SUPPLEMENTAL GROUNDWATER AND SURFACE WATER ANALYSIS FOR KIDDER CREEK ORCHARD CAMP ZONE CHANGE (A-14-01) AND USE PERMIT (UP-11-15)

GREENVIEW,

SISKIYOU COUNTY, CALIFORNIA

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Executive Summary

This report presents the results of a Groundwater and Surface Water Analysis for Kidder Creek Orchard Camp (KCOC) for a proposed project (Project) near Greenview, Siskiyou County, California. Kidder Creek is a large tributary of the Scott River basin and is observed to provide habitat for Coho Salmon in reaches near the project site. To accommodate the water supply needed at a full occupancy of 844 during the summer months, the Project would need to increase its groundwater use to approximately 37,980 gallons per day (gpd) which is equal to about 26 gpm during the summer months (ECORP Inc 2019). The existing camp demand is 4.8 Acre-Feet (AF) per year and that would increase to 25.3 AF with total buildout of the Project. This analysis focuses on three potential impacts of the Project to:

- Coho Salmon Fish Pools
- Nearby Domestic wells
- Impacts on downstream flows in the Scott River.

This analysis started by reviewing many documents and found 21 that contain pertinent hydrogeologic data. The foremost document that most subsequent investigations relied on was "Geology and ground-water features of Scott Valley, Siskiyou County, California, U.S.: Geological Survey water-supply paper 1462." Published in 1958 by Seymour Mack. This foundational report documented the groundwater resources of Scott Valley when little groundwater was used and therefore comes close to documenting "pre-development" conditions as far as groundwater use is concerned. Building on Mack's efforts were several insightful investigations. From 2008 to 2019 the University of California, Davis (UCD) - in a collaborative effort with a local groundwater committee appointed by Siskiyou County - constructed an integrated surface and groundwater model of the basin. A main focus of this effort was to gain a better understanding of the stream-aquifer relationships in the basin. In doing this, they recognized that domestic wells used so little water that they were of no significance to this stream-aquifer relationship.

This analysis of the KCOC Project focused on the area of the KCOC which is at the apex of the Kidder Creek alluvial fan just downstream from the mountain front. There are no water wells in this portion of the basin with historic groundwater level measurements, nor are there high yielding irrigation wells. Published information on the attributes of the aquifer are lumped together in the general area of the westside tributaries. Even Mack's work stopped just downstream of the Project area. There are however good geologic and soils mapping, land and water use data, a general sense of direction of groundwater flow, 34 Well Completion Reports from the California Department of Water Resources – Online System for Well Completion Reports (CADWR-OSWCR), and three pump test reports from KCOC files. These combined with mapping, aerial imagery, and elevations from Google Earth provide a foundation for developing useful data. From the Well Completion Reports (WCR) and pump tests, Groundwater Elevation, Depth to Bedrock, Thickness of Kidder Creek Alluvial Fan (KCAF) deposits, and Well Yield maps were constructed. Additionally, from the pump test reports the hydraulic conductivity of the aquifer was determined. All of these products were within range and consistent with the findings of Mack and UCD. Because Mack's and UCD's focus was mostly (not all) on irrigation wells and their yield, they considered the Bedrock as generally non- water

bearing. This analysis found that if a sufficient number of fractures were encountered the Bedrock unit could provide a domestic groundwater supply. This analysis did find, like the previous investigators in the rest of the basin, that this part of the basin comprises two hydrogeologic units: the unconfined Alluvial deposits and the Bedrock unit.

From published literature and agency databases, the basic components of a water budget were developed. The purpose was to get an understanding of the magnitude of the groundwater and surface water moving through the area. During this analysis it was apparent that one of the reasons domestic supply in a rural setting is not considered is because most of the water used at a homestead is not consumed but is returned to the groundwater supply via the septic system, which then percolates back into the groundwater supply after being cleansed as it moves through the geologic materials.

Besides the above-mentioned maps, four hydrogeologic cross-sections were constructed across the Kidder Creek Alluvial Fan deposits (KCAF). The resultant aquifer characteristics and understanding of the nature and extent of the aquifer, enabled determination of groundwater – stream impacts. Using a USGS drawdown Predictive Tool, cones of depression were calculated and plotted on a map.

Summary of Key Findings and Conclusions

The following conclusions are numbered for reference and not in any order of priority or importance.

1. The UCD Integrated Hydrologic Model metadata states "Due to the low population density of the valley, domestic pumping is not included in the model as it is a small portion of total groundwater extractions." Therefore, when the report refers to groundwater pumping it is not referring to domestic water use. (Tolley 2019, Pg 7881)
2. Extending Mack's work to the apex of the Kidder Creek Alluvial fan is consistent with the findings of this work and the UCD modeling efforts.
3. There were 18 WCRs and three pump test reports tied to parcels that are representative of the aquifer characteristics.
4. There was universal acceptance that the aquifer system in Scott Valley consists of the Alluvial deposits and the Bedrock. Additionally, it is accepted that the Alluvial deposits are an unconfined aquifer. Earlier investigations considered the Bedrock non-water bearing. This current evaluation, using wells constructed since these earlier investigations, indicate that the Bedrock, where fractured, is water bearing for domestic supply.
5. The Scott Valley Fault, previously referred to as the west side fault, has enough associated shearing that it could form a groundwater dam or impediment.

6. Kidder Creek from the Barker Ditch downstream is generally dry from late July to early October depending on when it starts raining in the Fall. There is a portion of Kidder Creek downstream from Highway 3 to Big Slough where the creek bed intersects the groundwater table and becomes a groundwater discharge area.
7. The alluvial deposits, for this analysis have been named the Kidder Creek Alluvial Fan deposits. These deposits are up to more than 100 feet thick in the upper Kidder Creek Fan area and yield about 10-60 gpm and have a hydraulic conductivity ranging from 2.5-10 feet/day. The depth to water is about 15-30 feet.
8. Groundwater flows in the aquifer from the mountain front towards the Big Slough-Scott River area and also down Oro Fino Valley. The groundwater is generally 15-30 feet below ground surface, and contouring the groundwater level data indicates that Kidder Creek, in the Project area, is not hydraulically connected to the groundwater body. This means that the recharge to the groundwater supply from Kidder Creek is only limited by the hydraulic head in the creek, the wetted area, and the hydraulic conductivity of the creek bed. A groundwater gradient to or from the creek bed does not exist. Given these hydrogeologic conditions, state of the art Stream Depletion equations do not apply, as no matter how much the groundwater table is drawn down by pumping, it doesn't change the amount or rate of groundwater recharge.
9. All the pools of concern but one for the Coho fishery are all up groundwater gradient of the Project area.
10. When looking at the impact of a domestic well on the groundwater supply, it is important to understand how the domestic use is different from other water uses from the aquifer. For the KCOC, the per capita water use is about 45 gpd. This is mostly because all outside water use is accomplished by surface water from the Barker Ditch. All water from the well that is used for washing, food preparation, and toilets is not consumptively used, it returns to the groundwater supply via the septic system. This means that about 40 gpd per capita (about 90%) ends up back into the groundwater supply which is a conservative estimate. The well drained soils and the shallow water table (about 20 feet below ground surface) allows this water to reach the water table within a month's time. This return of non-consumed water is why the net extraction of a domestic well under these conditions is less than 3 gpm for a well that produces about 20 gpm.
11. Given the aquifer characteristics, a USGS Predictive Tool calculated that well pumping on the KCOC property had a 150 to 200-foot radius for the cone of depression. This Predictive Tool assumes continuous pumping of the well. In actual operation, the well, like all domestic use wells, pumps on a cyclic pattern, which equates to a much smaller cone of depression or impact to aquifer. This means that even if Kidder Creek was hydraulically connected to the groundwater table, the cone of depression would not impact the creek nor capture sufficient water to impact the fish pools or nearby adjacent wells.

12. The Project would need about 26 gpm to meet ultimate demand. Given that conservatively 90% of the extracted water to meet this demand is not consumptively used, then only about 3 gpm is removed from the groundwater supply.
13. The impact on Scott River flows is not significant. The 3 gpm of net groundwater extraction is about 1% of the 183-gpm subsurface flow down Kidder Creek calculated from the aquifer characteristics. This amount is immeasurable with current technology.
14. Given the above, the impacts for the Project are:
    - Not significant on the fish pools along Kidder Creek,
    - Not significant on nearby wells,
    - Not significant for impacts to Scott River flow.

Introduction

This report presents the results of a Groundwater and Surface Water Analysis for Kidder Creek Orchard Camp for a proposed project (Project) near Greenview, Siskiyou County, California (**Figure 1**). The Project site is on 580 acres at the west end of South Kidder Creek Road, approximately 2 miles west of State Hwy 3, southwest of the community of Greenview in the Scott Valley. The Project plans to expand the use of the site and that requires Zone Change (A-14-01) and Use Permit (UP-11-15). At least one new groundwater well will be required with the proposed expansion. Additionally, a water storage and delivery system will be constructed to accommodate projected daily demand plus required storage for fire suppression. At a full occupancy of 844 occupants, approximately 37,980 gpd of water would be used during the summer months which is equal to about 26 gpm. The existing camp demand is 4.8 Acre-Feet (AF) per year and that would increase to 25.3 AF with total buildout of the Project (ECORP Inc 2019). This analysis focuses on three potential impacts of the Project to:

- Coho Salmon Fish Pools
- Nearby Domestic wells
- Impacts on downstream flows in the Scott River.

Purpose and Scope

The County of Siskiyou (County) sought proposals from professional hydrogeologists and geologists to perform a supplemental analysis regarding potential impacts of the proposed Project on potential interconnected surface water and groundwater resources. While it was expected for the consultant to conduct a site visit, no field work or data collection is expected.

The main tasks are:

- review the relevant portions of the DEIR and documents referenced in the DEIR and will conduct a literature search of all publicly available information regarding the geology and hydrogeology of the site and relevant data needed to fulfill the scope of work.
- assembling and reviewing the relevant available documents, information and data, the consultant will prepare a technical memorandum that analyzes potential Project impacts from the anticipated increased groundwater pumping on three resource categories:

  1) The seasonal pools in Kidder Creek located between the Barker Ditch diversion and a point approximately 3,500 feet downstream of this diversion.
  2) Nearby domestic wells,
  3) The net impact of Scott River flows downstream of the project.

Additionally, the consultant will make a determination based upon the data regarding the status of the connectivity between the water proposed to be pumped by the project and the water in nearby Kidder Creek and/or surround surface water features (e.g., un-connected groundwater; groundwater under the influence of surface water; surface water; etc.).

Figure 1 Project Location

List of Acronyms or Abbreviations

AF	Acre-feet
APN	Assessor Parcel Number
CADWR	California Department of Water Resources
CFS	Cubic Feet per Second, a measurement of stream flow
CGS	California Geological Survey
DEIR	Draft Environmental Impact Report
ET	Evapotranspiration
ETo	Reference Evapotranspiration, for short grass
FT, ft	Feet
GPD	Gallons Per Day
GPM	Gallons Per Minute, measurement of well yield
K	Hydraulic Conductivity
K_c	Crop coefficients
KCAF	Kidder Creek Alluvial Fan (geologic feature)
KCF	Kidder Creek Fan (physical geographic feature)
KCOC	Kidder Creek Orchard Camp
M,m	Meter
Mgal/d	Million gallons per day
MFR	Mountain Front Recharge
Mi,mi	Mile
MSL	Mean Sea Level
NOAA	National Oceanic and Atmospheric Administration
NCRWQCB	California North Coast Regional Water Quality Control Board
NRCS	U.S. Natural Resources Conservation Service
NRO	Northern Region Office of the California Department of Water Resources
OSWCR	Online System for Well Completion Reports
PLSS	Public Land Survey System
Qal	Quaternary Alluvium
Q	Rate of water flow (cfs) or well yield (gpm)
Q/s	Specific Capacity of a well, Q=the yield in gpm, s=drawdown in the well in feet
RCD	Siskiyou County Resource Conservation District
Sat.Thick.	Saturated Thickness, the distance between the static water level and the bottom of the well or aquifer
SVIHM	Scott Valley Integrated Hydrologic Model
SWRCB	California State Water Resources Control Board
SWL	Static Water Level, the non-pumping groundwater level in the well
SY	Specific Yield
SGMA	Sustainable Groundwater Management Act
UCD	University of California, Davis
USGS	United States Geological Survey
WCR	Well Completion Report

Brief Project Description

Kidder Creek Orchard Camp is referred to as either "Kidder Creek Camp", "KCOC" or "Camp" throughout the Project Description. Kidder Creek Orchard Camp is an approximately 580-acre property located at 2700 South Kidder Creek Road in Siskiyou County, specifically within the Greenview area of Scott Valley. The use of the Camp's land and facilities will continue to be for organized Christian camping as well as private and public events. The organized camping will have improved and expanded program and facility components that complement and enhance the natural aesthetics of the landscape. Multiple de-centralized programs operate as small and unique experiences combining on-site traditional camping activities with adventure/recreational opportunities in the surrounding areas.

The original 333 acres of property have been used for Christian camping for 40 years, and continues to be operated by Scott Valley residents, both paid and volunteer, with seasonal staff hired locally and outside the area. During the past decade, Kidder Creek Orchard Camp, Inc., a non-profit corporation, purchased 247 additional acres of land that are directly adjacent to the camp boundaries. It is the camp's desire to utilize these new properties for program and recreational opportunities that are consistent with the future vision of Kidder Creek as well as provide a 'buffer zone' for neighboring properties. For this reason, an amendment to the existing use permit was pursued. This project will consolidate and supersede three current use permits (UP-76-39, 1977; UP-84-37, 1984; UP-95-12, 1996). It will allow for the development of the future goals and objectives as defined in the Camp's Master Site Plan. For more detailed information see the Draft Environmental Impact Report (DEIR, Section 2.0 Project Description).

The number of guests is anticipated to increase from the current 165 by 679 to a total of 844. It is further anticipated that another well will be needed and a water storage and delivery system will be constructed to accommodate projected daily demand plus required storage for fire suppression. At a full occupancy of 844 occupants during the summer months, approximately 37,980 gpd of water would be used which is equal to about 26 gpm (ECORP Inc 2019). The current well produces about 20 gpm and it is anticipated that another well will yield about the same amount for a total well capacity of about 40 gpm.
https://www.co.siskiyou.ca.us/sites/default/files/fileattachments/community_development/page/15325/pln_20190801_kcoc_deir.pdf

Existing Documents Review and Summary

A search was conducted of the relevant available documents and data sources that pertain to the hydrogeologic conditions of Scott Valley. While the reference section contains all the references that were obtained, the purpose of this section is to identify those that contained pertinent information regarding the hydrogeologic and stream-aquifer relationships in the upper Kidder Creek Fan area. The following references are discussed in chronological order to understand how concepts, data, and findings have progressed over time. These references are also included in the Reference section at the end of this report in alphabetical order.

There are three types of Text or Fonts used in this section. The normal report font is the information or data that was identified in the reports, including comments of clarification or presentation of values in other units of measure. The quotes are for those sections of the reports where it was clearer to quote the report. The *italics* are used to highlight key points, data, or concepts that specifically pertain to obtaining a clear picture of the hydrogeologic system of the upper Kidder Creek Fan area and impacts of groundwater extraction. In this section references to page, figure, and table numbers are for those in the referenced report.

The documents and data sources can be divided into two major categories: 1) State of the Art, and 2) Resource Evaluations and Data. The State-of-the-Art documents are those documents that lay out the theoretical aspects of hydrogeologic investigations and stream-aquifer relationships. These documents generally do not contain specific groundwater basin data or identify the conditions of the hydrogeologic system, except when giving examples. They do suggest the conditions and processes to consider for a prudent investigation. It is up to the investigator(s) to determine which concepts to apply. For example, the Scott Valley is not physically connected to the ocean so concepts that apply to sea water intrusion do not have bearing on the valley's groundwater resources.

The Resource Evaluations and Data documents contain actual field collected data and the evaluation of those data. These documents focus on identifying the evidence for the conditions and processes that do exist. As with most resource evaluations, our understanding of the resource generally increases with time as more data are collected and understanding of the resource increases, instrumentation improves, and theories get refined. The investigator(s) needs to determine if the conditions and procedures that were used to collect the data are still valid and if the interpretation of the data are still true. For example, the USGS Water Supply Paper 1462 by Seymour Mack, while being a foundational report on the groundwater resources of the Scott Valley groundwater basin, was published prior to the development of the theory of Plate Tectonics and before the construction of at least 80% of the groundwater wells in the basin.

State-of-the-Art Documents

Heath, Ralph C. 1983, Basic ground-water hydrology: U.S . Geological Survey Water-Supply Paper 2220, 86 p. https://pubs.er.usgs.gov/publication/wsp2220

This document was published so that "everyone, from the rural homeowner to managers of industrial and municipal water supplies to heads of Federal and State water-regulatory agencies, become more knowledgeable about the occurrence, development, and protection of ground water. This report provides the basic concepts to also assist those working in the groundwater industry including hydrologists, geologists, engineers, well drillers, pump installers and the other disciplines working in the groundwater development and protection industry." This Water Supply Paper serves as a good illustrative glossary of technical terms. In the preface, there is a statement by Harold E. Thomas, Ph.d, Harvard University, that reminds everyone about the study of water movement underground "The science of hydrology would be relatively simple if water were unable to penetrate below the earth's surface."

The following are the assumptions, inputs, and results from this document that are pertinent to this investigation:

- "The purpose of this report is to present these basic aspects of ground-water hydrology in a form that will encourage more widespread understanding and use." This purpose statement has been fulfilled as the illustrations in this document can be found in many subsequent documents by the U.S. Geological Survey and many others. This document provides an illustrative glossary of terms used in this report on the hydrogeology of the Kidder Creek Area.
- Illustration on page 23 explains how to determine a gaining and losing stream based on a groundwater contour map.
- "Both the economic development and the effective management of any ground-water system require an understanding of the response of the system to withdrawals from wells. The first concise description of the hydrologic principles involved in this response was presented by C. V. Theis in a paper published in 1940. Theis pointed out that the response of an aquifer to withdrawals from wells depends on:
    1. The rate of expansion of the cone of depression caused by the withdrawals, which depends on the transmissivity and the storage coefficient of the aquifer.
    2. The distance to areas in which the rate of water discharging from the aquifer can be reduced.
    3. The distance to recharge areas in which the rate of recharge can be increased." [page 32]
- Heath points out that minus data like detailed aquifer analysis, that future well locations should consider the following:
    1. The minimum distance between pumping wells should be at least twice the aquifer thickness if the depth of the wells are less than about half the aquifer thickness.
    2. Wells near recharging boundaries should be located along a line parallel to the boundary and as close to the boundary as possible.

3. Wells near impermeable boundaries should be located along a line perpendicular to the boundary and as far from the boundary as possible. (See page 62 - Well Field Design)

Barlow, P.M., and Leake, S.A., 2012, Streamflow depletion by wells—Understanding and managing the effects of groundwater pumping on streamflow: U.S. Geological Survey Circular 1376, 84 p.

This document builds on Heath's 1983 report to present concepts relating to streamflow depletion, methods for quantifying depletion, and common misconceptions regarding depletion. In the fields of hydrogeology and groundwater hydrology, this 30-year period between these documents represents a time of immense research and experience in understanding the movement of groundwater. This report also describes "approaches for monitoring, understanding, and managing streamflow depletion." As stated on page one of the report: "The primary objective of this report is to summarize these scientific insights and to describe the various field methods and modeling approaches that can be used to understand and manage streamflow depletion. A secondary objective is to highlight several misconceptions concerning streamflow depletion and to explain why these misconceptions are incorrect.

A note of caution on using his report is identified on page 2 when discussing illustrations in the report, where Barlow states "In many other areas, however, the ground water system consists of a single, often unconfined, aquifer underlain by geologic formations, such as crystalline rock, whose permeabilities are so low that the formation can be assumed to be impermeable to groundwater flow. Aquifers of this type are used throughout the report to illustrate many of the factors that affect streamflow depletion by wells." Using a simple conceptual model of groundwater-surface water interaction helps explain the hydrogeologic concepts, but hydrogeologic systems are more complex. In the upper Kidder Creek Fan, the bedrock is fractured and does supply water to small yielding wells. While this is insignificant compared to large yielding irrigation wells it is not correct to "assume" that the bedrock is impermeable. Therefore, using the concepts in this report, which are excellent, one needs to understand the hydrogeologic systems. As stated on page one, the main objective of this report is to show how groundwater pumping can impact surface water resources and other groundwater users. Mentioned throughout this report are notes of caution and conditions for when surface water depletion occurs. Many of the following highlights are an attempt to show some of these cautionary conditions so that the concepts presented in the report are applied correctly.

