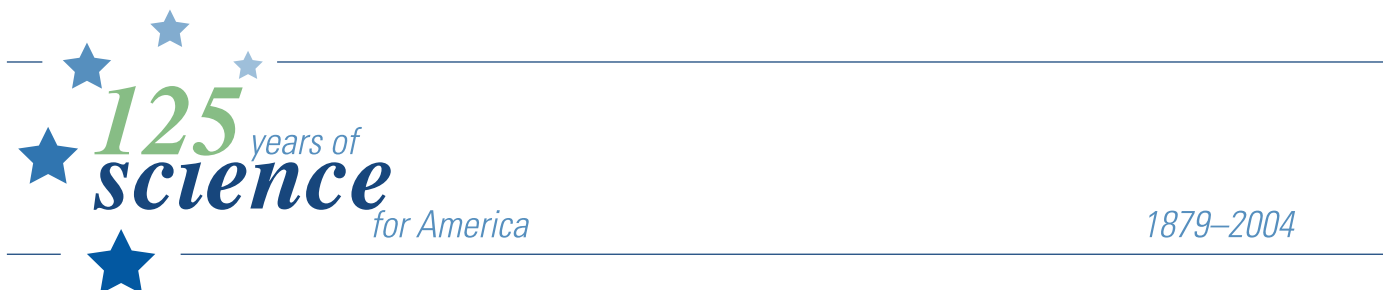




Hydraulic Conductivity of Near-Surface Alluvium in the Vicinity of Cattlemans Detention Basin, South Lake Tahoe, California

Open-File Report 2004-1201

Prepared in cooperation with the
EL DORADO COUNTY DEPARTMENT OF TRANSPORTATION,
TAHOE ENGINEERING UNIT and
CALIFORNIA TAHOE CONSERVANCY



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U.S. Department of the Interior
U.S. Geological Survey

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By Jena M. Green, Katherine K. Henkelman, *and* Rachel M. Caskey

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Carson City, Nevada
2004

U.S. DEPARTMENT OF THE INTERIOR
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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
acre	0.00405	square kilometer (km ²)
cubic foot (ft ³)	0.02832	cubic meter (m ³)
foot (ft)	0.3048	meter (m)
foot per day (ft/d)	0.3048	meter per day(m/d)
gallon (gal)	3.785	liter (L)
inch (in.)	25.4	millimeter
mile (mi)	1.609	kilometer
square mile (mi ²)	2.590	square kilometer

Temperature: Degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) by using the formula °F = [1.8(°C)]+32. Degrees Fahrenheit can be converted to degrees Celsius by using the formula °C = 0.556(°F-32).

Sea level: In this report, “sea level” refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929, formerly called “Sea-Level Datum of 1929”), which is derived from a general adjustment of the first-order leveling networks of the United States and Canada.

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Abstract

Cattlemans detention basin, South Lake Tahoe, California is designed to capture and reduce urban runoff and pollutants originating from developed areas before entering Cold Creek, which is tributary to Trout Creek and to Lake Tahoe. The effectiveness of the basin in reducing sediment and nutrient loads currently is being assessed with a five-year study. Hydraulic conductivity of the alluvium near the detention basin is needed to estimate ground-water flow and subsurface nutrient transport. Hydraulic conductivity was estimated using slug tests in 27 monitoring wells that surround the detention basin. For each test, water was poured rapidly into a well, changes in water-level were monitored, and the observed changes were analyzed using the Bouwer and Rice method. Each well was tested one to four times. A total of 24 wells were tested more than once. Of the 24 wells, the differences among the tests were within 10 percent of the average. Estimated hydraulic conductivities of basin alluvium range from 0.5 to 70 feet per day with an average of 17.8 feet per day. This range is consistent with the sandy alluvial deposits observed in the area of Cattlemans detention basin.

Introduction

Detention basins have been constructed in South Lake Tahoe, California to reduce the effects of urban runoff (fig. 1). Urban runoff is a concern in the Lake Tahoe basin because nutrients associated with urban runoff can decrease

the clarity of Lake Tahoe. Detention basins should reduce nutrient loads to Lake Tahoe by settling suspended solids and filtering runoff through alluvium. The amount of nutrient reduction from detention basins in South Lake Tahoe is unknown.

Cattlemans detention basin project began in November 2000 and is a cooperative study between the U.S. Geological Survey, the El Dorado County Department of Transportation, Tahoe Engineering Unit, and the California Tahoe Conservancy. The purpose of this five-year study is to determine whether the capture of urban runoff into Cattlemans detention basin reduces nutrients and sediments entering nearby Cold Creek, which is tributary to Lake Tahoe. Cattlemans detention basin is the focus of the 7-acre study area and is located in South Lake Tahoe, California (fig. 2).

Hydraulic conductivity of the alluvium in the vicinity of Cattlemans detention basin was estimated using slug tests so that ground-water velocities could be assessed. Ground-water flow direction and velocities around the detention basin affect dissolved nitrate concentrations of runoff filtering through alluvium. Ground-water flow in the study area must be quantified to evaluate how nutrient loads to Cold Creek and Lake Tahoe are affected by Cattlemans detention basin.

Purpose and Scope

Techniques and methods used to calculate the approximate hydraulic conductivity of the alluvium near Cattlemans detention basin, South Lake Tahoe, California are described in this report. A brief description of Cattlemans detention basin and geology of the area is provided, as well as a detailed discussion of how hydraulic conductivity was approximated for each monitoring well. The distribution of hydraulic conductivity near the detention basin also is reported.

2 Hydraulic Conductivity of Near-Surface Sediments in the Vicinity of Cattlemans Detention Basin, South Lake Tahoe, Calif.

