache Formation ('QTc'), and Martinez Formation ('Tm'). The 'al' is approximately 10 to 50 ft thick. The 'dcc' consists of dome and rubbly flows of sparsely porphyritic dacite and overlies the 'll' formation with maximum exposed thickness of approximately 200 ft. The 'll' represents lake deposits of ancestral Clear Lake with a maximum thickness of 200 ft and low permeability. The 'QTc' consists of siltstone, sandstone, conglomeratic sandstone, and tuff with a thickness of about 500 ft in the Project area. The 'Tm' underlies the 'll' and 'QTc' with unknown maximum thickness. As shown in Figure 4 and Figure 5, two fault lines cross the project area. These fault lines, along with well records, could be indicative of fractured volcanic rocks or sandstone in the vicinity.

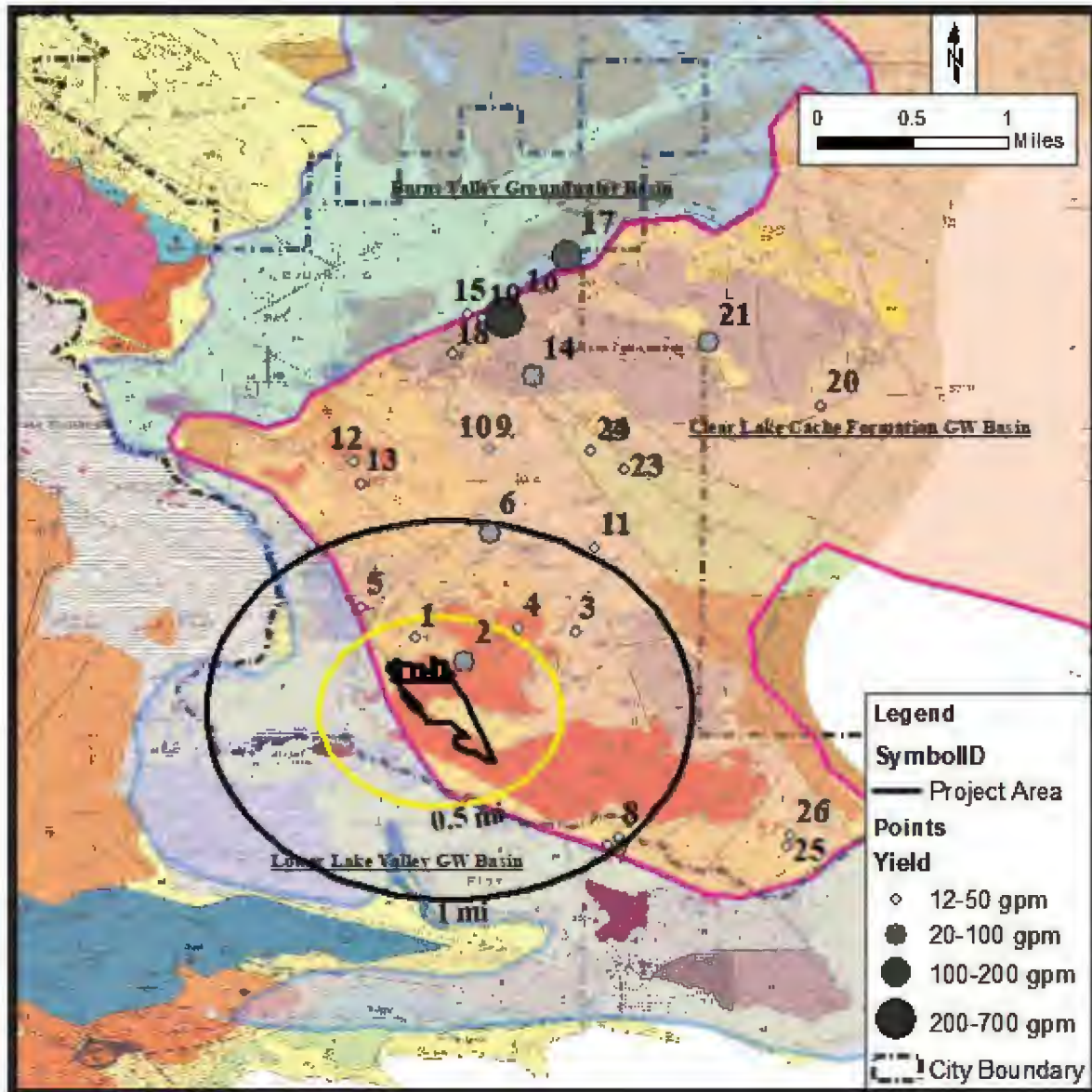


Figure 3. Regional Geology and Groundwater Wells

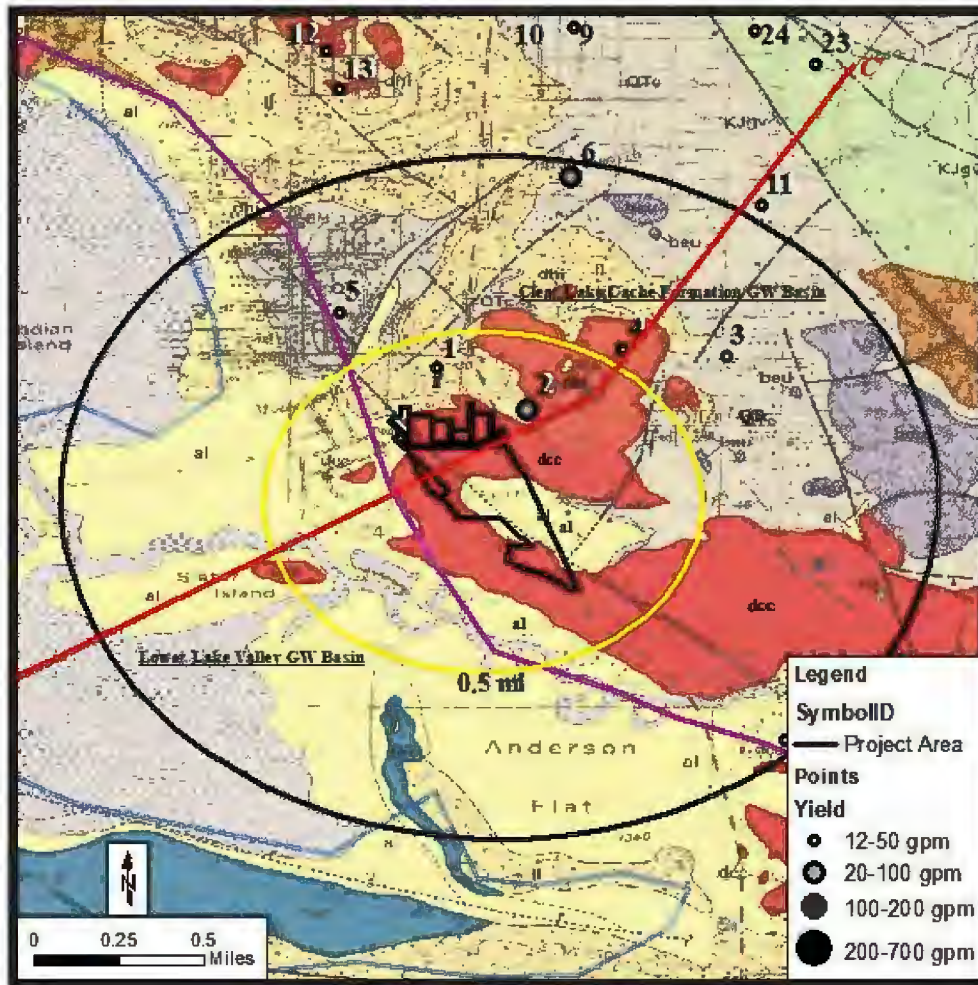


Figure 4. Geology and Groundwater Wells in Project Vicinity

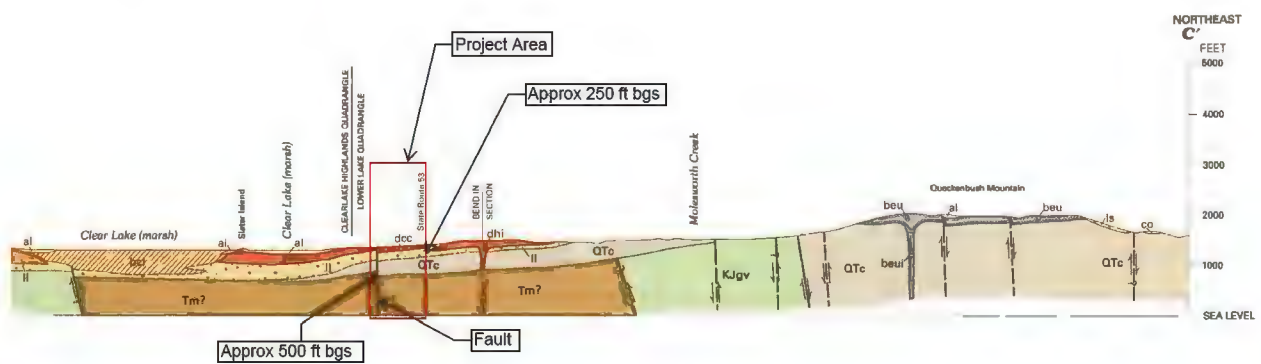


Figure 5. Geologic Cross Section

Potential Aquifer Yield

There is no information regarding the long-term capacity trends within the CLCF Basin. Well Completion Reports (WCRs) obtained from the California Department of Water Resources (DWR)² provide an estimate of the well's production at the time of construction which can be used as a general approximation of the basin's capacity, but they do not represent long-term maximum well production capabilities.