Additionally, under the section on Streamflow Response to Groundwater Pumping (pg 11) the report states "Unless otherwise stated, two important assumptions are made throughout this discussion:

1. that the stream and underlying aquifer remain hydraulically connected by a continuous saturated zone, and
2. that the stream does not become dry.

These assumptions may not be valid for extreme cases of large-scale groundwater development and limited streamflow where groundwater levels have been drawn down below the bottom of the streambed." *These two assumptions are critical to using the concepts in this report for the Upper Kidder Creek Alluvial Fan.*

Barlow's report discusses the importance of the distance of the pumping well to the water sources and the hydraulic diffusivity of the aquifer. On page 8 it states,

> "Streamflow depletion therefore generally will occur much more rapidly in confined aquifers than in unconfined aquifers (fig. A–1)."

- "Groundwater movement is nearly always substantially slower than the propagation of hydraulic stresses through most types of aquifers, particularly those that are the source of most large-scale groundwater withdrawals.", Page 8.
- Stream Depletion defined: "Streamflow depletion is equal to the sum of captured groundwater discharge and induced infiltration (modified from Heath, 1983)", Page 12
- The discussion of "Ways to express stream flow depletion" (pages 16&17) is based on calculations of a well producing one million gallons per day (Mgal/d) which is equivalent to 700 gpm; which is 35 times the yield of domestic wells in the upper Kidder Creek Fan area. Also, the distance to the stream is 250 feet in this example. Most domestic wells in the upper Kidder Creek Fan area are at least four times that distance.
- When discussing stream depletion of a well with a cyclic pumping rate (daily or annually) the calculated stream depletion from a well within 300-500 feet of the stream is about 33% of the pumping rate. The further the well is from the stream, the lower the depletion rate. (Page 28)
- Using a simulation, with a well pumping about 700 gpm and a distance of about 1,400 feet from the stream, the infiltration rate was zero. (Page 37, Fig 28)
- This report lays out several scenarios that demonstrate the relationship between surface water and groundwater and how they are connected and how changing one source impacts the other. All of the scenarios use high capacity wells for the pumping rate.
- Trying to determine stream depletion is problematic. Measuring stream flow while pumping a nearby well requires large pumping rates compared to streamflow under ideal stream gaging conditions. Another method is to collect long-term (decades) groundwater level and surface water measurements to determine depletion. (Pages 50-52)
- "Analytical and numerical modeling methods are the most widely applied approaches for estimating the effects of groundwater pumping on streamflow…. Although both modeling approaches have been widely used, numerical models provide the most robust approach for determining the rates, locations, and timing of stream flow depletion by wells." (Page 54)
- A general overview of the pros and cons of the different modeling methods is provided as well as a suggestion on which types of models should be used and under what circumstances.
- Concerning management of streamflow depletion (Page 73), this report states "The effect of a groundwater withdrawal on the timing, rates (or volumes), and locations of streamflow depletions is substantially different from those caused by a surface-water withdrawal, which has an immediate effect on the rate of streamflow at the point of withdrawal." Therefore, timing, extraction rate, and location of the well are critical.

It is extremely important to point out that these two documents do not provide absolutes, but conditions that should be considered. As they relate to the Kidder Creek Orchard Camp Project, none of these reports say there will be an impact, but that using the concepts provided, any impact and its significance could be identified and possibly mitigated.

Abbott, D.W, Spring 2015, *Technical Corner:Wells and Words*, Hydrovision, Volume 20, Number 1, published by Groundwater Resources Association of California, Sacramento, CA. https://www.grac.org/hydrovisions-spring-2015/
This article summarizes the relationship between drawdowns, transmissivity, and well yield to develop values of transmissivity and hydraulic conductivity from water well drawdown data. These formulas have served the industry well for decades in providing approximations of transmissivity when aquifer testing is lacking.

Cantor, Alida, Dave Owen, Thomas Harter, Nell Green Nylen, and Michael Kiparsky. 2018. Navigating Groundwater-Surface Water Interactions under the Sustainable Groundwater Management Act. Center for Law, Energy & the Environment, UC Berkeley School of Law, Berkeley, CA. 50 pp. Available at: https://doi.org/10.15779/J23P87 or law.berkeley.edu/gw-sw
"This report draws from a two-part workshop series held at UC Berkeley School of Law in June and July of 2017. The two day-long workshops brought together approximately twenty recognized thought leaders in hydrogeology, law, and policy, including key academics, practitioners, and decision makers. Participants were asked to discuss a range of legal and technical dimensions of groundwater-surface water interactions and water rights under the Sustainable Groundwater Management Act (SGMA). Topics included examples of conflicts between groundwater and surface water users and how conflicts have historically been resolved; how SGMA alters or should alter legal relationships between groundwater and surface water users; the tools needed to identify and address potential conflicts between groundwater and surface water uses; and the potential interactions between SGMA and other laws governing water use and environmental protection. Participants discussed these issues both in general terms and through the lens of specific case studies.

The authors synthesized content from the workshops and conducted additional legal analysis and technical and legal literature review to develop the policy-focused themes reflected in this report. This report strives to provide guidance for practitioners, including groundwater managers and state agency staff."

Resource Evaluations and Data

Mack, S. (1958). Geology and ground-water features of Scott Valley, Siskiyou County, California, U.S.: Geological Survey water-supply paper 1462.
This is the foundational document on the geology and groundwater resources of Scott Valley. It describes the valley and defines the geologic units and the groundwater resources as of the middle of the 1950s. The information contained in this report has remained a solid source of

information on the valley for the last 70 years. The following are the assumptions, inputs, and results from this document that are pertinent to this investigation:

- The field work for this report was conducted before about 80% of the existing wells in the valley were constructed. Therefore, it is the closest documentation of predevelopment conditions with only 900 AF of groundwater used for Urban and miscellaneous use and 1,000 AF of irrigation use. Surface water provided 38,000 AF for irrigation and 300 AF for domestic use.
- Additionally, the groundwater extraction and surface water hydrology were in their infancy. The California Geological Survey in publishing their 1987 Regional Geologic Weed Sheet incorporated the Devonian Greenstone of Mack into the Western Paleozoic and Triassic Belt. Likewise, the Abrams Mica Schist and Salmond Hornblende Schist have been suggested to be part of the Western Paleozoic and Triassic Belt and Stuart Fork Formation, respectively. While these delineations fit more with current geologic understanding, they do not change the nature of the formation nor their water bearing characteristics.
- Besides the delineation of the geologic units, there is little hydrogeologic information about the upper Kidder Creek Fan area. At the time of Mack's work, the general thinking within the groundwater community was that "bedrock" was considered "non-water bearing". This did not mean that the formations were devoid of groundwater, but that they did not provide sufficient water for irrigation or municipal wells, which was the focus of groundwater studies during that time period.
- Hydrologically, the groundwater contours on Plate 1 begin just downstream of the area of the Kidder Creek Orchard Camp Project.
- Mack's general conceptual model of the Upper Kidder Creek Fan area continues to hold true.

Harter, Thomas and Hines Ryan. 2008. Scott Valley Community Groundwater Study Plan. University of California. Groundwater Cooperative Extension Program. http://groundwater.ucdavis.edu/ScottValley.htm

The GW Study Plan summarizes the 2008 status of knowledge about the hydro-agro-eco-geography of the Scott Valley and outlines potential approaches to addressing critical current research needs. The Number 1 Objective of the plan is to "Improve our understanding of the hydrology of the Scott River system and the relation to water use." The plan lists questions to guide investigations into topics that may yield information useful for better management of the groundwater resources in the Scott Valley. *While this Supplemental Analysis does not include new field work, it does provide an analysis of data localized around Kidder Creek on the perimeter of the groundwater basin 7.5 miles upstream from the Scott River. As this analysis was conducted, the questions posited by the plan provided guidance.*

The following are the assumptions, inputs, and results from this document that are pertinent to this investigation:

- The GW Study Plan also identified that which is known about the groundwater basin. Most of this knowledge is based on Mack's (1958) USGS report mentioned above. Hydrogeologically, the GW Study Plan consolidates the local geology as: "The geologic formations in the Scott Valley can be divided into two units, the surficial alluvial deposits, and the underlying bedrock that also comprises the upland areas surrounding the valleys."
- The GW Study Plan estimates residential water use in the Scott Valley by estimating the non-urban population (those residing outside of Fort Jones and Etna) at 6,000 people, acknowledging that actual figures "are not readily available". Their estimate is that water demand (which is not the same as consumptive use) is about 200 gallons per person per day. They conclude that the estimated water demand could be about 1,350 acre-feet a year.
- The reported estimate of wells in Scott Valley that produce more than 0.2 cfs (90 gpm) is from 350 to 500 wells. There is little to no metered information on the actual groundwater extracted by these wells, which are mostly for agricultural use. Additionally, there is little understanding of the thickness of the alluvial deposits. Developing this information would clarify the nature and extent of the aquifer system and the stream-aquifer interaction.
- The report identifies Mountain Front Recharge as a source of basin recharge. However, there is no data on the amount of this recharge. But the report identifies discharge from the bedrock formation as a source of water to streams and springs along the groundwater basin boundary.
- The report concludes with the description of a plan to develop a groundwater-surface water model to help understand the groundwater-surface water system. The plan also includes those data collection and analysis tasks that improve the accuracy of the model. The compiling analysis of the data for this *Supplemental Groundwater and Surface Water Analysis for Kidder Creek Orchard Camp* are in alignment with the Phase I task 1a.

S.S. Papadopulos & Associates, 2012, Groundwater conditions in Scott Valley, Report prepared for the Karuk Tribe, March 2012.
"This memorandum describes an analysis of stream depletion impacts associated with pumping from two areas within the Scott Valley. One area is within the zone of "interconnected Groundwater" as delineated in the 1980 Scott Valley Adjudication. The second area is the area of alluvial fill within the Scott Valley that falls outside of the boundaries of the above referenced zone. This second area is further defined as the areas of irrigated lands as delineated from the 2000 land use survey. This area refers to the Scott River area and not the area in the upper Kidder

Creek Alluvial Fan. The analysis uses the Scott Valley Groundwater Model prepared by S.S. Papadopulos & Associates Inc. (July 2012).

Sommarstrom, S., and Thamer, P., 2013, Kidder Creek's Barker Ditch Study – Reach Assessment of the 2012 Season, Final Report, Scott River Water Trust.

This report documents the purpose, scope, and findings of the study of pools 1-8 on Upper Kidder Creek and their impact on the fishery. While the focus is on the viability of the pools for maintaining the Coho Salmon, there are a few observations and findings that shine light on the groundwater system in the area as well as the hydrology of the Upper Kidder Creek area.

- "An unnamed fault line trending northwest is located approximately where the alluvium begins on the valley margin and where the western mountain front ends. Kidder Creek has built a large boulder and cobbly alluvial fan" *It is important that this study describes the relationship between the mountain front and the apex of the Kidder Creek Alluvial Fan.*
- Kidder Creek was also cited in a 1974 state report on Scott Valley's water use as an example of a westside stream losing its entire flow after spring runoff to seepage through the highly permeable alluvial fan, and then the groundwater reappearing (discharging) further down the fan "where the water table intersects the surface channel" (CSWRCB 1974).
- In referring to the hydrology of the Kidder Creek, the authors captured this description from Water Supply Paper 1462 by Mack: "Normally, surface water from Kidder Creek and west Patterson Creek does not reach Scott Valley during the early part of the summer because water is diverted from the creeks' upper reaches for irrigation, and the remainder sinks into the coarse gravels of the fanhead area" (Mack 1958. p. 27). They continue by noting that the1955 USGS topographic map symbol of an intermittent stream confirms this observation.
- Floods have continuously transformed Kidder Creek's channel. The largest floods of record in Scott Valley in order of magnitude were in 1964, 1861, 1955, and 1974: events where significant channel changes occurred in the mainstem Scott River as well as in many tributaries.
- Page 9 provides a concise explanation of the water rights on the Upper Kidder Creek area.
- Page 10 provides a good summary of the Barker Ditch diversion and all the structures.
- The data for this study were collected in 2012, a dry year with the Fort Jones Precipitation Gage showing only 75% of normal precipitation.
- Flow measurements are within 5% accuracy, but below 2 cfs the accuracy drops to 5-12%.

- Max flow event for the period of study was 251.4 cfs on 6/5, and the lowest flow was 1.4 cfs on 9/16.
- The reduction of creek flow once the creek exits the bedrock channel of the canyon reach is posited that the water may be lost to groundwater percolation and evaporation. Cottonwoods and alders on the upstream, north bench also appear to be obtaining water from subsurface sources through the cobble bed.
- About 1 cfs is lost in the 1.1 miles between the RCD gage site and the Point of Diversion throughout the entire monitoring period. Similarly, about 0.2-0.5 cfs is lost in the ditch in the 1,000 feet between the POD (at D1) and below the fish screen after 7/31. These measurements confirm the values used in the UCD model for ditch loss rates and Mountain Front Recharge.
- Subsurface flows entered the stream about 2,200 ft below the Point of Diversion and are likely the cause of the increase in surface flow as measured at two locations downstream in July. On 7/16, there was more water flowing at 1,320 ft below the Point of Diversion than there was at 103 ft below the Point of Diversion. This is possibly due to addition of the fish screen's by-pass flows, which enter the stream 230 ft upstream and/or from significant leakage from the Barker Ditch about 120 ft below the fish screen. This is what could be contributing seepage to Pool 4 and not groundwater.
- Examining the existing data on natural inflow above Barker Ditch reveals that the lowest flows occur during September, bottoming out at below 1 cfs in dry water years (like 2009) and at about 2 cfs in normal and even wet water years (like 2011).
- The lowest pool, Pool 8, was originally the deepest in the study reach and, though disconnected by 1,550 feet below the flowing creek above Pool 4 on 9/10, retained water throughout the summer. Pool 8 is below the Kidder Creek Orchard Camp, from where it is possible that seepage from the two recreational ponds and the Barker Ditch could contribute to sub surface flow.
- Natural flows during the low flow period will likely not be able to keep Kidder Creek connected through the alluvial fan reach below Barker Ditch to below Highway 3, due to natural geologic conditions and available water.

Foglia, L., A. McNally, C. Hall, L. Ledesma, R. J. Hines, and T. Harter,. 2013. Scott Valley Integrated Hydrologic Model: Data Collection, Analysis, and Water Budget, Final Report. University of California, Davis, http://groundwater.ucdavis.edu/files/165395.pdf, April 2013. 101 p.

This report presents the data assembled and the methods used for data analysis and data modeling to prepare the Scott Valley Integrated Hydrologic Model Version 2 (SVIHM), which is currently under development. The report includes precipitation data analysis, streamflow data analysis and modeling, geology and groundwater data review and analysis, evapotranspiration and soils data analysis, and preparation of relevant watershed, land use, topography, and irrigation data. The main focus of this modeling effort was on the Scott Valley floor, i.e., those parts of the valley overlie the groundwater basin.

- The document provides a current (21st century) understanding of the geology of the Scott Valley area. While this does not change the hydrogeology understanding of the area, it does update the work of Mack (1958) to current understanding of the geology of the Klamath Mountains. This is the first document to name the westside fault as the Scott Valley Fault (Pages 20-22)
- For this analysis, there were no groundwater levels monitored. (Page 23)
- "At the Callahan station, 88% of the yearly precipitation occurs from October to April, while it is 90% at Fort Jones. Only about 2-inches of precipitation occur during the irrigation season, most of which would likely not reach the groundwater basin." (Page 33)
- ' However, the goal of the model is to understand the late summer/fall flows, which may affect fish, particularly juvenile coho and fall-run Chinook salmon. Inaccurate prediction of high flow events is not significantly affecting our analysis of late summer low flows." (Page 40)
- The analysis of the lithology from well logs shows that within the alluvial formation in the valley, there is no continuous clay layer and that the complete aquifer is heterogeneous. About 55% is clay, 35% gravel, and 10% sand. (Pages 57-59)
- For the Hydrologic Model, the upper Kidder Creek Fan area represents an exceedingly small portion of the Kidder Creek Subwatershed. (Page 61, Fig 16)
- The Scott Valley Land Use map shows all the upper Kidder Creek Fan area as Native Vegetation except for a few acres of "pasture" that is on the KCOC property. (Page 65, Fig 17)
- Water Use map shows no groundwater irrigated parcels in the upper Kidder Creek Fan area. Also, it shows that the wells the study identified in the area are all domestic wells. (Page 68, Fig 19)
- The Hydrologic Model assumes that because the depth to groundwater is about 20 feet, the precipitation that exceeds ETo is essentially instantaneous (because of monthly time steps) recharge in the model. (Page 73)
- "Domestic/urban water use other than that used for lawn/garden irrigation in Scott Valley is only a very small fraction of total water use in the Scott" Valley. (Page 75)
- These figures show that for the irrigation pasture at the KCOC there is about 35 inches of applied surface water and 18 -24 inches of recharge annually. (Pages 83 &84, Figs 20 & 21)

- The sensitivity analysis (Tolley et.al., 2019) of the Soil Water Budget Model and the Scott Valley Integrated Hydrologic Model will determine the accuracy of this model. (Page 94)

Tolly, Douglas, 2014, "Scott Valley Pumping Test Report".
https://ucanr.edu/sites/groundwater/files/311298.pdf
Three aquifer tests were conducted in 2013 to obtain additional hydraulic conductivity values for the Scott River Valley. While none of these were in the upper Kidder Creek Fan area, they do give some insights on the aquifer near the eastern half of the valley and are based on aquifer testing that was conducted exclusively to obtain aquifer characteristics.

University of California at Davis. 2016. Scott Valley, Siskiyou County, California: Voluntary Private Well Water Monitoring Program, Spring 2006 - January 2016 (PowerPoint Slides). retrieved from:
http://groundwater.ucdavis.edu/Research/ScottValley/
There were 50 groundwater wells that were monitored over a 10-year period. While there are no groundwater level monitoring wells in the upper Kidder Creek Fan area, levels where five wells measured in the same hydrologic zone could be representative of the groundwater levels in the upper Kidder Creek Fan area. The groundwater level hydrographs for the Upper Westside Zone: Well Numbers 3,15,29,30, and 44 showed the following characteristics:

- The graphs show that for the Upper Westside Zone groundwater levels vary mostly 20 feet below ground surface and deeper. These levels seem to remain at these depths year-round.
- Deepest groundwater levels occur in wells around the margin of Scott Valley: on the Upper Westside and in the Eastside Gulches Zones.
- Groundwater levels may continue to drop after Labor Day, through September and October and begin to recover in January.
- There is no evidence of long-term groundwater overdraft.

USDA. 2017. Custom Soil Resources Report for Siskiyou County, California, Central Part -Kidder Creek Camp. Natural Resources Conservation Service, 17 p.

This report provides a soil map of the Project area along with soil unit descriptions including soil profiles and physical properties.

Foglia, L., J. Neuman, D.G. Tolley, S.B. Orloff, R.L. Snyder, and T. Harter, 2018. *Modeling guides groundwater management in a basin with river-aquifer interactions*. California Agriculture 72(1):84-95.*https://doi.org/10.3733/ca.2018a0011*

This research article gives an overview of the Scott Valley Integrated Hydrologic Model and how it applies to California's Sustainable Groundwater Management Act. It also provides a summary of the inputs to the model and what some of the findings were of the modeling effort.