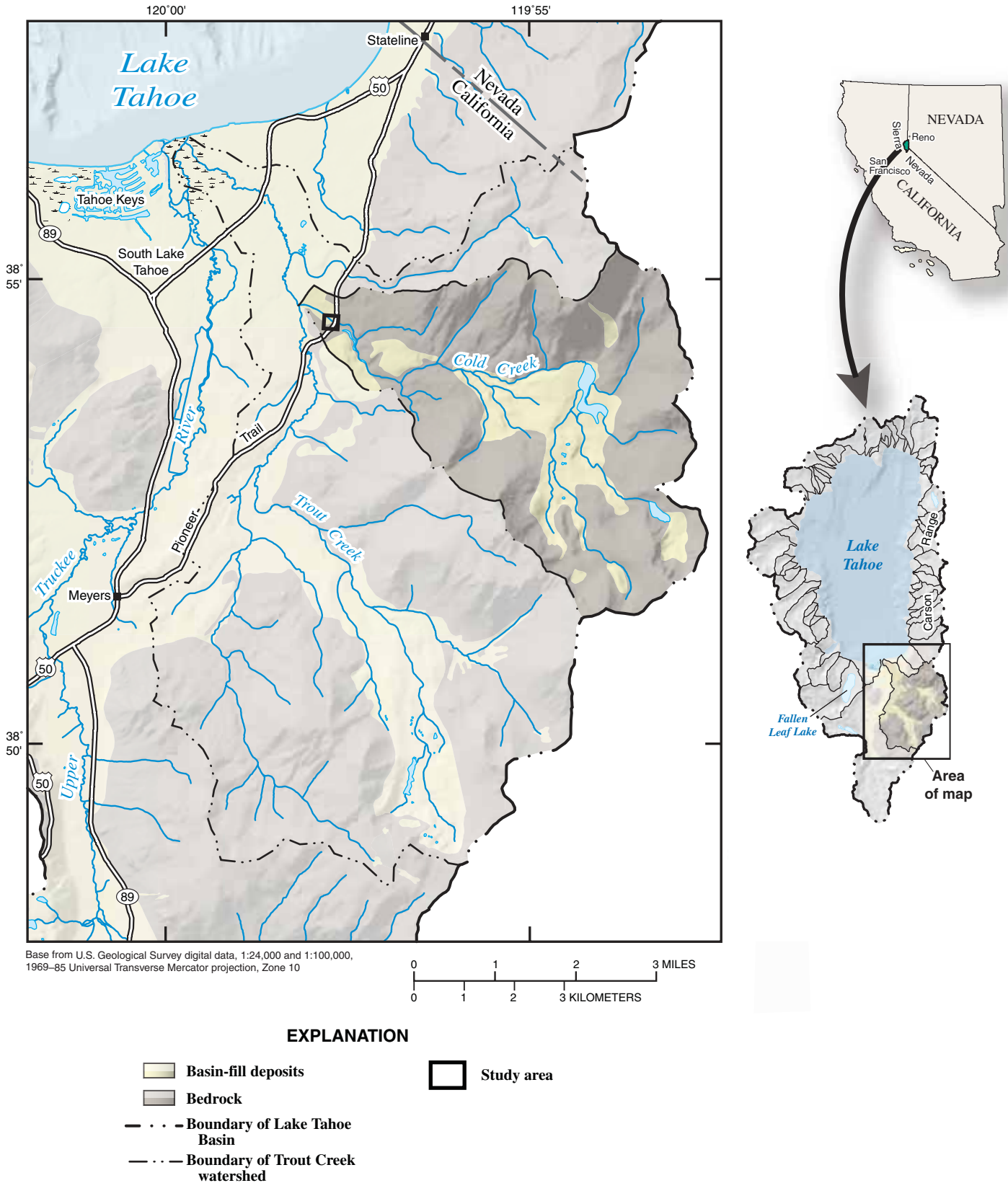


Figure 1. Location of Cattlemans detention basin with respect to Lake Tahoe and California.

Acknowledgments

The authors acknowledge employees from the El Dorado County Department of Transportation, Tahoe Engineering Unit who participated in this study. Clayton Chappell and Janell Gifford from the Tahoe Engineering Unit and Kim Carr from the California Tahoe Conservancy were instrumental in developing the work plan and for securing funding for this study. The authors would also like to thank David E. Prudic and James L. Wood for their dedicated assistance during all stages of this study.

Description of Cattleman's Detention Basin

Cattleman's detention basin is constructed on a meadow-like flat plain that is bordered to the east by Pioneer Trail and to the north and west by Cold Creek (fig. 2). A residential area is located at the south border. Access to the basin is located at the Cattleman's Court cul-de-sac.

Construction of Cattleman's detention basin began in August 2001 and was completed by October 2001. It is designed to hold a total volume of 22,000 ft³ of water without surface discharge. Large boulders and concrete were used in constructing a spillway on the west side of the detention basin to allow discharge when the capacity of the basin is exceeded. Flow over the spillway enters the adjacent meadow, which is restrained by bundled straw, or a biolog, to prevent overflow from the basin from directly entering Cold Creek (fig. 2).

A series of 30 shallow monitoring wells were installed at land surface around the detention basin to aid in determining whether nutrients are transported away from the detention basin by ground water (fig. 2). Wells were placed to the east and south of the basin where land-surface elevation was higher, and between Cold Creek and the basin, as well as in the meadow west of the spillway where land-surface elevation was lower. Data collected from the wells were used to estimate the direction and rate of ground-water flow from the detention basin to Cold Creek, and to evaluate changes in chemistry.

Geology of Lake Tahoe and the detention basin

Lake Tahoe was formed as a result of horst and graben faulting sometime between 7.4 and 2.6 million years ago (Ma) after andesitic volcanism and deformation (Gardner and others, 2000). An irregular oval in shape, Lake Tahoe stretches nearly 22 mi from north to south and 12 mi from west to east (Crippen and Pavelka, 1972). Ranked as the twelfth deepest lake in the world, Lake Tahoe is one of the largest lakes in the United States (Gardner and others, 2000). The lake has an average depth of 1,000 ft (greatest depth is 1,645 ft) and a total surface area of 191 mi². The Nevada-California state line passes through the lake; about 57 mi² of the lake is in Nevada and 134 mi² is in California (Crippen and Pavelka, 1972).