Domestic, irrigation, and municipal wells within the lower portion of the CLCF Basin that could be located (either approximately or relatively) and that have capacity data are shown in Figure 3, Figure 4, and Table 1. The majority of the wells are located over 1-mile from the Project area. Two wells are located within 0.5 miles and another 6 wells are located between 0.5 miles and 1-mile from the Project area. Of these 8 wells, the average yield is 49 gallons per minute (gpm). Wells in the deeper, shale sandstone (Cache Formation) tend to have higher yields in the vicinity of the Project area. The average yield for wells screened between about 200 ft and 500 ft below ground surface (ft bgs) or within sandstone (e.g., approximately within the Cach Formation) is 95 gpm. The highest reported well capacities were reported over two miles north of the Project area.

Minimum Capacity Needed

In accordance with Section 64554 of Title 22 of the California Code of Regulations (CCRs), public water systems are required at all times to have source capacity available to meet the maximum day demand (MDD). The MDD is the amount of water utilized during the highest day use, excluding fire flow.

Drinking water systems must provide a source water assessment that demonstrates the water source is adequate to meet the proposed use. If groundwater is used as the source, it must be demonstrated that the groundwater aquifer is sufficient to meet the MDD. For source wells whose primary production is from bedrock formation, such that water produced is yielded by secondary permeability features (e.g., fractures or cracks), the CCRs (as outlined in the California Waterworks Standards) require that the capacity of the well be determined using either a 72-hour well capacity test or a 10-day capacity test during the driest months of the year. The capacity of the well is assigned 25% of the well test constant pumping rate using a 72-hour test and 50% of the well test constant pumping rate for a 10-day test.

The MDD can be estimated as 1.5 times the average daily demand or 163,028 gpd or 113.2 gallons per minute (gpm). To meet the MDD, the constant well test pumping rate would need to be 453 gpm if the 72-hour test is used and 226 gpm if the 10-day test is used. In addition, the well must demonstrate proper recovery after the completion of the well test.

Based on the reported well yields (Table 1), a single well would not likely meet the required capacity of the proposed Project, and multiple wells would likely be required to meet the capacity.

² [California DWR WCR Map Application](#)



Table 1. Well Information for Wells Mapped in Figure 3 and Figure 4.