- Some measurements can be collected in the field to evaluate groundwater–surface water interactions, but computer models are needed to fully understand groundwater basin flow dynamics and assess impacts to stream flow under future groundwater management scenarios.
- In the discussion of the differences of models, the point is made that "For some applications, statistical models or analytical tools, which are based on highly simplified concepts and therefore have the least data input requirements and are computationally much less demanding, may be appropriate." (Page 85)
- This document acknowledges that there is groundwater in the bedrock formations. They state, "Surrounding the valley, the geology is comprised of relatively impermeable bedrock composed of metamorphic and volcanic units, although fractures do yield some water in the form of springs at the margins of the valley and in surrounding upland areas." (Page 86)
- Aquifer pumping tests conducted to develop aquifer properties for the model were just in the main subarea of the valley, along the Scott River corridor. (Page. 87)
- Aquifer recharge generally comes from excess rainfall, and deep percolation of applied irrigation water but also from streams entering the basin on highly permeable alluvial fans. Aquifer discharge generally occurs through groundwater fed wetlands and riparian vegetation, pumping (primarily for irrigation) and discharge to streams, mostly along the valley thalweg. (Page. 87)

Tolley D., Foglia, L., & Harter, T. (2019). Sensitivity analysis and calibration of an integrated hydrologic model in an irrigated agricultural basin with a groundwater-dependent ecosystem. Water Resources Research, 55, 7876-7901, https://doi.org/10.1029/2018WR024209

This report documents the sensitivity of the Scott Valley Integrated Hydrologic Model (SVIHM) to key parameters (i.e., input values). It also identifies within what ranges of values the model provides usable results. For example, in the Upper Kidder Creek area the original Hydraulic Conductivity value was 51m/day. But after Sensitivity Analysis and Calibration the value was reduced to about 10 m/day. Figure 1 tells most of the story concerning the upper Kidder Creek Fan area. There are no groundwater monitoring wells or identified irrigation wells in this area where the model can accurately calibrate against actual groundwater level or aquifer characteristics data. This does not mean that the model cannot be used in a general sense to address issues. The model's accuracy improves where there is groundwater monitoring data to calibrate the model. The aquifer parameters developed are the most accurate known values and are useful for approximating the true aquifer parameters based on data availability. The model is an excellent starting point for addressing data deficiencies in areas like the upper Kidder Creek

Fan area. The following are model assumptions, inputs, and results that are pertinent to this investigation:

- The SVIHM simulates hydrologic conditions in the Scott Valley from1 October 1990 to 30 September 2011.
- "Bedrock surrounding and outcropping within the valley is assumed to be impermeable relative to the valley sediments. Hydraulic conductivity and storage properties for the valley aquifer are spatially distributed between nine hydrogeologic zones (Figure 1), like those proposed by Mack (1958). The model simulates unconfined flow with variable storage and transmissivity." (Page 7881)
- "The wells and their locations were identified through well logs, stakeholder feedback, aerial photography, and field surveys when possible." (Page 7881)
- "Due to the low population density of the valley, domestic pumping is not included in the model as it is a small portion of total groundwater extractions." (Page 7881). Therefore, when the report refers to groundwater pumping it is not referring to domestic water use.
- One to 0.5 cfs per mile seepage from the surface water irrigation ditches was used in the model.
- Mountain Front Recharge is the amount of water moving from the bedrock formation into the alluvial fan deposits. This recharge was only modeled along the valley's westside as the eastside was considered in the rain shadow of the higher elevation of the westside range. Mountain Front Recharged inputs to the model ranged from about 0.5 cfs to about 5 cfs.
- "Canal seepage and MFR are constant and constitute the second largest inflow to the aquifer", deep percolation of applied water from irrigated land being the largest. (Page 7888)
- The model determined the dry reaches of the river and the tributary streams. These calculations were compared with the U.S Department of Agriculture imagery as a check.
- "Net fluxes between groundwater and surface water in the first half of the growing season appear to be largely controlled by precipitation and timing of runoff entering the valley from the upper watershed, while the second half is controlled by aquifer storage and groundwater pumping." (Page 7894)

ECORP Consulting, Inc. August 2019**.** Kidder Creek Orchard Camp **-** Draft Environmental Impact Report.
https://www.co.siskiyou.ca.us/sites/default/files/fileattachments/community_development/page/15325/pln_20190801_kcoc_deir.pdf

This document provides an evaluation of the impacts of the Project. The useful information pertinent to this analysis are mostly found in Section 3.3 (Hydrology and Water Quality):

- An in-depth project description including the hydrology of the Project area.
- A detailed description of the projected water uses and timing of that use of the Project (Table 3.3-3, page 3.3-11). The existing camp demand is 4.8 Acre-Feet (AF) per year and that would increase to 25.3 AF with total buildout of the Project.
- The number of Well Completion Reports available from the Online System for Well Completion Reports (OSWCR)
- An analysis of the Public Trust Doctrine as it relates to groundwater extraction and Kidder Creek fisheries (page 3.3-11)

UC Davis Technical Team for The County of Siskiyou, October 2019. Scott Valley GSP Chapter 2.1: Plan Area and Basin Setting (Public Comment Draft). https://www.co.siskiyou.ca.us/naturalresources/page/scott-valley-gsp-chapters

As stated, this is a public comment draft document that is in its formative stages. Yet, it has some useful information pertinent to this study.

- Figure 1 is a helpful map showing the watershed and groundwater basin boundaries and their relationship with the Scott River, major roads, and towns.
- Figure 5 shows the spatial relationship (by section) of the well completion reports on file with the California Department of Water Resources. The location of these reports is based solely on the location information provided by the water well drillers and have not been confirmed or verified by other means.
- Section2.1.1 contains a chronology of groundwater management in Scott Valley.
- The document contains information on all the Tribes, agencies (Federal, State, and Local) and groups that are working to resolve water issues in Scott Valley.

Harter, T. 2019. Scott Valley Siskiyou County, California: Voluntary Private Well Water Level Monitoring Program Winter 2006-Winter2018, University of California, Davis, *https://ucanr.edu/sites/groundwater/files/153816.pdf*

The groundwater levels presented in this report are not groundwater well specific. The Scott Valley is divided into hydrologic areas and groundwater levels. All the wells in those areas are aggregated. Therefore, there is no assurance that there are any water levels monitored in the Upper Kidder Creek area. *However, the reported groundwater levels are like those found on the Well Completion Reports in the Upper Kidder Creek area, which substantiates the accuracy of the reported measurements on the Well Completion Reports.*

California Department of Water Resources, 21 May 2021, *Adjudicated Basins Annual Reporting System – Siskiyou County*, sgma.water.ca.gov/adjudbasins/report/preview/192. This website contains the information on water use in Scott Valley as reported by Siskiyou County on behalf of the water users. The values reported are mostly from the UC Davis Groundwater Model. Information of interest is that there is about 1,000 acre-feet of groundwater use for urban and residential use and up to 44,000 acre-feet used for agricultural use. For the reporting period (10/01/2019 To 09/30/2020) there were 5 wells being monitored for groundwater level changes.

California Department of Water Resources, September 2020, California Groundwater Conditions Update – Spring 2020. https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Data-and-Tools/Files/Maps/Groundwater-Level-hange/DOTMAP_Reports/Spring-2020-Groundwater-DOTMAP-Report.pdf

This website by the California Department of Water Resources provides a statewide perspective of groundwater level changes. Of interest to this investigation are the following interpretations from these graphics.

- The twenty-year analysis of the groundwater trends of the six monitoring wells in Scott Valley (Figure 6) shows "no significant trend". There are only six wells that were monitored as these are the only wells on record that have groundwater level data during the Spring 2000-Spring 2020 period.
- Figure 1 is a "Statewide Annual Precipitation" from the National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information. The time period for this figure is 1970 to 2020.

Cummings, Chris, 2017, Draft Onsite Wastewater Feasibility Study for Kidder Creek Camp Master Site Plan, 11 pages.

This report documents the water needs of the Kidder Creek Orchard Camp (both existing and proposed facilities) and the wastewater facilities needed to service the camp. This includes the excavation of five, mostly eight-foot-deep test pits south of Barker Ditch in an area that was devoid of subsurface data and description of the geologic materials and their hydrologic characteristics. The key findings of this investigation are:

- The test pits encountered sandy clay to their total depth with no cobbles or boulders reported.
- The materials were almost all moderately to well drained.
- The test pits were excavated on 16 December 2016 and no free water was encountered in any of the test pits.

California Department of Water Resources. *Well Completion Reports*, 24 September 2020 *https://water.ca.gov/Programs/Groundwater-Management/Wells/Well-Completion-Reports*

"California Water Code Section 13751 requires that anyone who constructs, alters, or destroys a water well, cathodic protection well, groundwater monitoring well, or geothermal heat exchange well must file with the Department of Water Resources a report of completion within 60 days of the completion of the work." This website allows the public to obtain copies of these reports that have been filed with the California Department of Water Resources. The copies have the owners name and personal information redacted from the reports but do include in recent reporting requirements, the Assessor's Parcel Number of the well location. *While many of these reports are* *incomplete and the water well drillers are not trained geologists, their years of experience have allowed them to construct many good producing water wells and corresponding recorded data. This data often provides useful information about the aquifer and the water bearing materials in the area.* The following are the pertinent data that can be gleaned from these reports:

- Use of the well (i.e., Irrigation, domestic, or stock)
- Depth, perforated interval, and yield of the well
- The geologic materials encountered while drilling the well. In this case, if the well is deep enough, the thickness of the alluvial deposits and the contact depth with bedrock.
- Where water was first encountered and the static water level after the well was completed and the date.
- If a pump test was conducted, the yield of the well, the drawdown in the well during the test, and the length of the test.

Evaluation and Analysis of Existing Geologic Mapping and Water Well Data

This section provides the pertinent data and concepts from the above references that is used to build the hydrogeologic setting and conceptual model. Described here are the methods used to develop key products that will be applied in the section to determine the impacts of the Project on the groundwater supply and those that use and depend on it. This section is divided into: Physical Setting and Geology, Well Completion Reports, and Hydrogeology.

Physical Setting and Geology

The Project is at the apex of the Kidder Creek Alluvial Fan where Kidder Creek exits the Marble Mountains at the mountain front. Kidder Creek then continues flowing east to its confluence with Big Slough and then the Scott River. The Kidder Creek Alluvial Fan can be divided into upper and lower parts. The boundary is where the fan leaves the confines of bedrock hills near South Kidder Creek Loop Road. This is also where the groundwater gradient flattens and the groundwater flow starts to divide between continuation down Kidder Creek and a portion of the flow heading down Oro Fino Valley (Mack 1958, Plate 1). The Project Area is a sub-area of the upper Kidder Creek Fan that is proximate to the Kidder Creek Orchard Camp.

The Early investigators identified Kidder Creek as ephemeral and subsequent investigators have confirmed those findings (Sommarstrom 2013). Historically, before large groundwater extractions occurred, Kidder Creek would go dry by about July (Mack 1958). The USGS Etna Quadrangle shows Kidder Creek is ephemeral to about the mountain front and what is locally known as Pool 1 for the purposes of Coho preservation actions. Evidence suggests that at one time Kidder Creek could have flowed down Oro Fino Creek (Mack 1958). The Wright-Fletcher Ditch follows a topographic low that continues to Oro Fino Creek and could have been an ancestral distributary channel. It was not uncommon for the early settlers to use existing topography for the construction of irrigation ditches and levees.

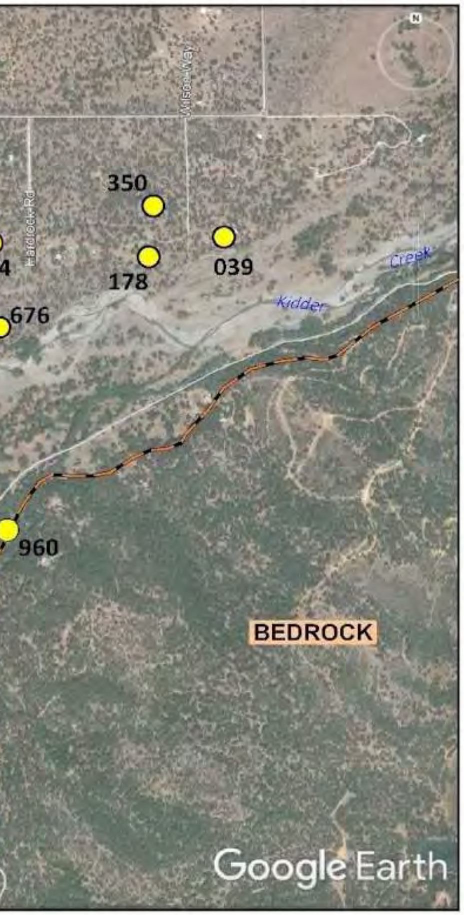
The Project is within the Klamath Mountains Geologic Province which has a long and complex history. Scott Valley was formed by tectonic forces that tilted the basin to the east along the Scott Valley Fault (Figure 2). While the Klamath Mountains Geologic Province is composed of many different rock types ranging in age from the Pre-Silurian to Recent and from igneous and metamorphic, metavolcanic, and metasedimentary rocks to alluvial deposits; the Project area can be simplified into two units, the Quaternary to Recent surficial alluvial deposits, and the Pre-Silurian to Cretaceous underlying bedrock (Mack 1958, Wagner and Saucedo 1987, Harter and Hines 2008, and Sommarstrom and Tamar 2013).

The Bedrock Unit comprises the older metasedimentary rocks (Abrams Mica Schist), followed by metavolcanic rocks (Salmon Hornblende Schist, which were followed by the Greenstone – metavolcanic andesitic rocks (Mack 1958). These metamorphic rocks have been intruded by Cretaceous-aged igneous and ultrabasic rocks (mostly granodiorite and serpentinite rocks) higher in the Kidder Creek watershed. These formations, while crystalline in nature, have been fractured and faulted to provide secondary permeability to wells and springs (Heath 1983). Mack mentions that the Greenstone is highly jointed which means it could have a higher secondary permeability than the Abrams Mica or Salmon Hornblende Schists. Mack, discussing the structural relationships of the Abrams Mica Schist and the Greenstone stated “However, along McAdam Creek, faulting perhaps of a localized nature is indicated, for near the contact of the Abrams mica schist with the greenstone the schist is strongly sheared.” (Mack 1958) This along with other mentions of the faulted relationships indicates that where faulting does occur, there is shearing which indicates the faults form a less permeable zone in the bedrock.

The alluvial fill in the valley consists of unconsolidated Pleistocene and Recent deposits. The two formations that are significant in the Project area are the Quaternary Alluvium (Qal) and the Kidder Creek Alluvial Fan deposits (KCAF). The KCAF are equivalent to the Recent Alluvial Fan deposits of Mack. The Quaternary Alluvium probably dates from Pleistocene to Recent age and is found in the Project area south of the Barker Ditch in the valley referred to as Taylor Divide. This area was mapped by Mack as Alluvial Fan deposits. But subsequent soils mapping by the Natural Resources Conservation Service and five test pits excavated in 2016 for the Wastewater Feasibility Report (USDA 2017 and Cummings 2017) show the materials in this area are significantly different from KCAF deposits. The test pits revealed geologic material consisting of mostly sandy clay with no cobbles or boulders. These mostly well drained materials are vastly different from the KCAF materials. Also, the soil mapping for the area shows Kinkle (soil classification number 183 and 184) class materials while KCAF deposits are mapped as Riverwash and Stoner gravelly sandy loam (soil classification numbers 212 and 230 respectively) (USDA 2017). The Qal deposit appears to be older as it is found at a higher elevation on the hillslope and is eroded by cut banks of the active Kidder Creek. The Qal does not match any of the other descriptions from Mack (1958) or any other reported geologic mapping in the area and is therefore identified as the general term Quaternary Alluvium.

There is one significant geologic structure in the project area which is the Scott Valley Fault (Foglia et.al. 2013). This fault transverses the Project area through Taylor Divide. As mentioned above, Mack (1958) pointed out there is shearing of faulted contact between the Abrams Mica Schist and the Greenstone. This would indicate that faulting between these two formations results in shearing and is therefore a reduced permeability or impermeable zone to groundwater movement. The age of the faulting is pre-Quaternary, as there is no evidence of offsetting the Qal or the KCAF deposits.

The contact between the Bedrock unit and the Alluvial deposits (KCAF and Qal) is shown on Figure 2 as an orange dashed line. This contact (minus the Qal unit) is also the boundary of the Scott Valley Groundwater Basin (Basin #1-005, CADWR 2004) and the boundary for the Scott Valley Groundwater Sustainability Area. The Alluvial units shown on Figure 2 fall under the Groundwater Sustainability Plan currently being developed by the County of Siskiyou Flood Control and Water Conservation District.



re Well Location

tion Report Location (approx.) with last 3 digits
ocations with 001, 002, or 003 are well pump
with limited well information.

Well Completion Reports

By utilizing the UCD groundwater model, the DEIR for this Project, and this analysis, there were three data sets of Well Completion Reports downloaded from the CADWR-OSWCR website. Well Completion reports, generally referred to as "well logs", if completed correctly, provided information on the well's location and use, the geologic materials encountered during drilling, and the hydrologic characteristics of the well, including static groundwater levels, specific capacity or pumping data. Since the information found in the Well Completion Reports is intended for the purpose of well development, some interpretation is necessary and expected.

About 1984, CADWR started providing WCRs that included a place to record Assessor Parcel Number (APN). With the application of the internet, the County's APN maps became easily accessible. With the creation of Google Earth, it was possible to tie a location of a WCR to a parcel and approximate the ground surface elevation. Recently, CADWR made the WCRs available through the OSWCR with the owner's name and other private information redacted. With these tools, it is possible to obtain a fairly accurate location of the WCR. WCRs for domestic wells are easier to locate as they generally are tied to the location of a homestead. While WCRs for irrigation wells can be anywhere on a very large parcel and if multiple parcels are on the farming operation, there is the potential for confusion of APNs. All this being stated, the information pertinent to the aquifer characterization is now easier to tie to a location.

For the UCD groundwater model, they obtained about 1,700 WCRs from the CADWR-OSWCR website with the intent of gaining a greater understanding of the hydrogeology of Scott Valley. The WCRs were geo-located using the APN, well owner's name and address (having access to unredacted owner information) at the time the well was constructed, or by the Township/Range/Section location on the WCR added by CADWR staff based on the information on the WCR by the water well driller. These methods were then field checked by visual inspection from public access locations or by aerial photography. Figure 3 shows the well use and distribution for the WCRs. Note that in the Project area, shown as a red box, there are 10-25 domestic wells, zero irrigation production wells, and zero public wells.

In the DEIR for the Project, ECORP looked for WCRs within a 1.6-mile radius of the Project and obtained 34 WCRs (ECORP Consulting, Inc 2019, Table 3.3.2). These WCRs were for wells constructed between 1974 and 2015 and had a reported depth to groundwater of 15 to 53 feet.

As part of this analysis, the CADWR-OSWCR provided 32 WCRs on 20 October 2020 for a search of Sections 35 & 36 of Township 43 N, Range 10 W. Additionally, data on three wells were provided by KCOC from their files. These had pertinent pump test and water level data, so for analysis purposes were assigned identification number 001, 002, and 003. Appendix A has the listing of the located WCRs and pump test reports and copies of the WCRs obtained from the OSWCR database. Well # 003 is identified on the pump test report as being used for irrigation, so it is shown on the data sheets as an irrigation well. However, the amount of land that this well irrigates is so small that it does not show up on the Land and Water Use Surveys. So, while it is technically an irrigation well (used for agricultural purposes), it does not have the influence on the aquifer system like an irrigation well.