Granitic rocks (mainly granodiorite) underlie much of the lake and the adjacent uplands. Andesitic volcanic rocks cover much of the northern and northwestern areas of the Lake Tahoe basin, whereas granitic rocks are covered by Quaternary glacial and alluvial deposits on the southwestern and southern end (Gardner and others, 2000).

At the site of Cattleman's detention basin, just above the confluence of Trout and Cold Creeks, alluvium covers the granitic rocks. The alluvial deposits primarily are floodplain sediments composed of silt and sand, and stream channel sediments composed of sand and gravel with locally interbedded lacustrine silt and clay (Harrill, 1977). The alluvium ranges from 10 to 20-ft thick near the mountains (including the study area) and as much as 500 ft thick near Lake Tahoe. Prior to the detention basin construction, 4 to 5 ft of fill was placed on top of the meadow in the study area during construction of the residential area. However, a large part of the fill was removed during the construction of the detention basin. It is characterized as a red-brown loamy sand with some gravel and scarce cobbles. The fill overlies a layer of dark gray (nearly black) organic-rich soil containing decomposing plant material. Due to the high organic content, this thin layer most likely was once the old meadow surface.

Below the highly organic layer is a medium to dark gray organic silt and sand with stringers of coarse sand and fine gravel. Generally, the thickness of these deposits range from 5 to 8 ft. Mica flakes are common in the silt and sand. Roots of the meadow grasses are common to a depth of one foot and sporadic decomposing wood pieces are found throughout the deposit.

The third layer in the detention basin area is a brown to yellow-brown sand and gravel. Although the thickness of this layer is unknown, it is found below the organic sandy silt layer. The yellow-brown color is the result of oxidation of iron. Granitic rock underlies the sand and gravel layer and was found when drilling well cc2 at a depth of about 6 ft below land surface. A cross section of the detention basin is shown in figure 3.

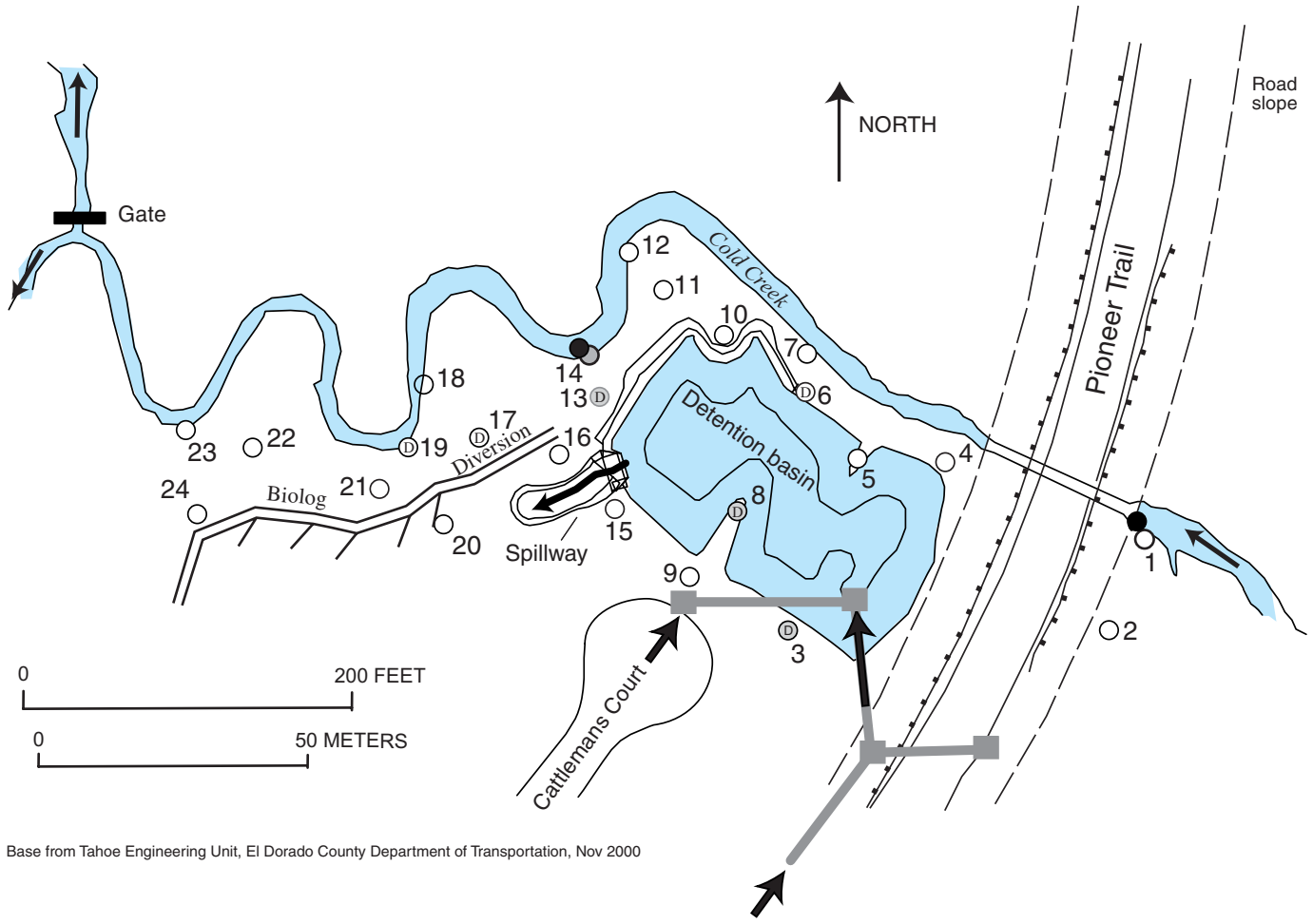
Estimates of Hydraulic Conductivity

Well Construction

A series of monitoring wells were installed in the vicinity of Cattleman's detention basin in November and December 2000. A total of 30 wells were installed prior to the actual construction of the detention basin. The purpose of the wells was to determine the depth of ground water, the direction of flow, the distribution of hydraulic conductivity, and ground-water chemistry prior to and after construction of the detention basin.