Well #	WCR Number	Proposed Use	Well Depth (ft bgs)	Range of Perforated Interval (ft bgs)	Well Yield (gpm)	Water Bearing Formation
1	WCR1978-004994	Domestic	66	40-61	44	Hard Rock w/ Fractures & Clay Seams
2	WCR2006-009042	Domestic	240	200-240	100	Black Clay/Green Rock
3	WCR1958-000865	Domestic	96	60-96	35	Boulder/Gravel/Porous Gray Rock
4	WCR1958-000866	Domestic	65	40-65	40	Porous Gray Rock
5	WCR1989-015224	Domestic	110	70-110	40	Volcanic
6	WCR2005-011249	Irrigation	250	230-250	60	Gray Shale
7	WCR1989-015146	Domestic	80	60-80	20	Volcanic
8	WCR2020-014022	Irrigation	80	20-80	50	Volcanic/Sandstone
9	WCR2002-010038	Domestic	140	100-140	30	Sandstone w/ Clay
10	WCR1966-001325	Domestic	145	80-90, 130-145	Not Provided	Sandstone
11	WCR1980-006408	Domestic	190	170-190	18	Sandstone
12	WCR1986-008973	Domestic	125	85-125	12	Broken Volcanic
13	WCR1992-013374	Irrigation	115	95-115	40	Sand and Obsidian
14	WCR2009-008178	Domestic	220	200-220	75	Volcanic & Basalt
15	WCR2013-008505	Irrigation	60	40-60	20	Volcanic
16	WCR2000-008848	Irrigation	339	180-338	700	Large Gravel/Green stone
17	WCR1998-007816	Irrigation	245	169-245	160	Volcanic
18	WCR1991-015922	Domestic	335	215-335	25	Volcanic/Soft Greenstone
19	WCR1984-006078	Domestic	185	145-185	50	Volcanic
20	WCR2001-009489	Domestic	493	233-493	16	Cemented Sand/Gravel/Clay
21	WCR1999-008667	Irrigation	240	200-240	55	Shale
22	WCR1989-015221	Domestic	300	180-300	75	Volcanic
23	WCR1987-010627	Domestic	155	95-155	40	Sandstone
24	WCR1981-005653	Domestic	290	250-290	15	Sandstone
25	WCR1985-008446	Municipal	200	120-200	30	Sandstone, Shale, Sandy Clay
26	WCR1985-008445	Municipal	200	60-200	25	Sandstone, Shale, Sandy Clay

Conclusion

Due to the sparse hydrogeologic data in the vicinity of the Project area, the range in reported well yields, and the required capacity of the overall Project, it is recommended that the City conduct exploratory drilling, via test wells, to characterize the potential well capacity at the Project site.

Based on the findings herein, there is a possibility of drilling wells with yields approximately 50 gpm to 100 gpm, drilled between 200-400 ft bgs, however, testing following the requirements of the California Code of Regulations would be required to determine the well capacity to meet the state's municipal standards for a drinking water permit.

Multiple wells and/or a combination of well water and surface water would likely be required to support the proposed Project. Exploratory testing would be required to determine how much capacity would be available from a groundwater source.



Limitations

The study of groundwater hydrology is very complex and often relies on limited data, especially in rural areas. Recommendations and conclusions provided herein are based on professional judgment made using information of the groundwater systems and geology in Lake County, which is limited and allows only for a general assessment of groundwater aquifer conditions and recharge. NorthPoint Consulting Group, Inc. is making analyses, recommendations, and conclusions based on readily available data, including studies and reports conducted by other professionals, Lake County, the State of California, and other consultants hired by the project proponent to prepare technical studies for the proposed project. If additional information or data becomes available for the project area, the recommendations and conclusions presented herein may be subject to change.

References

California Engineering Company, Inc. 2025. Technical Memorandum EIR Support Water and Sewer for City of Clearlake Airport “Concept” Development Project.

Hearn, B.C., Jr., Donnelly-Nolan, J.M., and Goff, F.E., 1995, Geologic map and structure sections of the Clear Lake Volcanics, northern California: U.S. Geological Survey Miscellaneous Investigations Map I-2362, 3 sheets, scale 1:24,000, available at <https://pubs.usgs.gov/imap/2362/>.