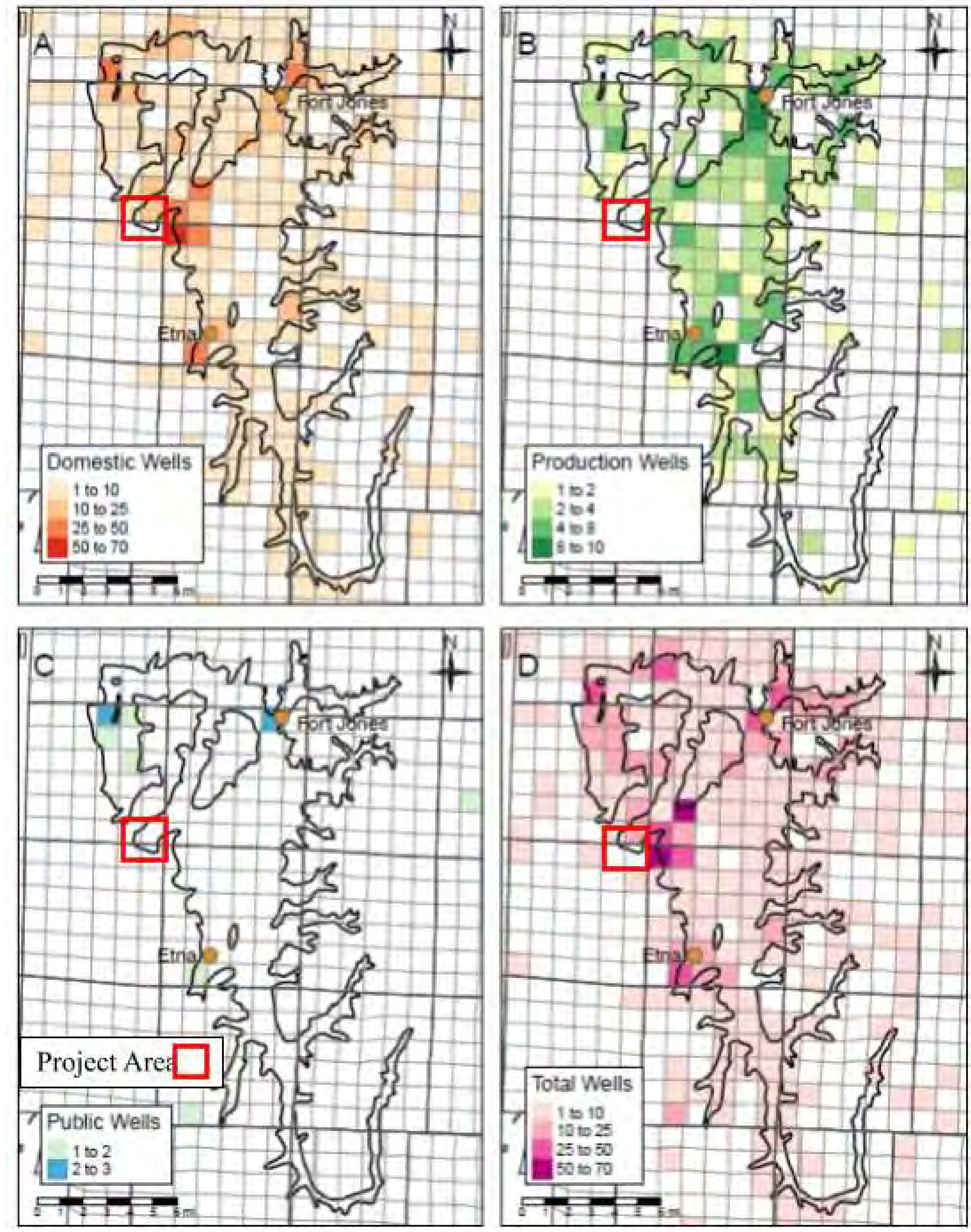


Figure 3 Choropleth maps indicating number of domestic (panel A), agricultural production (panel B), and public (panel C) Well Completion Reports present in each Public Land Survey System (PLSS) Section, according to data from the DWR Online System for Well Completion

Reports (OSWCR). Panel D shows the sum of panels AC. (UC Davis Technical Team for The County of Siskiyou, October 2019).

The WCRs were sorted into two groups, those with APN's and those without. The 18 wells with APN's were geo-located using Assessor Parcel Maps obtained from the Siskiyou County website. Then using Google Earth and any location information on the WCR, like a map or mileage, the locations were plotted as accurately as possible on a Google Earth image. Lacking exact location data, the well location was plotted next to the residence on that parcel. This was reasonable, as all the wells were used for domestic water use. At the same time, the ground surface elevation at that location was recorded from Google Earth. These ground surface elevations were then used to determine groundwater level elevations and top of bedrock elevations. As a quality check, these elevations were compared to USGS topographic map elevations as well as Lidar elevations where available. The well locations, including those with pump test reports provided by KCOC, were plotted on a Google Earth image, and assigned a number that corresponded with the last three digits of the WCR or 001-003 for the KCOC provided well data (Figure 2). This totaled 21 wells with good locations that provided valuable data about the aquifer including well depth, yield, static water level, depth to bedrock, and occasional pump test data. A visual check of the 14 wells without valid APN location information showed that these WCRs fell into the same range of aquifer values as the 21 locatable WCRs. This indicates that the 21 locatable WCRs are a good representation of the aquifer characteristics.

Evaluation of the WCRs incdicated sufficient data to construct 5 maps showing the characteristics of the Project area groundwater situation. These maps are:

- Depth to Groundwater
- Groundwater Elevation
- Depth to Bedrock
- Thickness of KCAF deposits, and
- Well Yields

<u>Depth to Groundwater Map</u>

There are 11 WCRs that report depth to water in the Project area. Figure 4 shows the spatial relationship of these reported depths to water. ECORPS, in their WCR search, found that depth to water ranged from 15 to 53 feet (ECORP 2019). These values were confirmed by this analysis, which found depth to water from located wells, generally ranging from 15 to 30 feet with two outliers.

Both outliers (Well # 464 & 963; depth to water of 50 and 8 feet respectively) are in wells on the edge of the Kidder Creek Fan. Well # 963 produces from the KCAF deposits but encounters bedrock at 55 feet. It is also where there is a small tributary draining onto the KCF. This also appears to be the northern cut-bank of the ancestral Kidder Creek. These two conditions make Well# 963 on the marginal part of the KCF. Well # 464 is 250 feet deep (completed depth of 150 feet) and produces only from bedrock. While this well does not produce from the KCAF deposits, it provides evidence that there is groundwater flowing through the bedrock fractures, even underlying the KCAF deposits.

Groundwater Elevation Map

Groundwater Elevation maps are helpful in determining the direction of groundwater flow and whether Kidder Creek is a gaining or losing creek in the Project area. The same eleven wells used in the Depth To Groundwater map were used in this map as well. The groundwater elevation values were calculated by subtracting the depth to water value from the ground surface elevation determined from Google Earth (Figure 5).

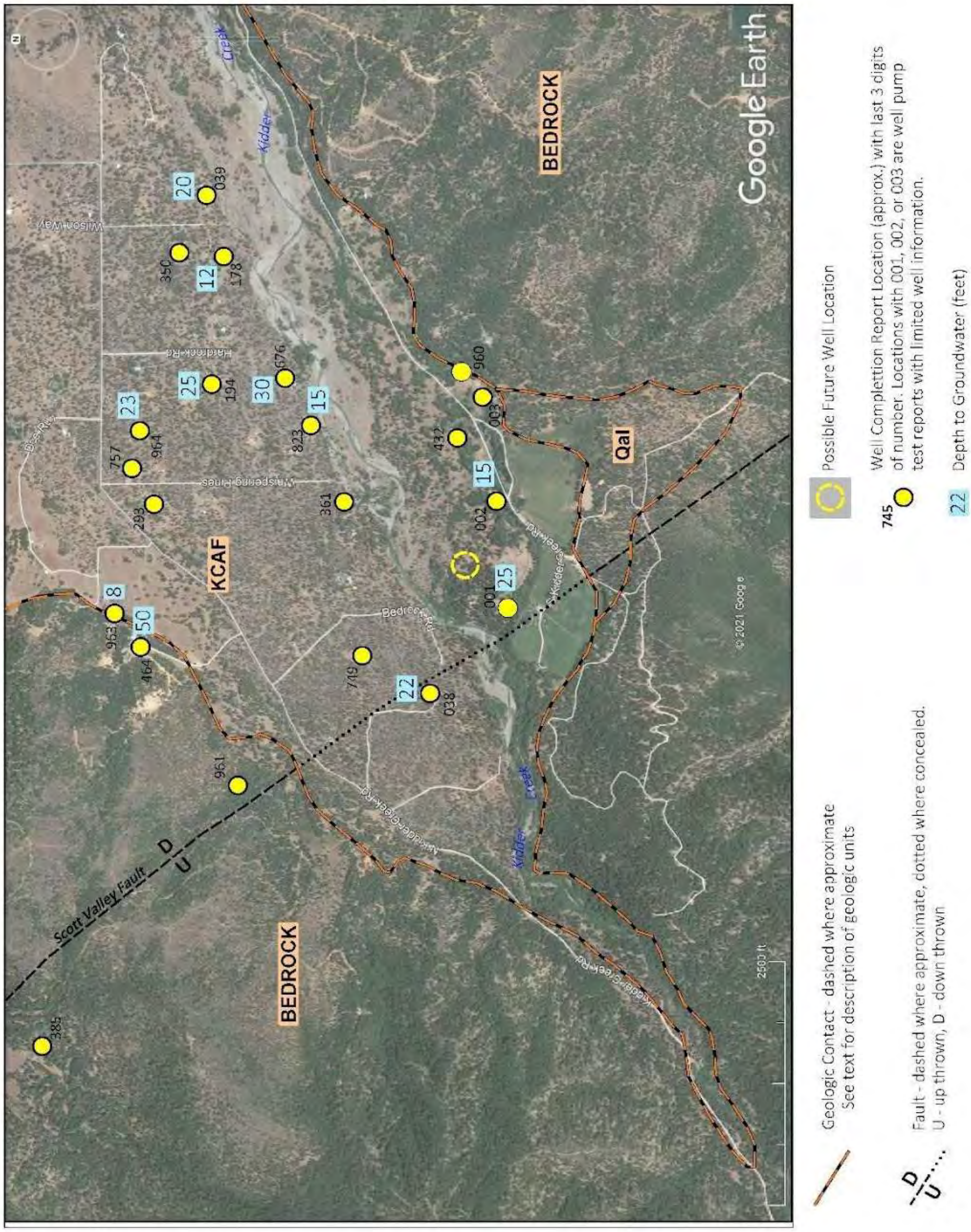


Figure 4 Depth to Groundwater Map

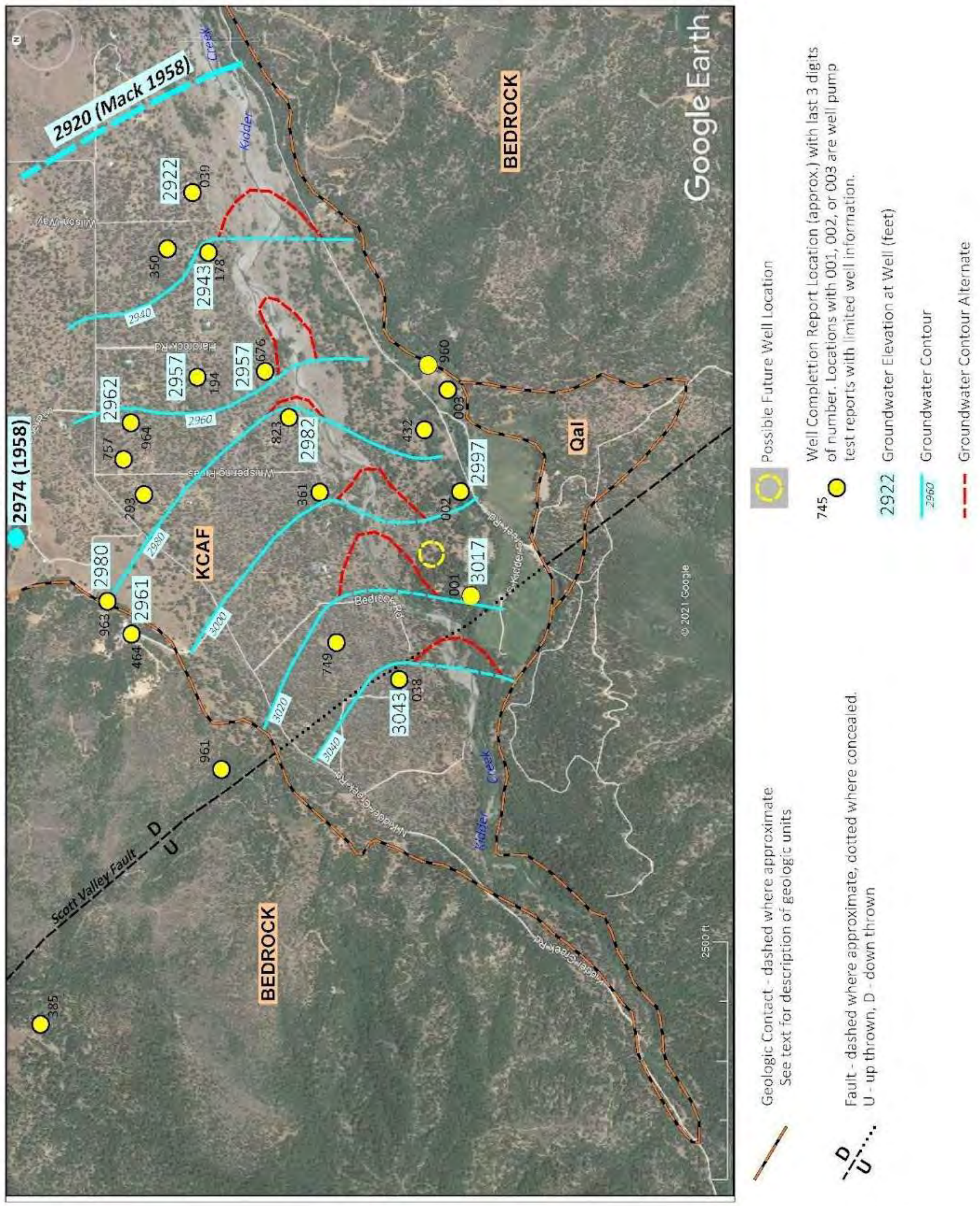


Figure 5 Groundwater Elevation Map

Because Well # 963 is producing solely from bedrock; it is no surprise that the groundwater elevation is 20 feet lower than the corresponding groundwater elevation for wells producing from the KCAF deposits. This is additional evidence that the bedrock aquifer system is different from the KCAF deposits. Because of the elevation difference (hydraulic head), this is an indication that the KCAF deposits in this locality might be recharging the bedrock aquifer. Well #432, located just east of the KCOC, encountered KCAF deposits to 65 feet and then bedrock to 325 feet. The driller sealed off a gravel section with the annular seal down to 20 feet. The well is cased to 225 feet with perforated casing at 100-120, to capture water from a 23-foot weathered fractured rock section, and from 205-225. The driller identified the geologic material from 105-128 as "Fractured yellow rock" which is indicative for weathered rock, with the yellow staining or weathering coming from oxygenated water. The water level in this well is not out of place with surrounding wells which indicates that there is a possibility that the water in the fractured zone is hydraulically connected with the overlying KCAF deposits. It also shows that the bedrock formation beneath the Kidder Creek Alluvial fan is water bearing for domestic supply. One other interest in this well is its proximity to Wells #003 and #960. The thin gravel section at 17-20 feet could be connected to the highly productive gravel encountered in the Wells # 003 and # 960. The well driller intentionally sealed off this gravel to protect the water quality of the water supply and the aquifer.

When constructing a groundwater Elevation Map, one can choose to just consider the groundwater elevations in wells or also include the streambed or water surface elevations. This map (Figure 5) shows both options. The light blue lines are lines of equal groundwater level elevation. The red dashed lines show an alternative interpretation if you take into consideration the Kidder Creek streambed elevation. Also on the map is a groundwater level from Mack's 1958 report and a bold dashed light blue line that is the furthest upstream Mack constructed in his groundwater contours. These data show that groundwater levels constructed by this analysis are consistent with Mack's construction. The general shape of the contours is also consistent with those developed by the UCD model (Figure 6). The shape of the contours are classic for an alluvial fan that is the source of groundwater recharge. The concave downstream appearance in both alternatives indicates that water is percolating from Kidder Creek and the fan and mounding beneath the creek causes the groundwater to move downstream and away from Kidder Creek. There is a slight flexure in the contours around North Kidder Creek Road and Whispering Pine Road that could indicate that there is a component of flow heading towards Oro Fino Valley, which is consistent with the maps shown in Figures 6 and 11.

One concern was that the groundwater levels associated with the construction of the wells were measured in the Winter/Spring or Summer/Fall in addition to different climate conditions over the last 34 years (1984-2018). Comparing Well #s 039,178, and 350, which are close together and have similar water levels and were measured in February 1996, August 1992, and March 1995 respectively. Their groundwater levels indicate that over Spring and Later Summer and over drought and wet years the groundwater levels change little. This is expected given that there is no major groundwater demand from wells in the area and that this part of the upper Kidder Creek Alluvial Fan gets recharged with the first flows of the year as shown in the Water Budget discussion. As mentioned previously, this map is similar to the maps produced by Mack and UCD. Additionally, this map, like Mack's, uses a 20-foot contour interval which will make it less susceptible to minor changes in levels of 1-5 feet. Therefore, this map is a good approximation of how a groundwater elevation map would appear if the water levels in these were measured in Spring and Fall and over varying climatic conditions under the current levels of development.

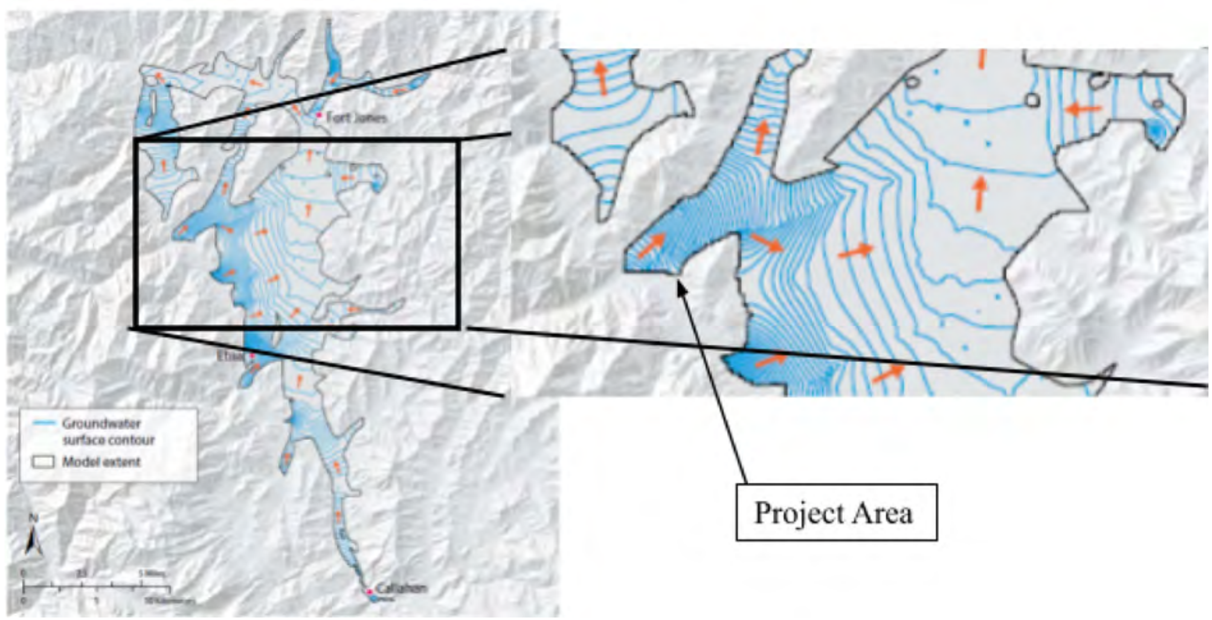


Figure 6 Groundwater Contours Generated by UCD groundwater model (Foglia, et.al. 2018)

Given that this map shows groundwater level contours that were constructed to include streambed elevations. The data in Table 1 was developed to show where the groundwater table would be beneath Kidder Creek. Where the blue contours cross Kidder Creek, the elevation of the creek bed was determined using Google Earth. The difference between the creek bed and the groundwater elevation contour is listed in Table 1. The depth of groundwater is 3-13 feet below the streambed. This information has implications on the hydraulic connection between the creek and the aquifer which will be discussed later under Hydrogeologic Setting and Conceptual Model.

Table 1 Groundwater Elevation Beneath Streambed

GW Contour Elev.	GS Elev. Streambed	GW Depth Below Streambed
Feet Above MSL	Feet Above MSL	Feet (Column 2 – Column 1)
3040	3044	4
3020	3025	5
3000	3012	12
2980	2983	3
2960	2973	13
2940	2946	6

Depth to Bedrock Map

Most of the WCRs in their Geologic Log section describe the materials the driller encountered in the construction of the well (see Appendix A). Consistent with previous investigations, the KCAF deposits are composed of boulders, gravel, sand, and clay in various mixtures. The Bedrock unit is usually identified in the Geologic Log as black, gray, blue, green, brown, or yellow rock, or shale rock, or just bedrock. The Depth to Bedrock map (Figure 7) was made using the depth in each well where bedrock was recorded. Many wells never encountered bedrock and drillers stopped drilling as they thought they had sufficient water. In this case, these wells are identified as "greater than XX (> XX)" with XX equal to the depth of the well. After plotting the depth to bedrock in each well, a pattern began to appear and equal depths to bedrock contour lines were drawn at 50-foot and 100-foot depths to bedrock. The contour lines show a buried channel of ancestral Kidder Creek cut into the bedrock.