Wells located in the area of the fill (well sites cc3–cc6, cc8–cc10, cc13, and cc15; table 1 and fig. 2) were installed in boreholes drilled to depths of 9 to 10 ft using a trailer mounted hollow-stem auger. These wells were completed in the gray silt and sand. Deeper wells (depths of 15 ft) were installed adjacent

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Base from Tahoe Engineering Unit, El Dorado County Department of Transportation, Nov 2000

EXPLANATION

- Ground-water level recorder
- Surfacewater level recorder
- ➔ Surfacewater flow direction
- ▬ Stormwater drain
- 9○ Shallow monitoring well (D includes an adjacent deep well)
Number is abbreviated well identification

Figure 2. Cattlemans detention basin in relation to Cold Creek, Pioneer Trail, and Cattlemans Court, South Lake Tahoe, California. Well identification numbers are abbreviated by omitting the “cc” designation preceding each number.

to the shallow wells at well sites cc3, cc6, cc8, and cc13 (table 1 and fig. 2). Wells located in areas not covered by fill (in the meadow and next to stream) were installed in boreholes augered by hand (cc1–cc2, cc7, cc11–cc12, cc14, and cc16–cc24; table 1 and fig. 2). Most of the wells were installed in boreholes augered to depths of 5 to 7 ft and a diameter of 4.5 in. Depth to ground water during installation ranged from 2 to 5 ft. Deeper wells (depths of 10 to 11 ft) were installed adjacent to the shallow wells at well sites cc17 and cc19. In this report, a shallow well adjacent to the deeper well at a well site is designated by an S following the well site number (for example; well cc3S,

table 1) and the deeper well is designated by a D following the well site number (for example; well cc3D, table 1). The purpose of the deeper wells was to determine whether ground-water flow or chemistry changed with depth.

All wells, except well cc2 and cc19D, consisted of nominal 2-in. schedule 40 PVC (polyvinyl chloride) pipe. Openings were cut into the pipe from 0.5 and 1.5 ft from the bottom at a width of 0.020 in. to form a screened interval in the well. Stainless steel rivets were used to secure a cap to the bottom of the pipe. A 5-ft section of flush threaded PVC was added to wells that were deeper than 10 ft. The joint was sealed with a Teflon

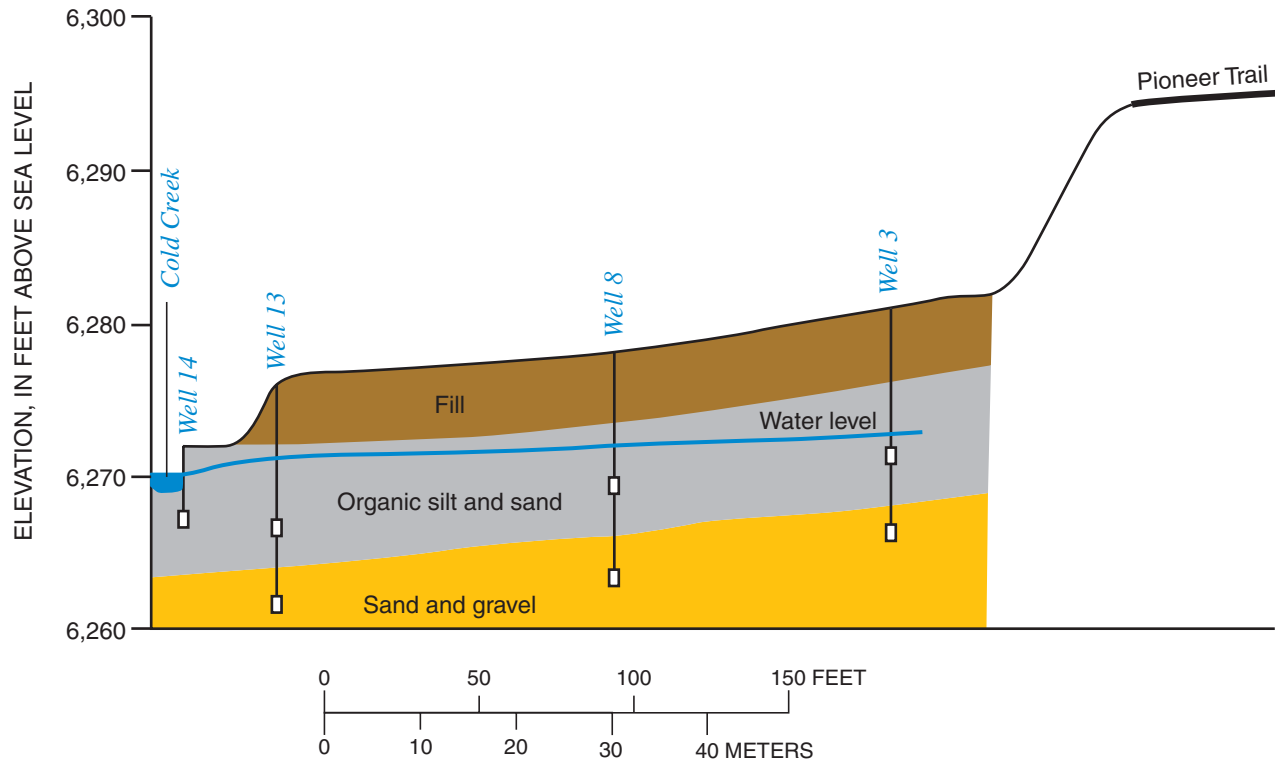


Figure 3. Distribution of alluvial deposits and fill materials between well 3 and well 14 at Cattlemans detention basin, South Lake Tahoe, California. Well identification numbers are abbreviated by omitting the “cc” designation preceding each number.

O-ring. Any excess casing that extended above land surface was cut off. Two wells, cc2 and cc19D, consisted of nominal 1-in. schedule 40 PVC pipe. This pipe had the same openings as the nominal 2-in. PVC pipe and was used in places where a smaller diameter auger bucket was needed to reach the desired depth.

All 2-in. monitoring wells were topped with a tightly sealed cap composed of two O-rings in order to prevent inflow of surface runoff into the well. Each cap is lockable. The two 1-in. diameter wells also were capped, but a rubber gasket was used to seal the top of the casing instead. Table 1 summarizes the construction information of all 30 monitoring wells installed in the area of the detention basin.

The annular space around each well casing was backfilled using a variety of material (fig. 4) beginning with very coarse silica sand (0.04 to 0.08 in.) that was placed around and slightly above the screen (0.5 to 1 ft). Silica flour, 1 to 3-ft thick, was placed on top of the silica sand and was designed to restrict vertical flow in the borehole. Although a bentonite grout typically is used to restrict vertical flow, silica flour was used instead to eliminate possible reactions of the sodium-rich bentonite with the ground water. The native material that initially was removed from the borehole was added until it reached approximately 2 ft from the land surface. Neat cement was poured in the top 2 ft and around the well cap to form a surface-seal for the borehole.

Method

Slug tests were done in a similar manner on 27 of the 30 monitoring wells. Usually, slug tests were repeated more than once on each well. Three wells (cc17S, cc17D, and cc2) were not tested. Prior to the start of a slug test, the depth to water was measured and recorded using either a steel or electric tape. In several wells, about 1 gal of water was pumped from the well, and the water level was allowed to recover to its static level. Once the water level recovered to its static level, a recording pressure transducer (Global Water Instrumentation Inc. WL15-003) that has a range from 0 to 3 ft was lowered and secured 1 ft below the water level. Continuous pressure readings were made until they had stabilized. After the pressure readings stabilized, the transducer was set to record every 1 to 2 seconds.

Each test consisted of rapidly pouring 0.079 to 0.26 gal of water from a graduated cylinder into the well (usually within 1 to 2 seconds) to imitate an instantaneous slug of water. This volume was sufficient to raise the water level in the well 1 to 2 ft. The time of each test was recorded. For most wells, either deionized water or water that had been previously pumped from the well was used for the tests. Water from Cold Creek was used in wells adjacent to Cold Creek. Water levels were measured using either a steel or electric tape after approximately one minute. If the water had not returned to its static level, a measurement was taken every 1 to 2 minutes thereafter until it had

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Table 1. Well name, land-surface elevation, and construction data for 30 monitoring wells in vicinity of Cattleman's detention basin, South Lake Tahoe, California

Well name	Standard identification number	Land- surface elevation ¹ (feet)	Depth (feet below land surface)		
			Bottom of well	Screened interval	
				Top	Bottom
cc1	385432119574001	6278.84	5.6	4.1	5.1
cc2	385432119574002	6281.57	6.8	5.3	6.3
cc3S	385432119574301	6281.23	10.2	8.7	9.7
cc3D	385432119574302	6281.21	15.1	13.6	14.6
cc4	385433119574201	6279.12	10.2	8.7	9.7
cc5	385433119574202	6278.03	10.2	8.7	9.7
cc6S	385433119574301	6277.37	9.0	7.5	8.5
cc6D	385433119574302	6277.40	15.0	13.5	14.5
cc7	385433119574203	6273.29	5.0	3.5	4.5
cc8S	385432119574303	6278.13	9.2	7.7	8.7
cc8D	385432119574304	6278.15	15.0	13.5	14.5
cc9	385432119574305	6279.30	9.9	8.4	9.4
cc10	385433119574303	6276.39	10.2	8.7	9.7
cc11	385434119574401	6272.83	5.6	4.1	4.6
cc12	385434119574402	6272.64	5.1	3.6	4.6
cc13S	385433119574401	6275.14	10.2	8.7	9.7
cc13D	385433119574402	6275.69	15.2	13.7	14.7
cc14	385433119574403	6272.60	5.5	4.0	5.0
cc15	385432119574401	6278.33	10.2	8.7	9.7
cc16	385433119574404	6273.47	7.2	5.7	6.7
cc17S	385433119574501	6272.71	6.7	5.2	6.2
cc17D	385433119574502	6272.82	10.6	9.1	10.1
cc18	385433119574503	6271.93	5.1	3.6	4.6
cc19S	385433119574504	6272.19	5.6	4.1	5.1
cc19D	385433119574505	6272.11	10.0	8.5	9.5
cc20	385432119574501	6272.77	7.2	5.7	6.7
cc21	385432119574601	6272.19	5.0	3.5	4.5
cc22	385433119574701	6271.94	5.6	4.1	5.1
cc23	385433119574702	6271.08	5.4	3.9	4.9
cc24	385432119574701	6271.97	5.5	4.0	5.0

¹Land-surface elevation referenced to pin set by El Dorado County Department of Transportation at end of Cattleman's Court cul-de-sac. Elevation referenced to NAVD of 1988.

Results

Slug tests were analyzed with Bouwer and Rice (1976) in a spreadsheet (Halford and Kuniansky, 2002). Pressure data from each slug test was imported directly into the spreadsheet. Other required information for analysis of each slug test includes well construction information (listed in table 1), the static water level, and the volume of water poured into the well. Estimates of the hydraulic conductivity from slug tests of the 27 wells are summarized in table 2 and shown in the appendix. The appendix summarizes information regarding well construction, static water level, the slug displacement, and estimated hydraulic conductivity, and includes the comparison of the fitted line to measurements recorded by the pressure transducer.