Thickness of KCAF deposits Map

The thickness of the KCAF deposits is the distance from the ground surface to where bedrock was encountered. Instead of showing the depth to bedrock, it shows the thickness of the KCAF deposits above the bedrock. This value is important as it shows the thickness of the aquifer (i.e., the KCAF deposits). The map showing the thickness of the KCAF deposits (Figure 8) has the same pattern as the Depth To Bedrock map but in this case, it was easier to construct with 20-foot contour intervals. This created a map that clearly shows the filling in the bedrock channel with the KCAF deposits, with the thickest part of the unit being the deepest part of the channel eroded into the Bedrock unit. This map also shows that the aquifer thickness under the Project is from 0-80 feet thick.

Well Yield Map

Plotting the reported yield of the wells on the map does not reveal any significant pattern (Figure 9). Well #s 178 and 823 have the highest yields in the center part of the fan. These wells encountered "water gravel" between 50-80 feet. Well # 178 within this range, encountered a thicker section which usually results in a higher yield. These wells might have encountered what is referred to as a paleochannel in the fan deposits. The wells NW of North Kidder Creek Road seem to have much lower yields and could be a result of being on the edge of the KCAF deposits. Along the Barker Ditch in the Project area, there are a few wells that yield 30-95 gpm. These are 26-40 feet deep and where there are geologic logs, they show many feet of gravel. This along with being close to the Barker Ditch (a source of recharge) could account for the higher yields. Otherwise, the wells fall into a yield range of about 10-25 gpm. This is more than sufficient for a domestic supply of water. While these wells can produce this amount of water, they might not use this amount as the actual well production is governed by the size of the pump.

Mack (1958) stated on page 14, "Although some wells have bottomed in bedrock, no wells in the Scott Valley area are known to derive water from any of the above rocks. Consequently, for the purpose of this report, the units comprising the bedrock are considered to be non-water-bearing." Well #s 385, 432, and 464 have their perforated portion of the well in the Bedrock and obtain yields ranging from 5 to 20 gpm. Well # 961 has zero yield reported, yet the driller completed the well. Therefore, it seems the yield on this well is probably less than 1 gpm. The construction of Well # 432 is covered under the section on Groundwater Elevation Map, and its yield is 15 gpm (in the range of other domestic wells in the area). The main point is that the Bedrock is water bearing for a domestic supply if sufficient water filled fractures are encountered.

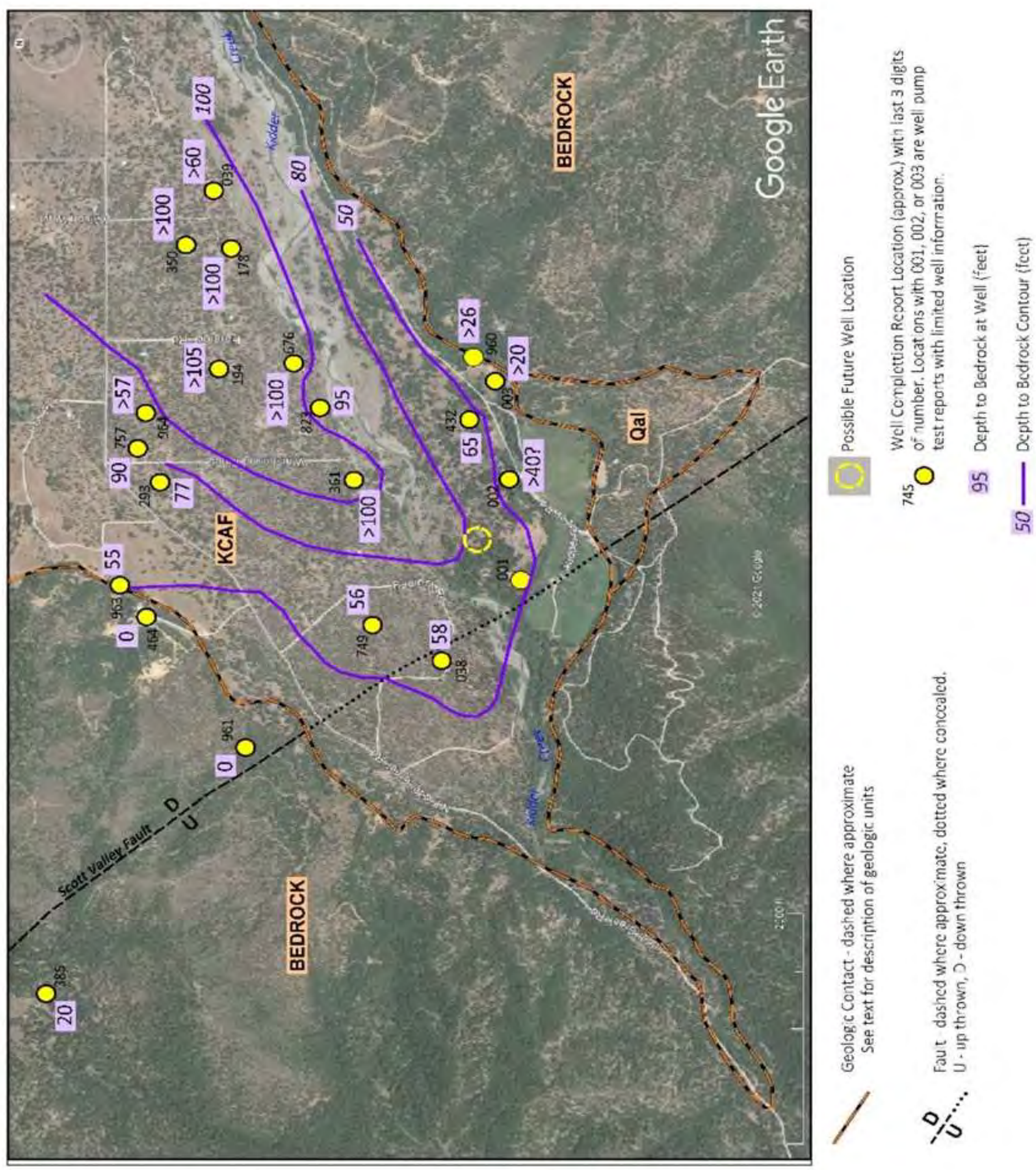


Figure 7 Depth to Bedrock Map

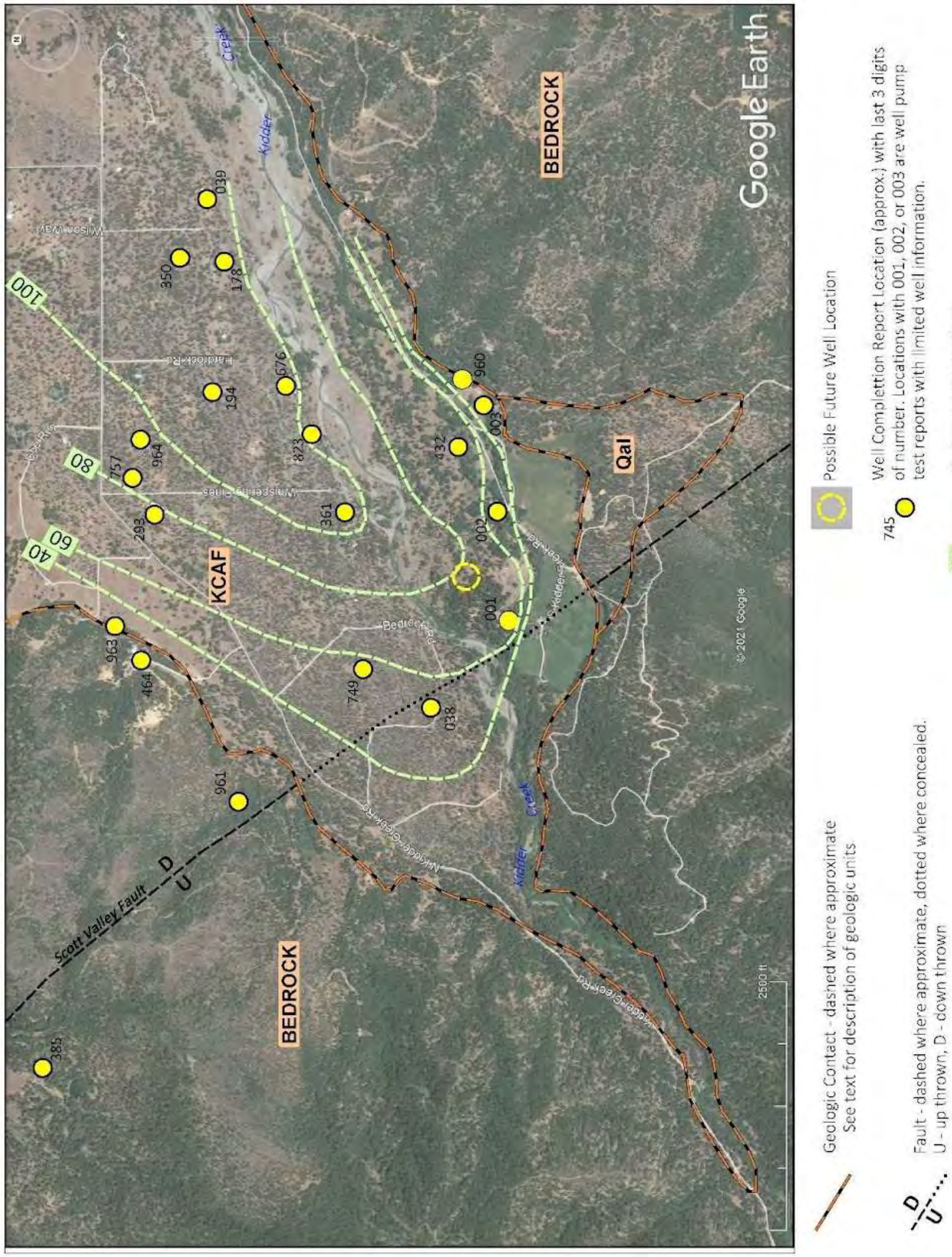


Figure 8 Thickness of Kidder Creek Alluvial Fan Deposits Map

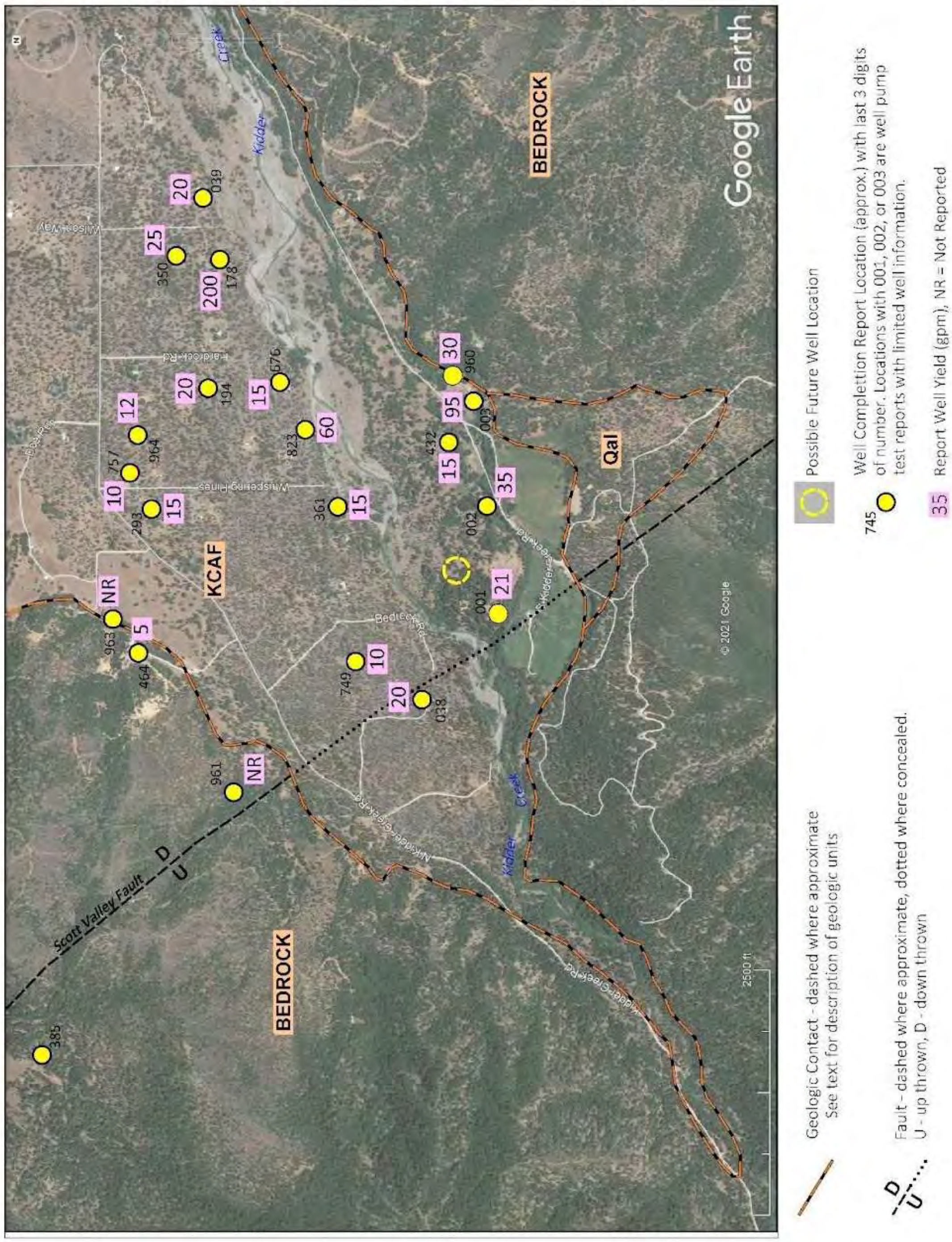


Figure 9 Well Yield Map

Hydrogeology

All the references concur that the groundwater system in Scott Valley consists of two aquifers, the alluvial deposits and the Bedrock aquifer. The Alluvial deposits aquifer consists of various layers of gravel, sand, and clay deposited by tributary streams and the Scott River. While most reports consider the Bedrock as non-water bearing, the WCRs show that some wells do obtain yields of about 5 gpm or greater from the fractured Bedrock aquifer. The UCD modeling efforts incorporated a “Mountain Front Recharge” component that contained a significant portion of flow from the Bedrock aquifer via springs and subsurface inflow. This is supported by reports from KCOC staff who have observed springs with significant flow coming from the Bedrock and Qal deposits in the Taylor Divide area (pers comm KCOC staff). The Alluvial deposits have primary porosity, and the Bedrock has secondary porosity (Heath 1983). None of the previous studies have shown any kind of confining layer which is consistent with the WCRs in the Project area. Therefore, both aquifers are considered unconfined.

Figures 5,6, and 10 clearly show that groundwater flows in Kidder Creek Alluvial Fan deposits in an easterly direction from the mountain front (the fan apex) to the Scott River. Both Figures 6 and 10 show that the groundwater flow divides at the west end of Chaparral Hill and part flows towards Oro Fino Valley and part flows along Kidder Creek to Big Slough and the Scott River. Just downstream of the Highway 3 bridge, the Kidder Creek Fan gradient flattens, resulting in the groundwater levels approaching the ground surface. This has been a historic groundwater discharge area on the fan before Kidder Creek reaches Big Slough and the Scott River (Mack 1958). This discharge area provides groundwater to the irrigation wells between the Hwy 3 Bridge and the Scott River.

In the Project area all but one of the wells are used for domestic supply and are generally less than 100-feet deep which is about the thickness of the KCAF aquifer. Most wells produce about 10-25 gpm which is an indicator of the lower permeability of the aquifer than elsewhere in the valley. The UCD’s Scott Valley Integrated Hydrologic Model used aquifer values from Mack (1958), drawdown values from WCRs and aquifer test data (Tolly 2014) from irrigation wells to approximate hydraulic conductivity (K) values for each of their hydrologic areas (Tolly et al 2019). While this was very appropriate for hydrogeologic conditions in the main portion of the valley, it did not provide K values for the areas not served by irrigation wells where the wells are generally at or less than 100 feet and they encounter less permeable materials. These aquifer values make these areas less than suitable for an agricultural irrigation supply.

Mack, 1958
WSP 1462

is

A review of the WCRs and pump test data from three domestic wells in the Project area (Well #'s: 001,002, and 823) provide suitable specific capacity (Q/s) data that can be used to obtain an approximation of K (Abbott 2015). Two methods were selected to obtain K values which are listed in Table 2, these methods are:

1. Equation method: Transmissivity (T) = Drawdown (Q/s) X 1500 for unconfined conditions. Transmissivity is then divided by the depth of the well that is in the saturated portion of the aquifer (depth of the well minus the depth to water) to obtain K.
2. Graphical method: Using the graphical method with a known Q and Q/s, T is determined.

Table 2 Aquifer Characteristics for selected wells

	Well # 001 – Camp Well		Well # 002		Well # 823	
Parameter	Equation	Graphical	Equation	Graphical	Equation	Graphical
Depth (ft)	73	73	40	40	95	95
Yield (gpm)	21	21	9	9	60	60
SWL (ft)	25	25	15	15	15	15
Drawdown (ft)	25	25	20	20	20	20
Sat. Thick. (ft)	48	48	25	25	80	80
Q/s (gpm/ft)	0.57	0.57	0.55	0.55	3.0	3.0
K (feet/day)	2.5	3.4	4.8	5.9	7.5	10.1
K (gpd/ft^2)	19	25	36	44	56	75

Based on the drawdown data from these three wells, drawdowns from pumping domestic wells are in the range of 20-25 feet, whether they yield 9 or 60 gpm. The yields seem to correlate with Saturated Thickness, the more saturated thickness the higher the yield. This could be related to an increased chance of finding a water-bearing gravel bed. Notice also that the static water level is 15-25 feet, which is a consistent level throughout the KCAF.

Water Budget

Having described the physical characteristics of the area, it is important to understand the movement of water through the area. One method to accomplish this is through a water budget analysis. This section is not a detailed analysis of the budget, but a highlighting of the items of the budget that are pertinent to the impacts of the Project on the local water supply. The basic format for this analysis is to identify the components of the budget. These are the same components of the UCD models of the basin, but here we will discuss those items pertinent to the Project area in the upper Kidder Creek Fan. The equation is simply:

Inflow-Outflow=change in storage

Inflow

The major inflow components to the Project area are precipitation, streamflow percolation, Mountain Front Recharge, Barker Ditch seepage, deep percolation of applied water, and percolation of septic effluent. Precipitation varies from dry to wet years but while the Project does not change the amount of precipitation, it can change how much rain infiltrates into the groundwater basin. As mentioned in the DEIR (ECORP Consulting Inc 2019), the precipitation that falls on the new structures and roadways will run off instead of falling on the ground. Given the "well-drained" characteristics of the soils (USDA 2017) the run-off will quickly percolate into the ground. This would increase the amount of precipitation that ends up in the groundwater supply. Under natural conditions, there is effective precipitation which is the amount of precipitation that is not evaporated and percolates into the ground to be used by vegetation or percolate to the groundwater supply. The concentrated run-off from structures, if it is slow enough to percolate into the ground, moves the water below where dry atmospheric winds and vegetation (by evapotranspiration) can remove it.

Kidder Creek is a significant source of groundwater recharge to the Scott Valley aquifer. Kidder Creek was the example in the 1974 SWRCB report on Scott Valley's water use of a westside stream losing its entire flow after spring runoff to seepage through the highly permeable KCAF deposits; only to return water to the surface where the water table intersects the land surface (Figure 11) (Sommarstrom 2013, SWRCB 1974, Mack 1958). Photo 1 visualizes this situation, showing that this loss of stream flow occurs in the Fall as the early rains start to appear. On 14 October 2016 photographs were taken of Kidder Creek flow where the creek exits the mountain front and about 3 miles downstream at the Highway 3 bridge. At the mountain front, the flow of Kidder Creek was 30.2 cfs. At the Highway 3 bridge, the flow was zero. This means that 30.2 cfs was percolating into the groundwater basin since in mid-October ET of riparian vegetation is zero or near zero. One cfs flowing for 24 hours equals two acre-feet. That means in one day 60.4 acre-feet of water was added to the groundwater basin. Granted that some of this water was used to fill "bank storage", but it does give an indication of how much water percolates in the creek bed. Putting this in groundwater extraction terms, this is equivalent to 13,500 gpm of recharge. As a normal winter progresses, the creek covers more of the bed and the hydraulic head increases as the depth of water increases which moves more water into the aquifer. To give a sense of magnitude, with a total Project demand at buildout of 25.3 AF per year, this one day recharge event replaced the annual use of water in about 10 hours.

Photo 1: 14 October 2016. Photo on left Kidder Creek downstream from the fish screen; flow was 30.2 cfs. The photo on the right is looking upstream from the Highway 3 bridge. (Photos from KCOC files)

Mountain Front Recharge is the water that percolates into the bedrock in the mountains and foothills and flows toward the valley floor. The groundwater enters the groundwater basin by subsurface inflow into the KCAF, and by springs and seeps in the mountains or along the valley margin. The UCD model found that the values ranged from .5 cfs to 5 cfs. In groundwater extraction terms that is 225 to 2,200 gpm. The values in the Project area are probably closer to the lower end.

Seepage from irrigation ditches, like the Barker Ditch, was included in the model at a rate of about 0.5 cfs per mile (Tolly 2019). This is a reasonable estimate based on years of experience (Shawn Pike, DWR Watermaster Service, Personal Communication). The Barker Ditch transverses about 0.6 miles along the KCOC property and is on the boundary between the KCAF deposits of the active channel and the older floodplain deposit in the pasture and orchard area. Along this reach, there is about 0.3 cfs or 134 gpm of water seeping into the aquifer. There are stretches along the ditch where this seepage supports riparian vegetation.

Deep Percolation of Applied Water is irrigation water from the Barker Ditch that is more than vegetative needs or the water that escapes below the root zone before the plants can capture it. There are about 24.8 acres of pasture (Figure 12) that are irrigated by surface water via the Barker Ditch in the Project area (ECORP, Inc 2019). CADWR used in their 2016 Siskiyou County Land and Water Use Survey an Applied Water rate of 2.7 acre-feet/acre and a deep percolation rate for pasture of 3-5% of Applied Water (personal communication George Valente, CADWR). The pasture is on well drained soils, so assuming a deep percolation rate of 5% for the 67 acre-feet of Applied Water equates to about 3 AF (or about 1 million gallons) of water added to the groundwater supply.

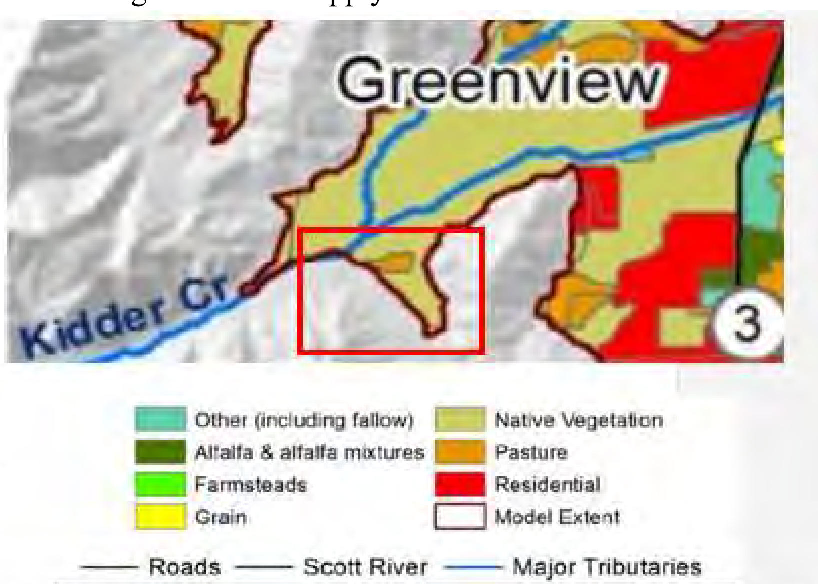
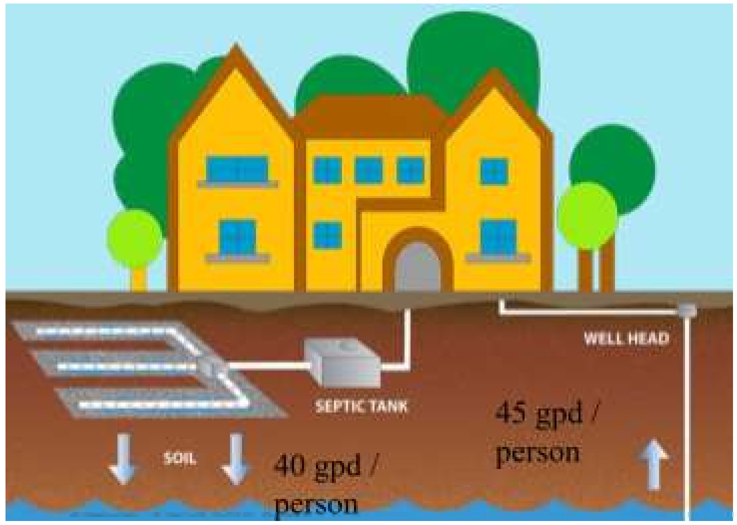


Figure 12: Land Use Map of the Project Area, Red Box -KCOC Location (Foglia 2013)

*Figure SEQ Figure * ARABIC 12 Land Use Map*

Percolation of septic systems effluent is usually ignored in water budgets because the amount is so small in comparison to other water sources. But, in rural areas, like the Project area, cleansed septic effluent returns a significant portion of the water extracted from domestic wells. For example, the Project's per capita water use is 45 gpd. This value is lower than general domestic per capita water use which is about 60-80 gpd. The main reason for this is that for the Project, all outside watering is by surface water from the Barker Ditch. In general, the major domestic water use (i.e. the household) is outside watering. The human body requires about 2 gallons per day to sustain bodily function. The rest of the water is used for water disposal (flushing toilets), dish washing and cleaning, laundry, and personal hygiene. This water all goes down the drain and into the septic tank. From there the water is disinfected through bacterial breakdown. Then, given the well-drained soils of the area, the cleansed water percolates into the aquifer; below where it could be subject to evaporation or consumption by vegetation. This means that about 40 gpd per capita ends up back into the groundwater supply which is a conservative estimate as shown in the diagram above. The well drained soils and the shallow water table (about 20 feet) is why the UCD Hydrologic Model assumed that precipitation and surface water (including septic tank effluent) that exceeds ETo is essentially instantaneous (Foglia et al 2013). UCD's use of the word "instantaneous" refers to the monthly time steps of the computer model. It does not mean that the water instantly flows into the aquifer. It does mean that the water from the septic tank does reach the aquifer within a couple of months, so there is plenty of time for the water to be cleansed.



Outflow

The major outflow components in the Project area are: Subsurface outflow, Evaporation of vegetation, and Groundwater extraction. Subsurface outflow from the area continues down the KCAF and then divides just upstream of Chaparral Hill, with about one-third flowing down the Oro Fino Valley. Given the Groundwater Elevation Map (Figure 5) and the calculations of K (Table 2) it is possible to calculate an approximate amount of subsurface flow out of the area using the formula Q=TWI. Where Q is the subsurface flow, T is the transmissivity of a foot width of aquifer (K times aquifer thickness), W is the width of the aquifer (width of KCAF at that location), and I is the groundwater gradient (the difference in elevation between two groundwater contours divided by the distance between contours in feet). Using the K value from Well # 823 (the average of the two values from Table 2=65.5 gpd/ ft^2) and the aquifer thickness (75 feet), the fan width of 3,800 feet, and the gradient of 0.02 the calculated approximate aquifer subsurface outflow is about 275 gpm or 0.62 cfs.

Determining the Evapotranspiration of vegetation in the Project area is difficult compared to areas of extensive irrigation. Figure 12 shows the portion of the land and water use map from the UCD model based on CADWR Land and Water Use data (Foglia et al 2013). The evapotranspiration value for the native vegetation area is $K_c = 0.6$, which is basically just the evaporation that can be obtained by precipitation and soil moisture storage. So, the lands that are identified as "native vegetation" do not take measurable water from the groundwater supply but do capture some of the water before it can percolate to the groundwater supply. The one exception to this is the 24.8 acres of irrigated pasture. This area is solely irrigated by surface water from the Barker Ditch and therefore there is no use of groundwater on these lands. As explained above, this pasture does contribute via the deep percolation of applied water to the groundwater supply.

As stated earlier, the only groundwater extraction in the Project area is from domestic wells. The reported information is that there is about 1,000 acre-feet of water used for domestic purposes in Scott Valley. Most of this is around the towns of Fort Jones and Etna. There are no reported values for the Project area. However, using Google Earth to count residences one can obtain an approximation of the amount of groundwater that is used in this specific area. There are about 40 residences overlying the KCAF from the mountain front to Bird Track Lane and from North Kidder Creek Road to the hills south of KCOC. From Google Earth all but a half dozen of these residences had little to no evidence of outside water use for gardens or animal husbandry. The SWRCB estimates that the per capita residential water use for the North Coast Region (for the years 2014-2020) averages 68 gpd (SWRCB 2021). As discussed previously (see septic tank effluent percolation), most of this water used enters the septic tank and percolates into the ground and is returned to the groundwater supply in a short period of time. Assuming 4 people per residence, and conservatively using the 68 gpd per capita, the total amount of residential use is about 11,000 gpd. This equates to about 12 AF per year or at a continuous extraction, about 8 gpm. If we assume an ultra-conservative value of only 40 gpd/capita is returned to the groundwater supply via the septic tank and the rest is lost due to consumptive use (evaporates or by outside watering), then there is only about 5,000 gpd that is removed from groundwater supply or 5 AF per year. This analysis underscores the conclusion from UCD's modeling efforts as they state "Domestic/urban water use other than that used for lawn/garden irrigation in Scott Valley is only a very small fraction of total water use in the Scott Valley. (Foglia et al, 2013, Page 75)

Change In Storage

As stated previously, Mack's 1958 report was close to showing the pre-development groundwater conditions of Scott Valley. Existing long-term measurements of groundwater levels shows that with seasonal variation the change in storage is near zero (Harter 2019). Most of these measurements were for irrigation wells and none were in the upper Kidder Creek area. None of the existing data indicates that this would not also be representative for the upper Kidder Creek Fan area. There is evidence of this in Figure 4 which shows the depth to groundwater in newly constructed wells from the 1980's to current where the depth to groundwater hasn't changed significantly even from Spring to Fall or wet to dry years. Also, the Groundwater Elevation Map (Figure 5) is like the geologic map with contours constructed by Mack (1958). Therefore, existing data indicates that the current groundwater storage levels are near those of pre-development of the groundwater aquifer. These data also support the concept that the upper Kidder Creek fan recharges yearly and there is no long-term reduction in groundwater storage.

Hydrogeologic Setting and Conceptual Model

The aquifer system of the Project area consists of the Kidder Creek Alluvial Fan deposits that backfilled the eroded channel in the bedrock created by the ancestral Kidder Creek. KCAF deposits, the main aquifer in the area, are known to be from zero (at the edges with the bedrock) to more than 100 feet thick towards the center of the upper Kidder Creek fan. The Project area is at a part of the upper Kidder Creek fan where the ancestral Kidder Creek was creating the cut bank in the bedrock. This feature is interpreted from the closeness of the contours in Figure 8. The Project area is at the mountain front where Kidder Creek is leaving the bedrock-controlled channel and transforms to a braided stream (where percolation of stream flow starts in significant amounts). While there are no wells south of KCOC, conventional groundwater theory says that groundwater usually follows topography. So, any precipitation and run-off that occurs from Taylor Divide north on the Qal unit will percolate into the well-drained soils and probably moves along the Qal / Bedrock contact beneath the camp to Kidder Creek.

Figures 13-18 are cross-sections through the Project area to provide a diagram of the hydrogeologic conditions based on published reports, geologic mapping, and WCRs, Figure 13 is an overview map showing all the key features on or near the KCOC property, the cross-section locations, the well locations used in the crosssection map area. Specifically identified are key hydrologic and physical features such as Kidder Creek, the Barker Ditch and Wright-Fletcher Ditch diversion points, pools 1-5, the camp's well (number 001), the approximate location of a proposed new well, and the boundaries of the geologic units. Cross Sections 1-3 are orientated perpendicular to the axis of the Kidder Creek Alluvial Fan and near parallel to groundwater contours (Figure 5). The Cross Sections have a vertical exaggeration of 10 to 1 in order for them to fit on a page in landscape view and also so that topographic features can be seen on the relatively flat topography. This means that the vertical scale is 10 times greater than the horizontal scale which makes the topography and well depths seem deeper than they are in a 1 to 1 scale. The Cross Sections also show the saturated thickness of the KCAF which is based on groundwater levels recorded on the WCRs and Pump Test Reports.

These cross sections show that the Bedrock extends beneath all the KCAF deposits. Comparing the cross sections show the thinning of the KCAF deposits towards the south sides of the fan and from the east at the mountain front. The Scott Valley Fault traverses the area in a northwesterly trend. While there is no evidence of it offsetting the KCAF deposits, the potential for shearing along the fault would cause it to be a groundwater dam along its length. This could cause groundwater moving through the Bedrock unit's fractures to upwell recharging the KCAF deposits and may explain the near perennial pools in Kidder Creek that occur at the mountain front.

Cross Section 1 (Figure 14) shows the geologic units and the Scott Valley Fault in the subsurface as well as the KCAF unit extending upslope south of the Barker Ditch. The nature of the KCAF here, based on the Soil Survey Mapping (USDA 2017), is more of a flood plain portion of the Kidder Creek Fan since the material is lacking the cobbles and boulders. The material consists more of gravelly, sandy, and sandy clay materials (Stoner series # 230) typical of floodplain deposits. Well# 001 does not have a geologic log recorded, but is likely typical of termination due to encountering bedrock. Identification of bedrock usually takes less than 5 feet of drilling to confirm. Based on this experience, the Bedrock contact was extended to the bottom of Well # 001. This interpretation is consistent with Figure 8.

Cross Section 2 (Figure 15) shows that neither Well#'s 002 and 361 encountered Bedrock. But based on the previous discussion on when drillers quit drilling, well# 002 could have hit Bedrock. Well# 361, while never reaching the bedrock, had sufficient water at a reasonable cost to warrant terminating drilling. Like in Cross Section 1, both of these wells are consistent with Figure 8. This Cross Section also shows the braided nature of Kidder Creek with multiple channels at differing bed elevations. As flows increase, the channels at higher elevations fill with water. This Cross Section also shows a slight mound of the groundwater table (i.e. saturated zone).

Cross Section 3 (Figure 16) shows a slight mounding of groundwater beneath the creek channel and also a steep cut bank on the south bank. The fact that Well #960 shows coarse gravel for the complete depth is indicative that both wells # 003 and 960 encounter an abandoned creek channel that is also adjacent to the Barker Ditch.

The Stream Profile Cross Section (Figure 17) shows the west to east section down the Kidder Creek Alluvial Fan and follows the thalweg of Kidder Creek. Note that the vertical scale has changed which causes the thickness of the geologic units to seem thinner. This section gives a sense of where pools 1-5 occur in relation to the Scott Valley Fault. Note the thickening of the KCAF deposits in an easterly direction. The thickness of the KCAF deposit and the saturated zone is based on Cross Sections 1-3 and Figure 8.

Figure 18 is a Conceptual Model of what is most likely happening on the upper Kidder Creek Alluvial Fan. This model is a compilation of the published data and interpretation of the WCRs. Pools 1-5 are at the Mountain Front where the gravels of the Kidder Creek Alluvial Fan deposits are the thinnest. The Scott Valley Fault is shown to be a groundwater dam or impediment which could cause the groundwater in the fractured rock in the Bedrock unit to upwell by hydraulic pressure along and just upstream side of the fault into the KCAF deposits. A similar situation occurs where Hat Creek in Shasta County crosses the Big Springs Fault just downstream of the Big Springs subdivision south of Old Station. Big Springs, with a flow of almost 400 gpm, comes close to doubling the flow of Hat Creek (CADWR 1984, pg 73-75). There is no doubt that Kidder Creek is the major source of recharge to the KCAF deposits and a significant source to portions of Scott Valley along the Kidder Creek fan. There is, however, evidence that in the

Project area, Kidder Creek is not in continual hydraulic connection with the groundwater table. Mack (1958) constructed his contours along the lower Kidder Creek fan perpendicular to Kidder Creek with occasional downstream curves which indicate mounding under the creek. This analysis found that was also the best fit of data and it would be incorrect to draw contour lines (red lines on Fig 5) that would include hydraulic connection to Kidder Creek.

Based on the data, except in high flow periods, Kidder Creek is not hydraulically connected to the water table. This situation does not preclude groundwater mounding beneath Kidder Creek as illustrated in the diagram to the right. This would mean that recharge is entirely controlled by the permeability, rate of streamflow, and wetted area and not by groundwater gradients. Unlike in the central part of Scott Valley, pumping, as little as there is in volume and rate, would have minimal to no impact on the flow of Kidder Creek.

Probable hydraulic conditions of the Upper Kidder Creek Alluvial fan. (Barlow 2012, Fig 5A,)

Well Interference

When the pump of a well is activated, the pump starts to remove water from the well. The water level will start dropping in the well creating a pressure difference which allows water to flow through the perforations into the well. This creates a cone of depression around the well. This cone of depression will continue to enlarge until a sufficient gradient is established which allows enough water to flow into the well to replace the water being extracted. When the gradient is sufficient and the water flowing into the well equals the water being extracted, the drawdown in the well stabilizes at that level and the cone of depression ceases to grow. Well # 001- Camp Well shows this occurring in the well when the pump test was performed.