Estimates of hydraulic conductivity are reported only to the nearest significant figure (0.1, 1, and 10) because errors in the estimates of hydraulic conductivity were found to range from 10 to 25 percent (Bouwer and Rice, 1976). However, a more recent analysis indicates errors ranging from 10 to 100 percent (Brown and others, 1995). Furthermore, the Bouwer and Rice method tends to underestimate the hydraulic conductivity (Brown and others, 1995). Pouring water as quickly as possible down the well is not instantaneous as the method assumes. A percentage of the volume of water leaked through the screen and into the alluvium as it was poured into the well. Thus, for slug tests having estimated hydraulic conductivities exceeding a few feet per day, the effective volume of water used in the computation of y_0 was always less than the actual volume poured into the well. The discrepancy between the effective volume and the actual volume was greater with increased hydraulic conductivity. The largest discrepancies were recorded in wells that had estimated hydraulic conductivities that exceeded 10 ft/d. The time it took to pour water into the well generally was less than 4 seconds. For the well with the highest estimated hydraulic conductivity (well cc6S), the estimated rise in water level at time zero should have been 1.45 ft assuming that 0.238 gal of water was poured instantly into the well. The estimated hydraulic conductivity was no different when the rise of 1.45 ft was assumed at time zero and the next water level measurement was made at 4 seconds. Assuming the time of the next measurement was 3 seconds instead of 4 seconds, the hydraulic conductivity would increase by 10 ft/d and the error would be 15 percent.

The slug test results from well cc2 are not included in the overall analysis of Cattleman's detention basin. This is because well cc2 is located at a higher elevation than the other wells and the static water level was within the screened interval of the well. When water was poured into the well, it also had to fill the gravel pack surrounding the well above the initial water level. There is no correction within the Bouwer and Rice analysis that corrects for this situation and therefore these tests were not included in the analysis.

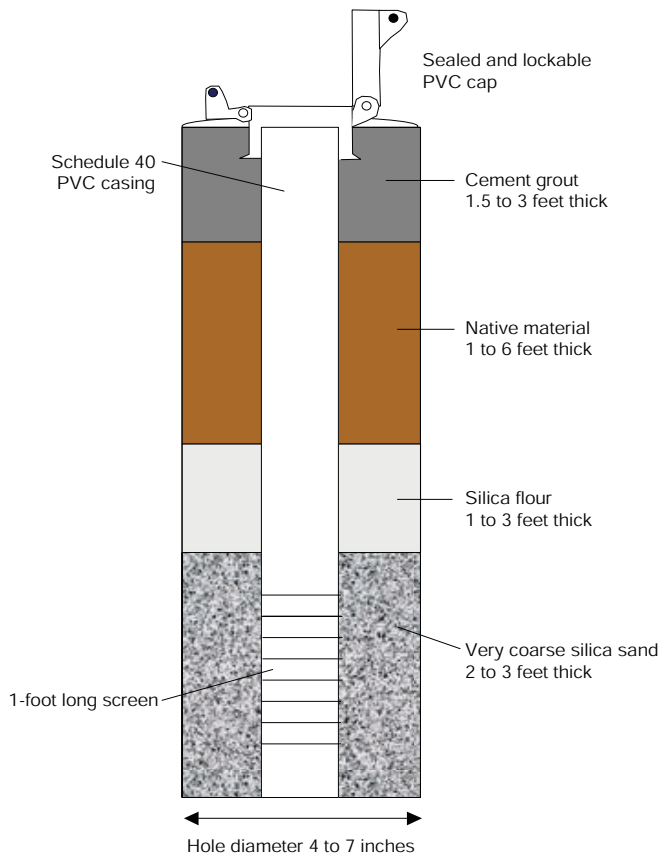


Figure 4. Construction of wells near Cattleman's detention basin, South Lake Tahoe, California.

returned to within 0.02 ft. The time of the water level's recovery was documented. This process was repeated until the determined number of slug tests was completed on each well.

Data from the pressure transducers were downloaded from a Personal Digital Assistant (PDA; Palm Inc., Model m105 Handheld) to an on-site laptop computer using Windows XP and plotted on an x-y graph to view the quality of the pressure data. This was done to insure that the pressure transducer was recording pressure every 1 to 2 seconds and that the pressure transducer had not accidentally slipped from its secured position. In some instances, supplemental tests were done because the pressure transducer had not been correctly set or because it had inadvertently slipped.

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Table 2. Results of slug tests in wells near Cattlemans detention basin, South Lake Tahoe, California

Well name	Date of test	Initial water level elevation ¹ (feet)	Average displacement ² (feet)	Estimated hydraulic conductivity (feet per day)	Number of slug tests
cc1	11/06/03	6275.85	1.57	1	2
cc3S	11/06/03	6272.43	1.45	2	3
cc3D	11/06/03	6272.45	1.22	10	3
cc4	11/06/03	6273.47	1.21	10	3
cc5	11/06/03	6272.33	1.19	20	3
cc6S	11/06/03	6271.5	1.02	70	4
cc6D	11/06/03	6271.53	1.05	30	3
cc7	11/06/03	6271.68	1.13	10	3
cc8S	05/27/03	6274.44	1.28	10	2
cc8D	05/27/03	6274.32	1.02	20	3
cc9	06/10/03	6272.95	0.89	40	3
	10/30/03	6271.68			
cc10	06/09/03	6272.05	0.95	30	3
cc11	10/30/03	6270.46	1.08	2	6
cc12	06/10/03	6271.72	0.96	20	3
cc13S	05/27/03	6272.34	0.93	20	5
cc13D	05/27/03	6271.81	1.11	10	3
cc14	05/27/03	6270.91	0.88	20	3
cc15	10/30/03	6271.12	1.04	10	5
cc16	06/10/03	6271.82	1.08	5	3
cc18	11/06/03	6269.52	1.29	40	3
cc19S	11/06/03	6269.54	1.2	1	1
	06/24/03	6270.26			1
cc19D	06/24/03	6270.19	1.64	0.5	2
cc20	06/10/03	6271.11	0.93	20	1
cc21	06/10/03	6270.53	0.93	10	1
cc22	06/10/03	6269.99	1.13	40	4
cc23	11/06/03	6268.69	1.41	20	3
cc24	06/10/03	6269.58	0.93	10	1

¹ Land-surface elevation referenced to pin set by El Dorado County Department of Transportation at end of Cattlemans Court cul-de-sac. Elevation referenced to NAVD of 1988.