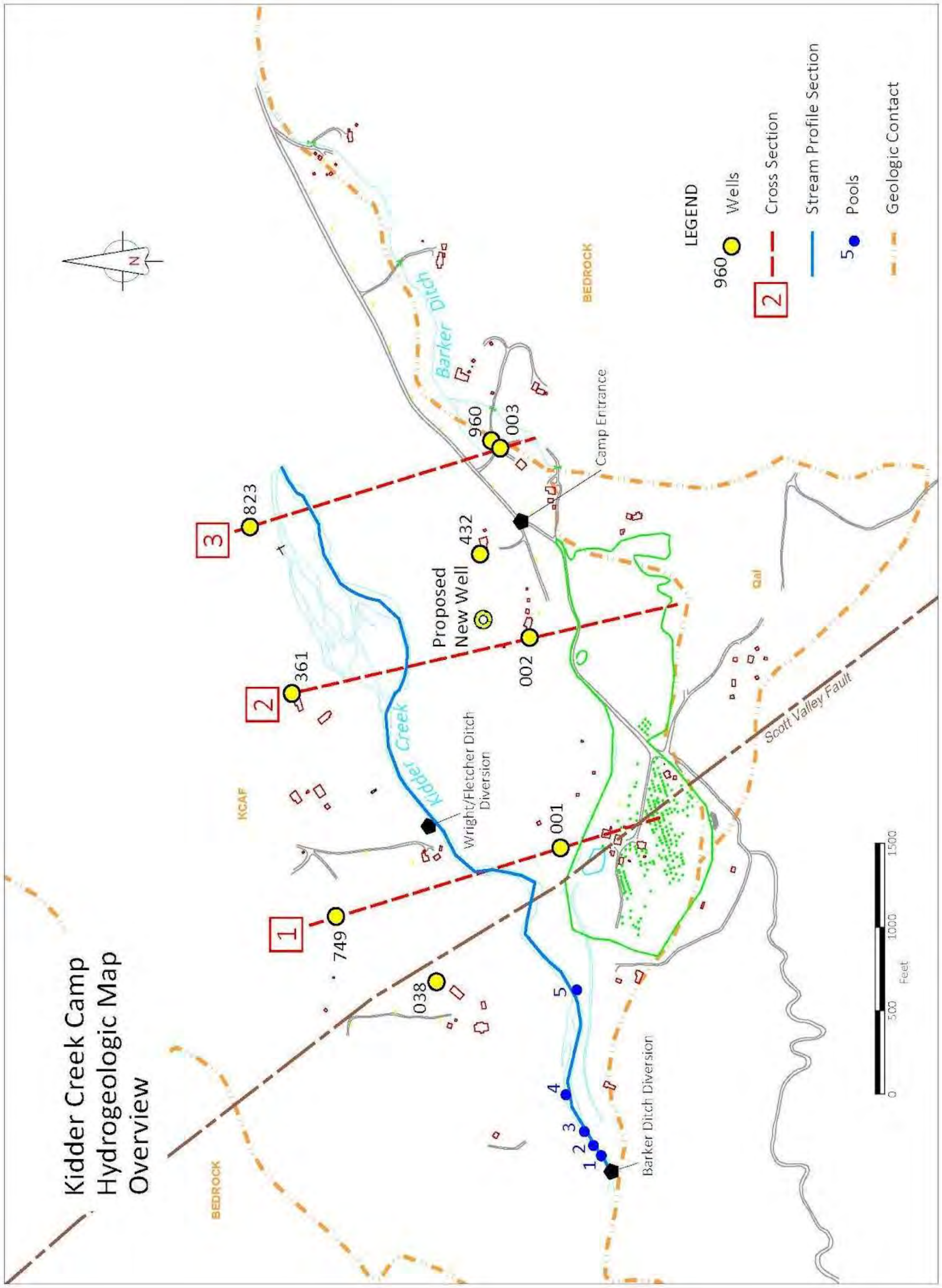


Figure 13 Hydrogeologic Overview Map of KCOC

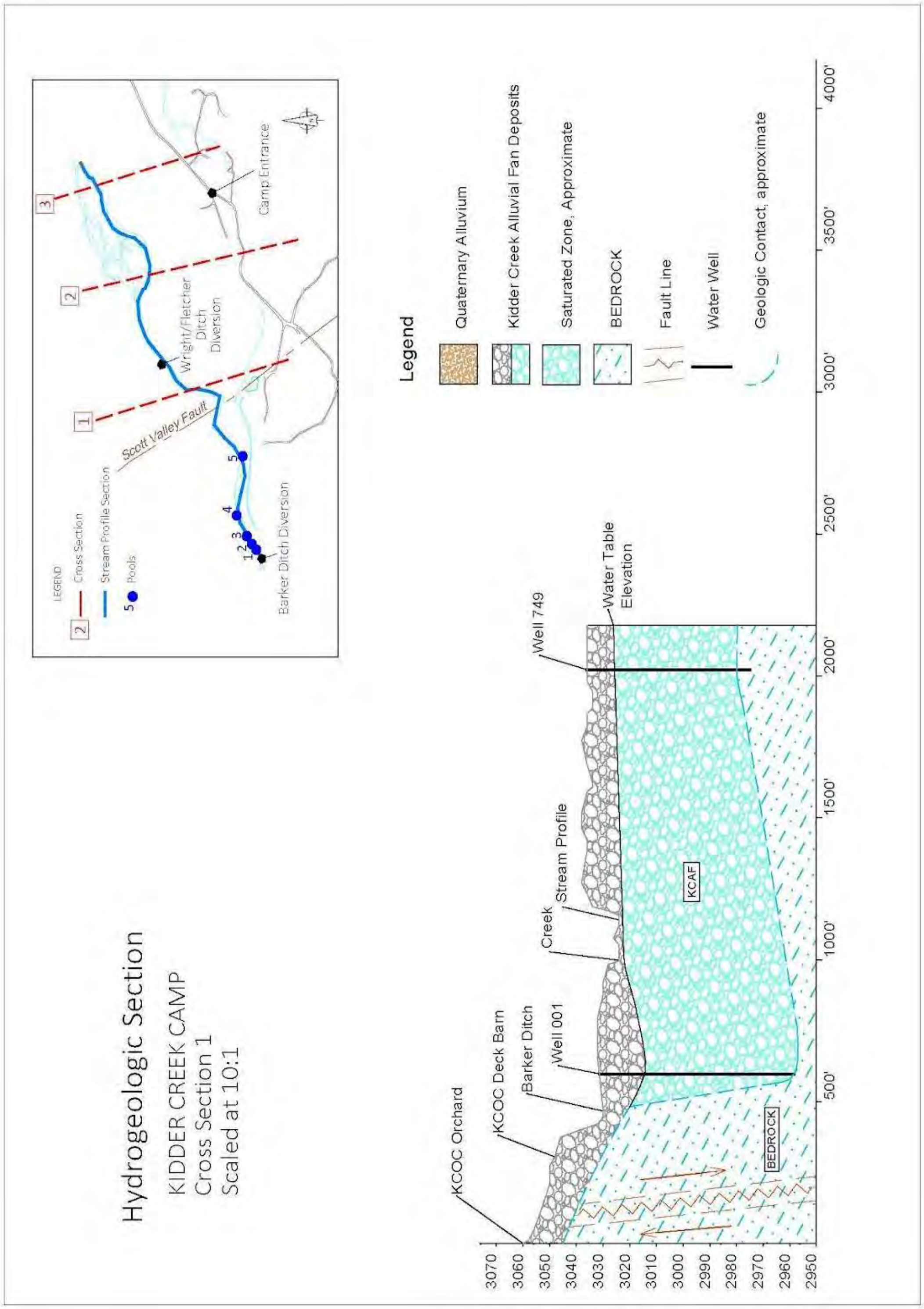


Figure 14 Cross Section 1

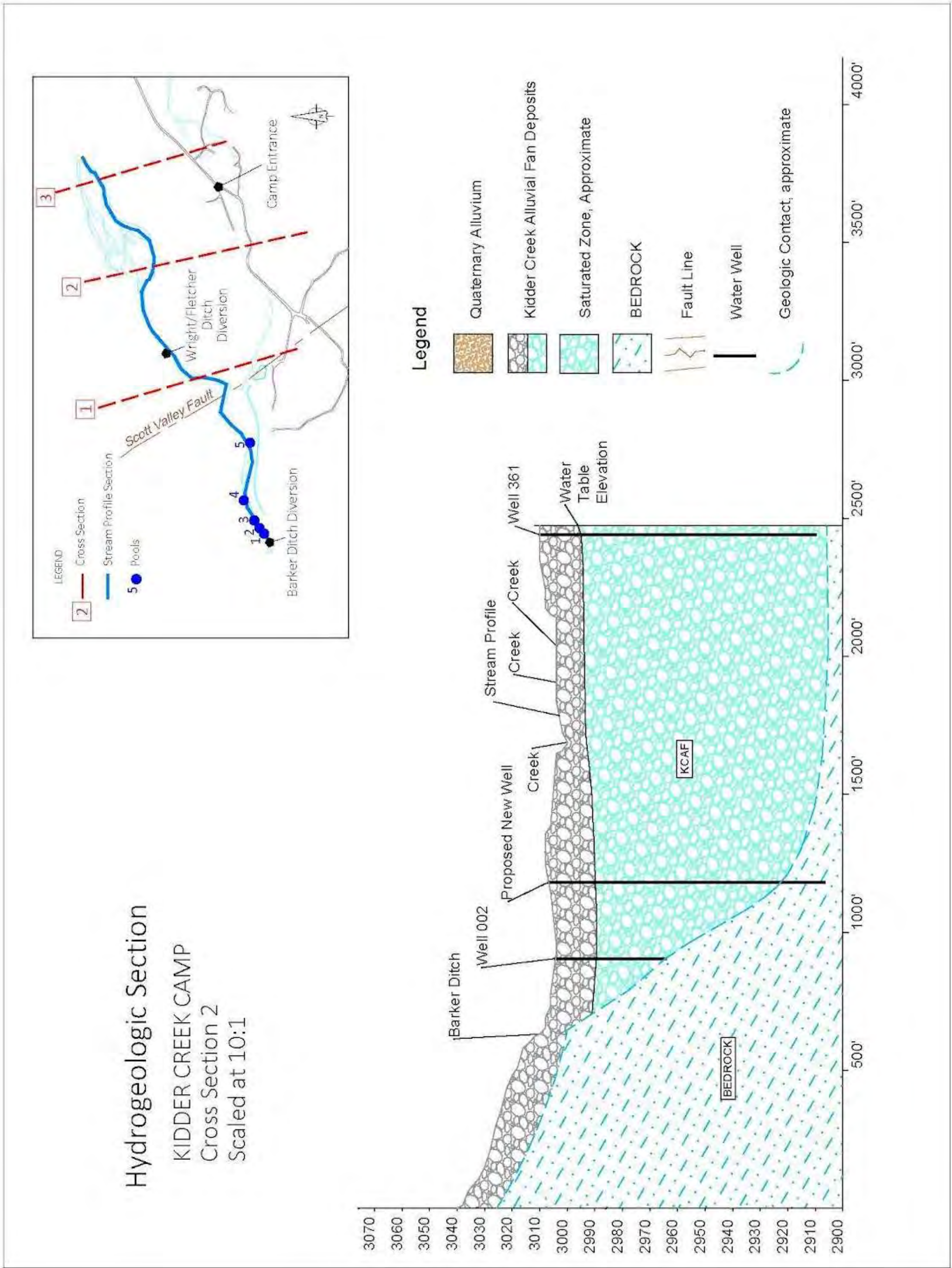


Figure 15 Cross Section 2

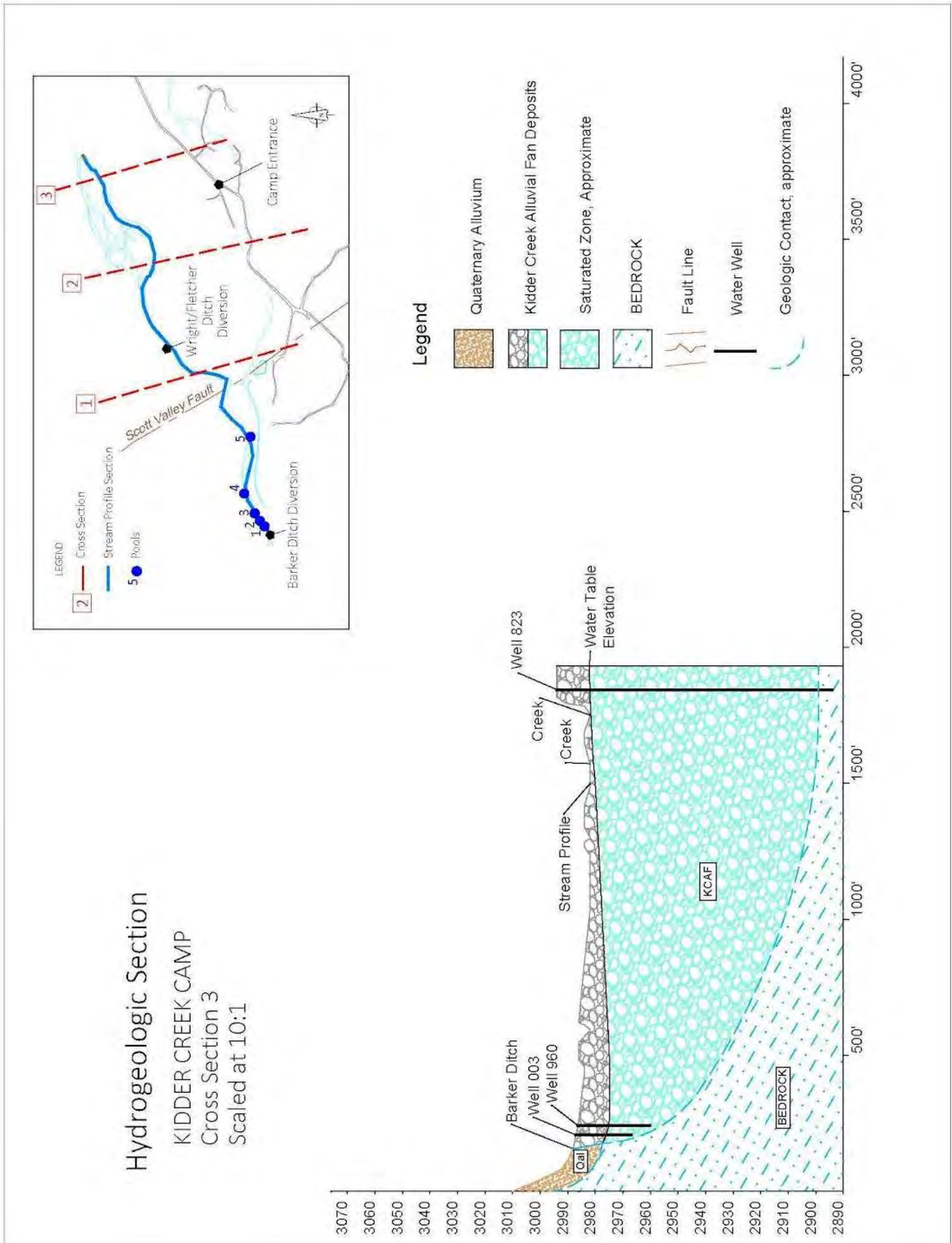


Figure 16 Cross Section 3

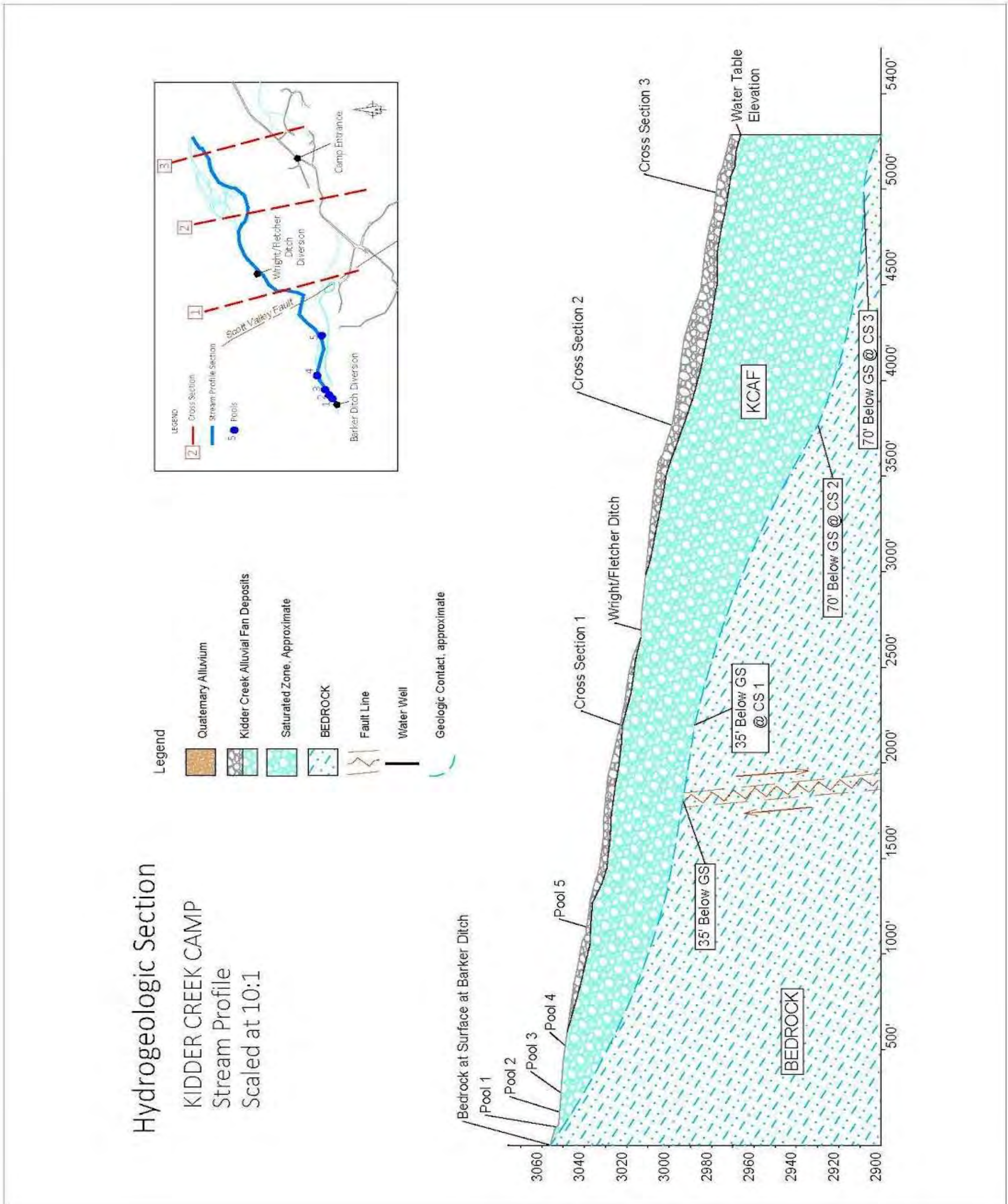
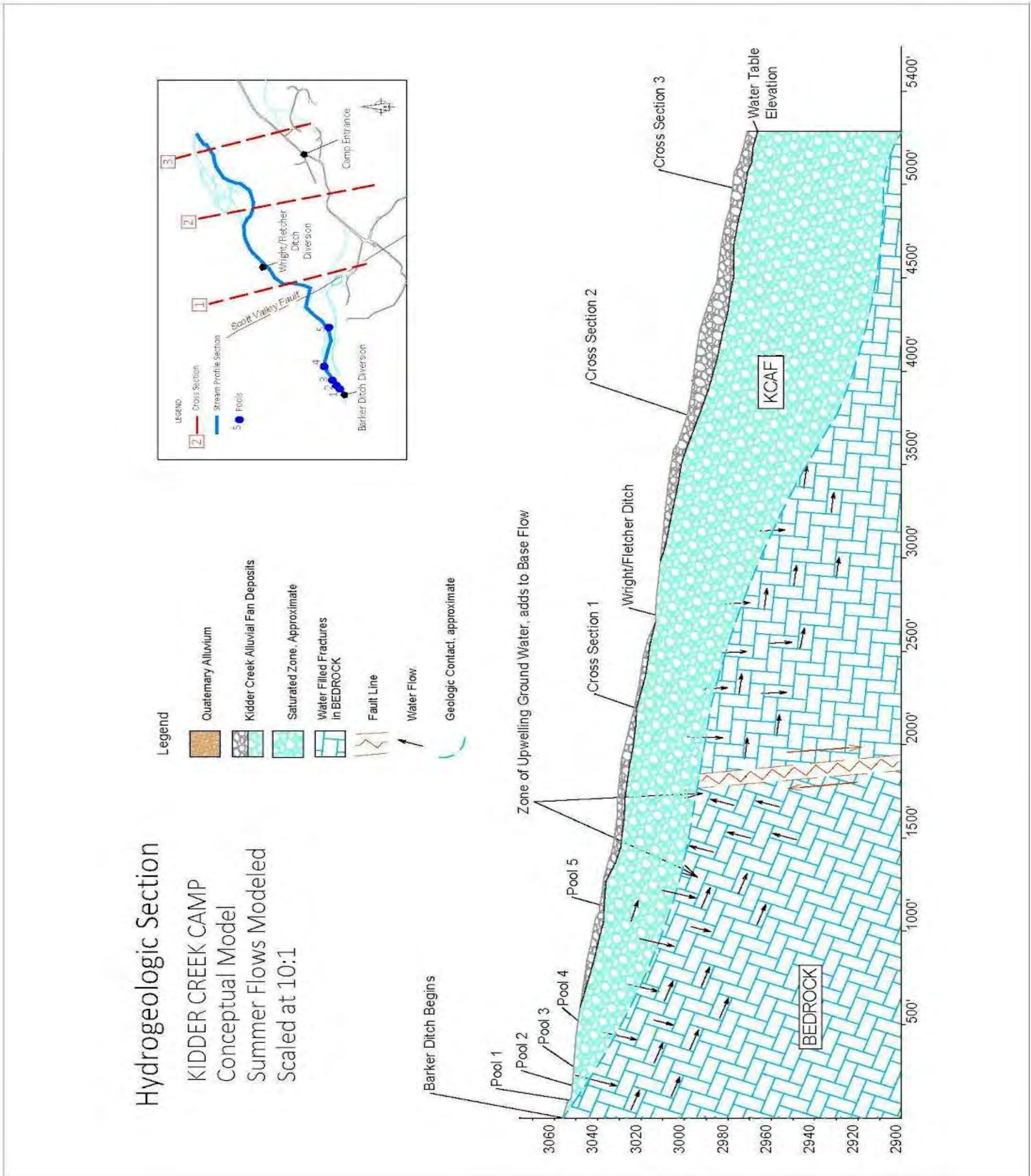


Figure 17 Stream Profile Cross Section



Hydrogeologic Section
KIDDER CREEK CAMP
Conceptual Model
Summer Flows Modeled
Scaled at 10:1
Legend
Quaternary Alluvium
Kidder Creek Alluvial Fan Deposits
Saturated Zone, Approximate
Water Filled Fractures in BEDROCK
Fault Line
Water Flow
Geologic Contact, approximate
Zone of Upwelling Ground Water, adds to Base Flow
Barker Ditch Begins
Pool 1
Pool 2
Pool 3
Pool 4
Pool 5
Cross Section 1
Wright/Fletcher Ditch
Cross Section 2
Cross Section 3
Water Table Elevation
KCAF
BEDROCK
3060
3040
3020
3000
2980
2960
2940
2920
2900
500'
1000'
1500'
2000'
2500'
3000'
3500'
4000'
4500'
5000'
5400'
Scott Valley Fault
Wright/Fletcher Ditch Diversion
Barker Ditch Diversion
Camp Entrance

The static groundwater level at the start of the test was at 25 feet below the measuring point. After 10 minutes of pumping at a rate between 15-28 gpm, the groundwater level stabilized at 62 feet below the measuring point (drawdown of 37 feet) for about the next two hours as did the pumping rate at about 21 gpm. After 10 minutes the cone of depression stopped expanding as there was sufficient groundwater level gradient to supply the approximately 21 gpm. Likewise, Well # 002, stabilized at 35 feet (20 feet of drawdown) after 1.5 hours of pumping at about 9 gpm. Well # 003 stabilized at something less than 20 feet (the total depth of the well) after 5 minutes, pumping at about 95 gpm.

There are several formulas available to calculate the radius of the cone of depression. These formulas generally depend on the following conditions to be true:

1. The water-bearing materials are of uniform permeability within the radius of influence of the well.
2. The aquifer is not stratified.
3. For a water table aquifer, the saturated thickness is constant before pumping starts; for a confined aquifer, the aquifer thickness is constant.
4. The pumping well is 100 percent efficient.
5. The pumping well penetrates to the bottom of the aquifer.
6. Neither the water table nor piezometric surface has any slope; both are horizontal surfaces.
7. Laminar flow exists throughout the aquifer and within the radius of the influence of the well.
8. The cone of depression has reached equilibrium so that both drawdown and radius of influence of the well do not change with continued time of pumping at a given rate.

While these conditions seem to be unattainable, the formulas usually produce reliable values for the use of determining drawdown impacts and water well design parameters. With time, the U.S. Geological Survey has developed a predictive tool that gives a reasonable approximation of radius of the cone of depression for planning purposes (Halford et.al. 2002). While this tool was developed for confined aquifers, if it is used with an unconfined system with a specific yield value for the storage coefficient, it does provide a reasonable approximation. Calculating for a confined aquifer will generally produce a greater radius for a cone of depression than using a higher level formula for an unconfined aquifer. Therefore, this predictive tool will produce a larger cone of depression than using the higher level formulas, providing a margin of error protection for the analysis.

There are three wells that had sufficient data to calculate hydraulic conductivity values (see Table 3). Given the K values it is possible to calculate, using the USGS predictive tool, a conservative distance from a well where the cone of depression ceases. The available pump-tests show that within an hour or two the cone of depression ceases to grow. The UCD modeling of the alluvial aquifer used a specific yield of about 5% or 0.05 for the Kidder Creek subwatershed (Foglia et.al. 2013 and Tolley et.al. 2019). Table 3 shows the data that was used in the Predictive Tool and the calculated radius of the cone of depression. While this Predictive Tool will calculate the cone of depression out to 10,000ths of a foot, for practical purposes and keeping within the accuracy of the data, it was assumed that “zero” was at about a tenth of a foot (the distance from the end of the big thumb to the first joint).

Wells #001 and 002 are characteristic of the cone of depressions for the area of KCOC and south of Kidder Creek and the Well # 823 gives a good approximation for the area north of Kidder Creek. South of Kidder Creek, the aquifer is shallower and has a lower hydraulic conductivity. North of Kidder Creek, the aquifer is thicker, and the wells are deeper, resulting in higher hydraulic conductivities.

These calculations of the cone of depression are very conservative for the following four reasons.

- First, The Predictive Tool calculates the radius of the cone of depression for 24-hours of continuous pumping. As mentioned earlier, two of the pump tests data showed that pumping equilibrium was reached after approximately 1 to 2 hours as the cone of depression stabilized and did not continue to expand.
- Second, is that Well # 823 was tested at 60 gpm and that was the value used in the Predictive tool. The parcel does not reveal a high water use and a pump rated at about 20 gpm was probably installed. The actual pumping rate would be closer to 20 gpm or less.
- Thirdly, based on the discussion on consumptive residential water use, these three wells consume less than 20 gpd per household. The water returning to the septic tank and percolating into the aquifer would reduce the size of the cone of depression by providing recharge.
- And the fourth point is that domestic wells do not run continuously like irrigation wells. Domestic wells pump water into a pressure tank and then cycle off until the pressure drops to a set level. When using the water for outside use, the pump can stay on for hours. But with just inside use, the pump cycles of and on at a rate depending on the use. During the non-pumping periods, the cone of depression is reducing in size as the aquifer reaches equilibrium.

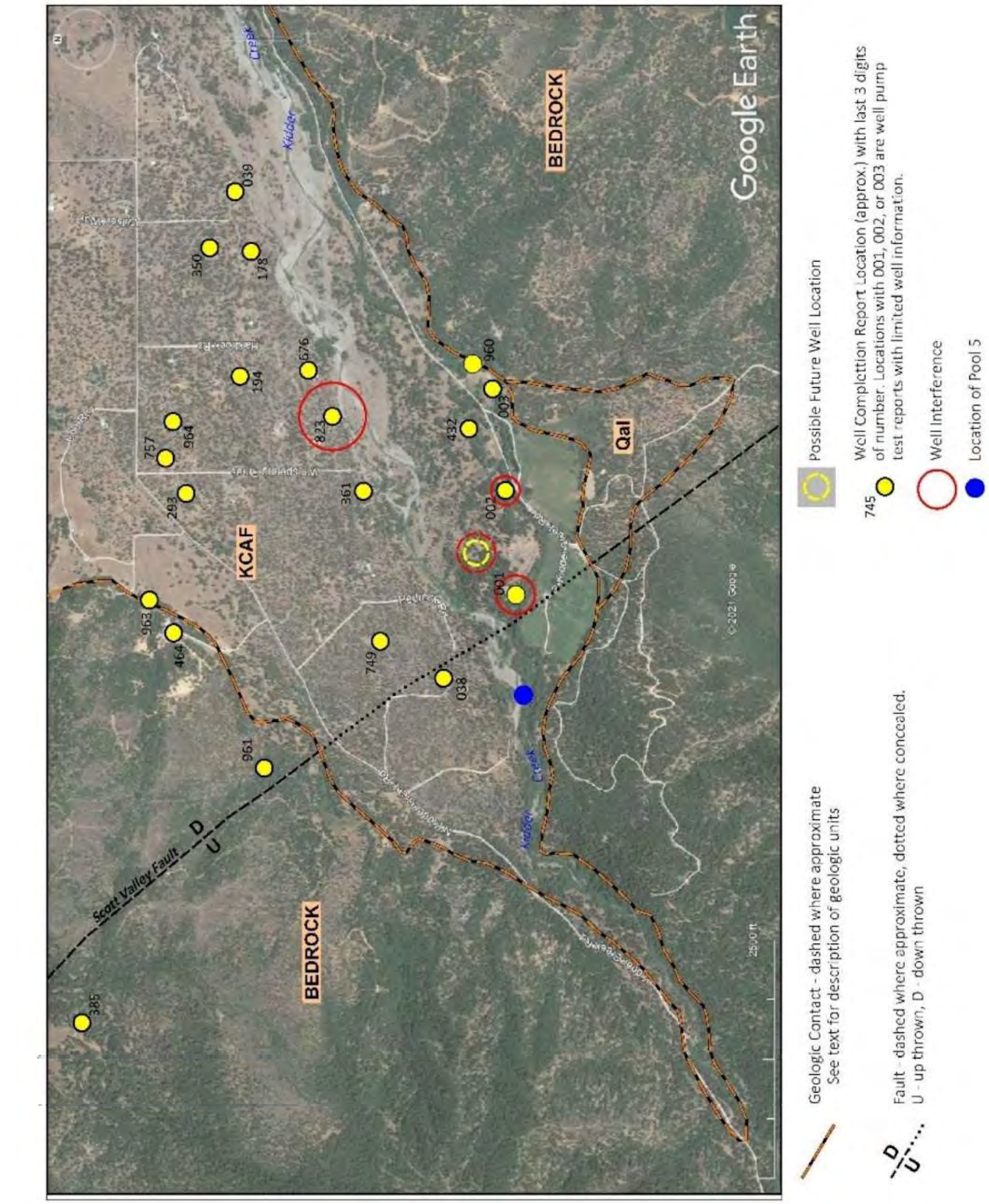
Table 3 Cone of Depression Radius Calculation

	Well # 001 – Camp Well		Well # 002		Well # 823	
Parameter	Equation	Graphical	Equation	Graphical	Equation	Graphical
Depth (ft)	73	73	40	40	95	95
Yield (gpm)	21	21	9	11	60	60
SWL (ft)	25	25	15	15	15	15
Drawdown (ft)	25	25	15	15	20	20
Aquifer Thickness (ft)	48	48	25	25	80	80
Storage Coefficient	0.05	0.05	0.05	0.05	0.05	0.05
K (feet/day)	2.5	3.4	4.8	5.9	7.5	10.1

Radius of Cone of Depression (ft)	200	200	150	150	350	350

These cones of depression radii were plotted on the area map to show the spatial relationship of the cones and the potential impact concerns (Figure 19). It cannot be stated enough that these calculations are very conservative for the reasons listed above and therefore, there is a significant safety factor in these calculations.

At a full occupancy of 844 occupants, approximately 37,980 gpd of water would be used during the summer months (ECORP Inc 2019). This is equal to about 26 gpm of groundwater extraction to meet this need (with 90% or 23 gpm returning to groundwater supply as little or no groundwater is used for outside watering). It is anticipated that another well yielding 20 gpm will be needed. Figure 19 shows a possible well location for this well and its cone of depression (based on calculation from Well # 001). With both wells performing cyclic pumping the cone of depression would be reduced. Since an estimated 23 gpm is returned to the groundwater supply, the net groundwater extracted from the aquifer is 3 gpm. This fundamental concept is important for understanding impacts and the groundwater – surface water interactions.


BEDROCK
KCAF
Qal
BEDROCK
Scott Valley Fault
D
U
385
961
963
464
749
038
001
002
003
960
432
361
293
757
964
194
823
676
350
178
039
Kidder Creek
Google Earth
Geologic Contact - dashed where approximate
See text for description of geologic units
Fault - dashed where approximate, dotted where concealed.
U - up thrown, D - down thrown
Possible Future Well Location
745
Well Completion Report Location (approx.) with last 3 digits of number. Locations with 001, 002, or 003 are well pump test reports with limited well information.
Well Interference
Location of Pool 5

Groundwater – Surface Water Interactions

The main concerns of Groundwater-Surface Water Interactions from this Project are potential impacts on the Coho Salmon Fish Pools, nearby domestic wells, and on downstream flows to the Scott River. The existing documentation and models did not consider the impact of domestic wells to be a significant impact to stream flow because of the low density of wells and their small amount of water extraction compared to irrigation wells (Papadopulos 2012, Barlow 2012, Foglia 2013, and Tolly 2019). To clarify, the characteristics of a domestic or residential well are:

- They have a well yield in the 5-30 gpm range.
- They use cyclic pumping to provide about 70 gpd per capita or a family of four using about 280 gpd
- In many parts of rural California, more than half of the water used (in this case outside water is part of the use) percolates back to the groundwater supply via the septic tank with the net effect of reducing the consumptive use of the groundwater supply.

The guiding document on stream-aquifer impacts (Barlow 2012) emphasized that the concern is with wells that yield about 700 gpm, located within 300-500 feet of the stream, and with hydraulic connection that could capture 33% of its yield from the stream. Barlow continues that once the well is 1,400 feet away from the stream, the stream depletion rates decline to zero at the stream. These conditions were used by UCD in their modeling efforts. In this analysis, the wells yield less than 3% of the well yields of Barlow's concern. Additionally, as stated previously most of the water extracted for domestic use returns to the groundwater supply in a short period of time (typically in 1-2 months), unlike applied irrigation water in Scott Valley where in 2016 about 3-6% percolated back into the groundwater supply (Personal Communication George Valente, DWR-NRO). These conditions alone make groundwater-surface water interactions not significant. Additionally, if Kidder Creek is not hydraulically connected to the aquifer, as has been posited here based on existing data, then the whole discussion of groundwater-stream water interactions becomes mute according to Barlow (2012). This is because no matter how much the groundwater table is drawn down by pumping, it doesn't change the amount of water leaving (induced recharge) or entering the stream (capture).

The following discussions focus on the potential impacts on the Coho Salmon Fish Pools, and nearby domestic wells, and on downstream flows to the Scott River.

Coho Salmon Fish Pools

There are eight pools of concern to the State and Federal fisheries agencies with pools 1-5 having the greatest concern. Sommarstrom and Tamer (2013) in their analysis of the pools posited concerning Pool #8 (which is upstream from the Wright/Fletcher Diversion Ditch) that it is the deepest pool in their study reach, and though the creek bed is dry for 1,550 feet below the flowing creek at Pool #4 on 10 September 2012, it retained water throughout the summer. They further posited that this pool might be maintained by seepage from the Barker Ditch or the KCOC's recreational pond. They noticed that there was also spring flow from the left bank and found that flow was continuous downstream to the Wright/Fletcher Diversion Ditch. There are three additional possibilities for the water in Pool #8. One being, as shown on Stream Profile Cross Section (Figure 17) the depth of the pool intersects the groundwater table. The second, is that Pool #8 is maintained by hyporheic flow. Hyporheic flow is the transport of surface water through sediments in the creek bed in flow paths that return to surface water. In a braided stream like Kidder Creek this is very likely. The third is that seepage from deep percolation of applied irrigation water and from the Qal is helping to maintain the pool.

All the pools of concern are up groundwater gradient from the proposed well. While this does not guarantee that groundwater extraction at KCOC cannot capture groundwater (Barlow 2012). The cone of depressions of the existing wells and the future well do not intercept any of the pools.

Additionally, the lowest recorded flow in Kidder Creek is 0.6 cfs (KCOC files) that was recorded in September 2016, a statewide average water year. At this flow the Pool #4 stayed hydrated and as the evapotranspiration in the upper watershed started to lower, Kidder Creek levels rose. As mentioned above, the net expected removal of water from the groundwater supply is about 3 gpm. Even if this total amount were subtracted from the flow of Kidder Creek (which current data and analysis shows it will not), it would reduce the 0.6 cfs (equivalent to 268 gpm) by 1.1%, which is not significant, in fact it isn't measurable with existing stream gauging equipment and it is within the measurement error with existing equipment.

Nearby Domestic Wells

Figure 21 also shows that the calculated cones of depressions do not intersect the existing wells of neighbors. This is consistent with the decision by the groundwater modelers to not consider domestic use in their models. Again, these calculations are conservative and assume the wells are pumping continuously for 24-hours and none of the extracted water returns to the groundwater supply. The impact on the neighbors is not significant.

Downstream Flows to the Scott River

As stated earlier, existing groundwater elevation maps show that about 1/3 of the subsurface flow of Kidder Creek flows down the Oro Fino Valley (Mack 1958, Foglia 2018). As Sommarstrom and Tamer (2013) stated "Natural flows during the low flow period will likely not be able to keep Kidder Creek connected through the alluvial fan reach below Barker Ditch to below Highway 3, due to natural geologic conditions and available water." This observation was first reported by the early settlers to the valley (Mack 1958) and unrefuted by all published documents on this matter. Therefore, the potential impacts to the Scott River fall into two time periods: Winter-Spring, and Summer-Fall.

During the Winter-Spring period, Kidder Creek is generally flowing (see Photo 1). In October 2016 the flow was about 30 cfs or about 13,000 gpm. Records from KCOC on late Spring flows show flows in the 40-50 cfs range (up to 22,000 gpm). Given these flows, extracting 3 gpm from the aquifer is not significant.

During the Summer-Fall period Kidder Creek ceases to flow below the Barker Ditch by late July. Therefore, any impact to the Scott River would be by reduction in subsurface flow that eventually surfaces in the high-water table area east of Highway 3. As stated earlier under Outflow, the aquifer's subsurface outflow is about 275 gpm or 0.62 cfs or with the groundwater extraction equaling about 1%. When considering only 2/3rds of the subsurface flow travels down Kidder Creek with the rest going down Oro Fino Valley, the impact to the high-water table east of Highway is about 2 gpm at most. Because the groundwater discharges in this zone and there are several irrigation wells in the area, the probability is very low that any of this reduction in flow would be evident in the Scott River. Given these data, the impact of the Project on the Scott River is not significant and below measurement capabilities.

Conclusions

The following conclusions are numbered for reference's sake, not in any order of priority or importance.

1. 21 published documents were identified that contain pertinent data useful to determining the impacts of the Project on the groundwater supply and to Kidder Creek.
2. There was universal acceptance that the aquifer system in Scott Valley consists of the Alluvial deposits and the Bedrock. Additionally, it is accepted that the Alluvial deposits are an unconfined aquifer. Earlier investigations considered the Bedrock non-water bearing. This current evaluation, using wells constructed since these earlier investigations, show WCRs that indicate that the Bedrock in its fractured zones is water bearing for domestic supply.
3. The Scott Valley Fault, previously referred to as the west side fault, has enough shearing that it could form a groundwater dam.
4. Kidder Creek from the Barker Ditch downstream is generally dry from late July to early October depending on when it starts raining in the Fall. There is a portion of Kidder Creek downstream from Highway 3 to Big Slough where the creek bed intersects the groundwater table.
5. There were 18 WCRs and 3 pump test reports tied to parcels that are representative of the aquifer characteristics.
6. The alluvial deposits, for this analysis have been named the Kidder Creek Alluvial Fan deposits. These deposits are up to 100 feet thick in the upper Kidder Creek Fan area and yield about 10-60 gpm and have a hydraulic conductivity ranging from 2.5-10 feet/day. The depth to water is about 15-30 feet.
7. Groundwater flows in the aquifer from the mountain front towards the Big Slough-Scott River area and also down Oro Fino Valley. The groundwater is generally 15-30 feet below ground surface, and contouring the groundwater level data indicates that Kidder Creek, in the Project area, is not hydraulically connected to the groundwater body. This means that the recharge to the groundwater supply from Kidder Creek is only limited by

the hydraulic head in the creek, the wetted area, and the hydraulic conductivity of the creek bed. A groundwater gradient to or from the creek bed does not exist. Given these hydrogeologic conditions, state of the art Stream Depletion equations do not apply, as no matter how much the groundwater table is drawn down by pumping, it doesn't change the amount or rate of groundwater recharge.

8. When looking at the impact of a domestic well on the groundwater supply, it is important to understand how the domestic well is different from other water uses of the aquifer. For the KCOC, the per capita water use is about 45 gpd. This is mostly because all outside water use is accomplished by surface water from the Barker Ditch. All water from the well that is used for washing, food preparation, and toilets is not consumptively used, it returns to the groundwater supply via the septic system. This means that about 40 gpd per capita (about 90%) ends up back into the groundwater supply which is a conservative estimate. The well drained soils and the shallow water table (about 20 feet) allows this water to reach the water table in less than a day or two. This return of non-consumed water is why the net extraction of a domestic well under these conditions is less than 3 gpm for a well that produces about 20 gpm.
9. All but one of the pools of concern for the Coho fishery are up groundwater gradient of the Project area.
10. Given the aquifer characteristics, using a USGS Predictive Tool, calculated that wells pumping on the KCOC property had a 150-200-foot radius for a cone of depression. This Predictive Tool assumes continuous pumping of the well. In actual operations, the well, along with all domestic use wells, pump on a cyclic pattern, which equates to a much smaller cone of depression or impact to the aquifer. This means that even if Kidder Creek was hydraulically connected to the groundwater table, the cone of depression would not impact the creek nor capture sufficient water to impact the fish pools or nearby adjacent wells.
11. The impact on Scott River flows is not significant. The 3 gpm of net groundwater extraction is about 1% of the 183-gpm subsurface flow down Kidder Creek calculated from the aquifer characteristics. This amount is immeasurable with current technology.
12. Given the above, the impacts for the Project are:
    a. Not significant on the fish pools along Kidder Creek,
    b. Not significant on nearby wells,
    c. Not significant for impacts to Scott River flow.

Potential Mitigation

The amount of net groundwater use is so small that mitigation is difficult to quantify. But there are two practices identified in the DEIR that when implemented will increase groundwater recharge and reduce consumptive use by vegetation. These include:

- Capture of run-off from buildings and hard surfaces and dissipate in permeable areas or incorporate permeable hard surfaces, for percolation to the water table. Given the well-drained soils in the area, dissipation by sheet flow onto adjacent soil surfaces would be effective. While hard surfaces (roofs, patios, and walkways) generally are thought of just producing run-off, they also remove the plants that capture and evapotranspirate water moving to the groundwater supply.

- Forest thinning and brush removal not only lowers the fire danger, it also lowers evapotranspiration of the vegetation. This allows more precipitation and run-off to percolate into the aquifer.

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