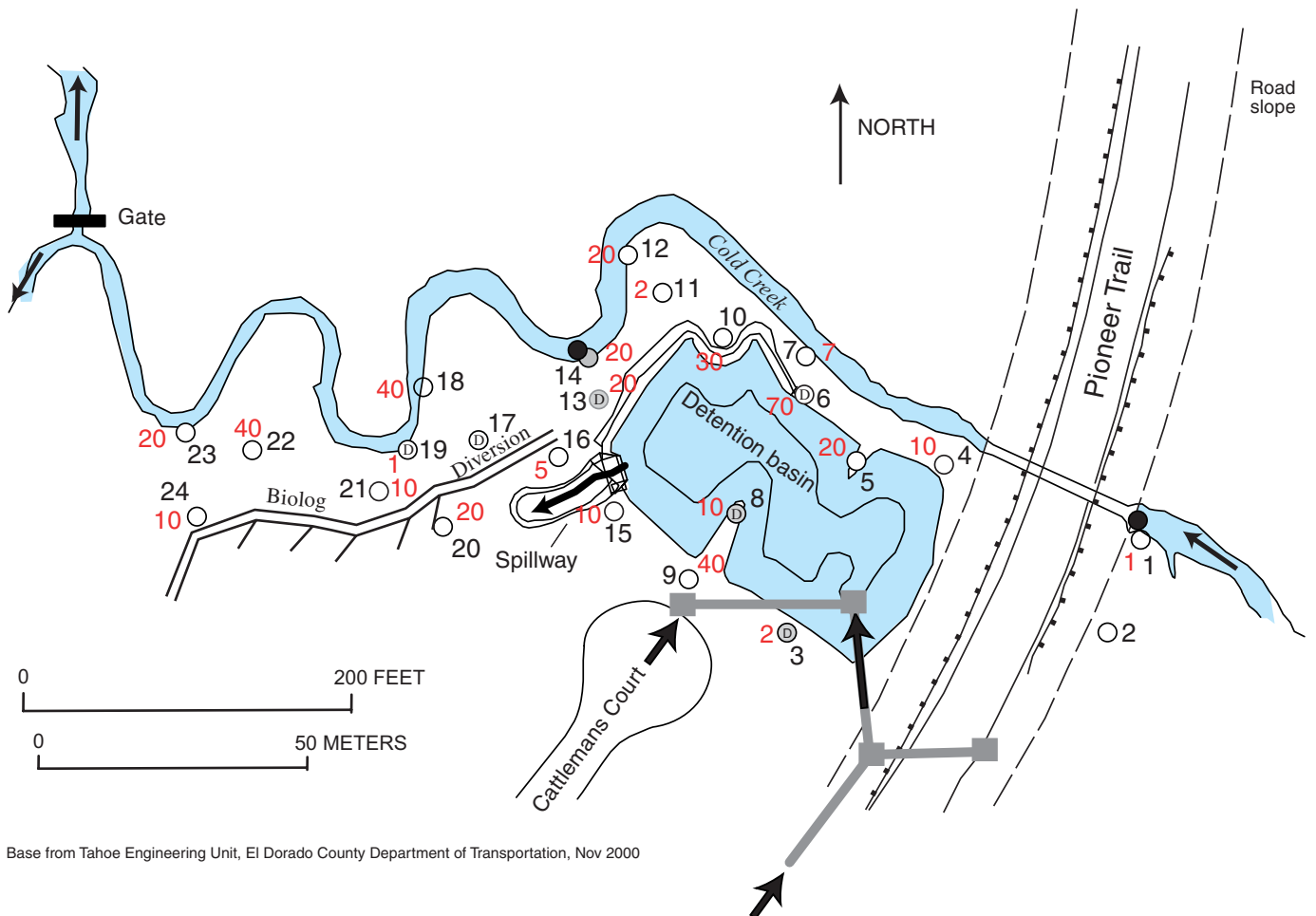
² Wells tested only once include exact displacement.

Discussion

The estimated hydraulic conductivities of the alluvium near Cattlemans detention basin range from 0.5 to 70 ft/d (fig. 5). The distribution is slightly skewed with the majority of estimated hydraulic conductivities ranging from 1 to 20 ft/d (fig. 6). There were six estimates that exceeded 20 ft/d and only one estimate that was less than 1 ft/d. The mean (average) value of hydraulic conductivity is 17.8 ft/d, whereas the median value is 10 ft/d. The 25th percentile is at 10 ft/d and the 75th percentile is at 20 ft/d indicating that at least half of all estimates range from 10 to 20 ft/d. The estimates of hydraulic conductivity from

these slug tests are consistent for alluvial deposits that are a silty to clean sand (Freeze and Cherry, 1979) and are thus consistent with the texture of the alluvial deposits that were found when the monitoring wells were augered.

No significant conclusions can be drawn between estimated hydraulic conductivities between the shallow and deeper wells due to a lack of sufficient estimates in the deeper wells. With only five estimates of hydraulic conductivity of the deeper sand and gravel, there is not enough evidence to support differences in the hydraulic conductivities between the shallow meadow deposits and the deeper sand and gravel.



Base from Tahoe Engineering Unit, El Dorado County Department of Transportation, Nov 2000

EXPLANATION

- Ground-water level recorder
- Surfacewater level recorder
- ➔ Surfacewater flow direction
- ▬ Stormwater drain
- 20○ D Shallow monitoring well (D includes an adjacent deep well)—
23 Black number is abbreviated well identification;
Red number is hydraulic conductivity in feet per day

Figure 5. Distribution of hydraulic conductivity near Cattlemans detention basin, South Lake Tahoe, California. Well identification numbers are abbreviated by omitting the "cc" designation preceding each number.

10 Hydraulic Conductivity of Near-Surface Sediments in the Vicinity of Cattlemans Detention Basin, South Lake Tahoe, Calif.

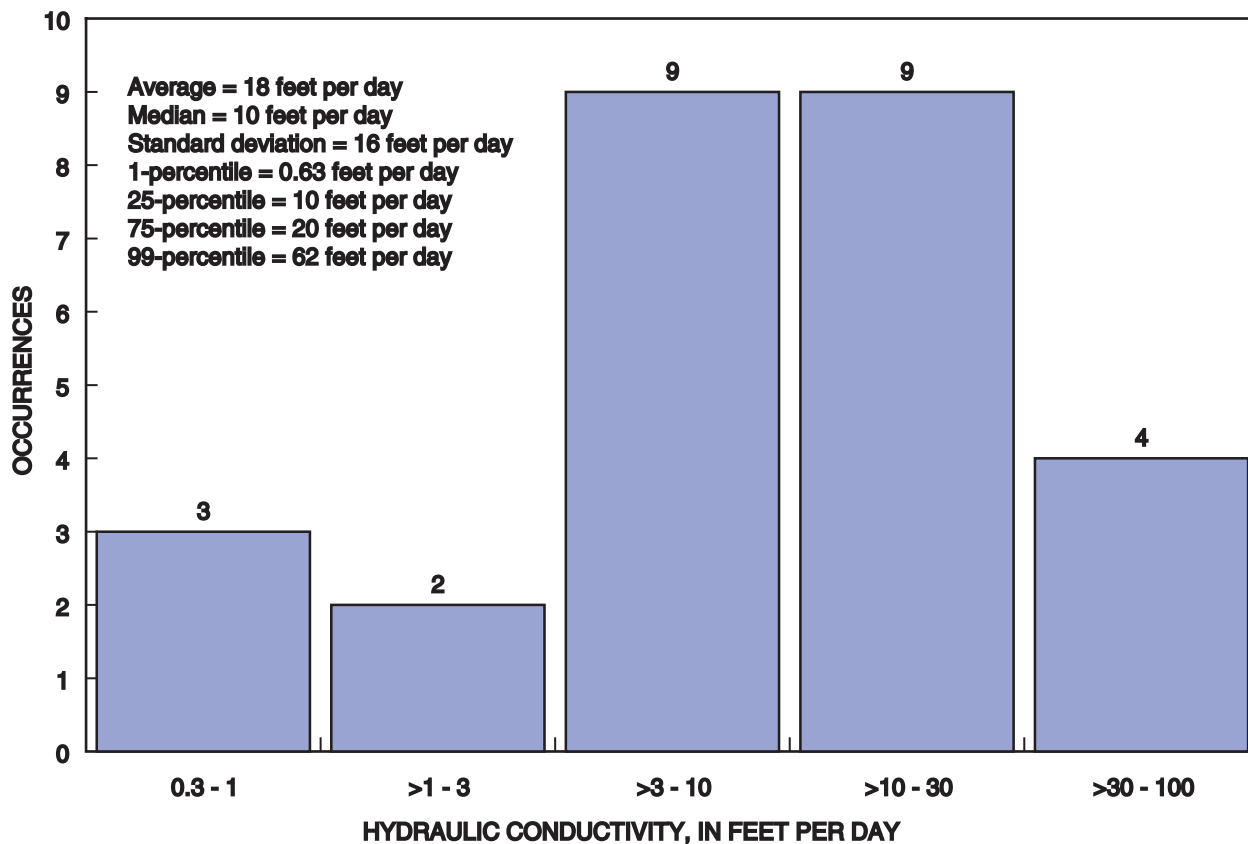


Figure 6. Range of hydraulic conductivity in all tested wells near Cattlemans detention basin, South Lake Tahoe, California.

Summary and Conclusions

Cattlemans detention basin project is a five-year study that began in November 2000 in cooperation with the El Dorado County Department of Transportation, Tahoe Engineering Unit and the California Tahoe Conservancy. The purpose of this study is to determine if the installation of Cattlemans detention basin reduces nutrients and sediments in surface flow before entering Lake Tahoe. Estimating hydraulic conductivity of the alluvium near Cattlemans detention basin is important in evaluating the subsurface transport of nutrients from the detention basin to nearby Cold Creek. The purpose of this report is to describe the techniques and methods used to estimate the hydraulic conductivity of the alluvium and to present the results of the analysis.

A total of 30 shallow monitoring wells were installed in the vicinity of the detention basin, ranging in depth from 5 to 15 ft, to assess the direction and rate of ground-water flow. Hydraulic conductivity was estimated by testing 27 wells (22 in the shallow meadow deposits and 5 in the deeper sand and gravel). Estimates of hydraulic conductivity were determined using the Bouwer and Rice analysis of slug tests. The response of the slug

test was recorded every 1 to 2 seconds using a recording pressure transducer, which had a range from 0 to 3 ft, after 0.079 to 0.26 gal of water was rapidly poured down each well.

Hydraulic conductivities of the alluvium ranged from 0.5 to 70 ft/d, with more than half between 10 and 20 ft/d. The range in hydraulic conductivity is consistent with the sandy texture of the alluvial deposits. Estimates of hydraulic conductivity were reported only to the nearest significant figure because a percentage of the water poured into the well leaked through the screen and into the alluvium as it was poured into the well. This caused a discrepancy between measured water-level displacement and that which was estimated from the volume of water poured into the well. For the well with the highest estimated hydraulic conductivity (well cc6S), the estimated rise in water level at time zero should have been 1.45 ft assuming that 0.238 gal of water was poured instantly into the well. The estimated hydraulic conductivity was no different when the rise of 1.45 ft was assumed at time zero and the next water level measurement was in 4 seconds. Assuming the time of the next measurement was 3 seconds instead of 4 seconds, the hydraulic conductivity increased by 10 ft/d and the error would be 15 percent.

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