HRS

TESTS OF EXISTING WELLS AND TEST-WELL SITE SELECTION AT HODGDON MEADOWS AND WHITE WOLF CAMPGROUND AND TEST-WELL DRILLING AND COMPLETION TUOLUMNE MEADOWS AND WHITE WOLF CAMPGROUND

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YOSEMITE NATIONAL PARK

Prepared for

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Prepared by

HRS WATER CONSULTANTS, INC.
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Memorandum

To: Regional Director, Western Region

From: Manager, Western Team, Denver Service Center

Reference: Yosemite, Contract No. 1443-CX-2000-92, Task Orders 18 and 21, Rehabilitate Tuolumne Meadows, White Wolf and Hodgdon Meadow Utilities, Pkg. 383, PT 05

Subject: Well Evaluation and Test Well Drilling Report

Please find attached for your files one copy of a completed report entitled "Tests of Existing Wells...Test Well Site Selection...and Test Well Drilling..." for Tuolumne Meadows, White Wolf, and Hodgdon Meadow, Yosemite National Park, dated January 1994. The report was prepared by HRS Water Consultants of Lakewood, Colorado, through Arber Associates of Denver, Colorado.

The report describes the following: Existing wells were evaluted for capacity and water quality. Test wells were drilled to determine if surface water supplies at Tuolumne can be replaced by wells, and to provide a needed supplement for existing wells at White Wolf.

If there are any questions, please call the A/E manager, Mr. Mark Johnston, at (303) 969-2298.

(SGD) Robert S. Budz

Robert S. Budz

Attachment

cc:
Supt., Yosemite, w/c att. (2)

bcc:
DSC-PGT, w/c att.
DSC-TWE-Johnston, w/c att.
Werrell, Water Resources
TWE:MJohnston:jm:1/28/94:2221:YOSE383.MJ

TABLE OF CONTENTS

1.0 INTRODUCTION: WELL TESTING AND TEST-WELL SITE SELECTION

HRS Water Consultants, Inc., has completed Tasks 1 and 2 of the Yosemite National Park well evaluation work. Task 1 consisted of aquifer tests and assessment of overall condition of three wells: Hodgdon Meadows wells 1 and 2 and White Wolf well 1. Task 2 consisted of selection of sites for one new well at White Wolf and two new wells at Tuolumne Meadows. The on-site work on these tasks was completed during the period September 19-26, 1993. Eric Harmon, P.E., performed the aquifer tests, well evaluation, and hydrogeologic test-well site selection work.

During the field work, Mr. Harmon met with a number of National Park Service personnel, including Messrs. Mark Johnston and Steve Bainbridge of the Denver Service Center, and Messrs. Bob Howard and Mark Butler of Yosemite National Park. During the aquifer tests Mr. Harmon was aided by Mr. Jim Reynolds, who was most helpful in expediting the testing. The Yosemite Research Center and Mr. Mark Johnston loaned us aerial photographs of Tuolumne Meadows and the White Wolf area, allowing us to perform Task 2. Site maps were provided by Mr. Johnston and Mr. Bainbridge.

Part 1 of this report documents the well testing and evaluations (Task 1) and well-site selection (Task 2), presents conclusions regarding the wells tested, and discusses recommended sites for drilling new test wells at White Wolf and Tuolumne Meadows.

1.1 WELL TESTING AND EVALUATION

The tests of the three wells, Hodgdon Nos. 1 and 2, and White Wolf No. 1, were performed sequentially beginning with Hodgdon No. 2, then White Wolf No. 1, and last Hodgdon No. 1. All three tests were performed in the same manner. The order of testing was chosen to maximize the pump off-time prior to testing. The existing submersible pumps in each of the wells were shut down a minimum of 12 hours prior to beginning the test period to allow aquifer water levels to recover. Figures 1 and 2 depict the locations of the wells tested.

Upon startup of each test, both drawdown and production rate were monitored, first, at frequent intervals (one minute) which gradually increased to three-hour intervals by the end of the 36-hour pumping-test periods. After the pumps were switched off, measurements of water level were made until the water level had recovered sufficiently so that less than 10 percent of the total test-period drawdown remained. During the testing, periodic measurements of pH, water temperature, specific conductance, and motor amperage were made. The first three were used to estimate whether the source of ground water changed during the test duration, while amperage was used to monitor pump performance.

All three wells are equipped for normal operation with Rockwell totalizing flowmeters. These were used to measure pumping rates during the testing. As a crosscheck on meter accuracy, periodically during each test a stopwatch was used to measure the length of time it took to fill a five-gallon bucket with discharged water. All of the meters were accurate, though occasionally the meter impellers would stick or hang up due to small particulate matter in the pumped water. Water produced during the pumping tests was pumped to waste via a fire hose connected at the downstream end of the pipe/valve manifold serving each well.

Drawdown was measured with a dual-conductor electrical well measuring probe ("m-scope"), which consists of two conductor wires embedded in a measuring tape on a reel. When the water level is contacted in the well, a circuit is completed, actuating a buzzer and light, thus indicating depth to water. Before each test the m-scope tape was disinfected with a 300 mg/l chlorine solution. In addition, an acoustic well sounder provided by Yosemite National Park personnel was used as a crosscheck on the m-scope measurements. This instrument creates a popping sound at the wellhead, which travels through the air in the well casing, echoes from the water surface and returns to the sounder. Electronic circuitry in the instrument computes water level based on the echo return time and the speed of sound in air. The m-scope and echo sounder generally were in close agreement, though false readings occasionally were suspected from both instruments due to cascading water in the wells.

1.1.1 Hodgdon Meadows Well No. 1

The test of Hodgdon Meadows well no. 1 began at 9:00 a.m. on September 24 and continued until 9:00 p.m. on September 25, at which time the pump was switched off. During the 36-hour test period, the pumping rate was kept as constant as possible to facilitate data analysis. Based on a review of pumping records and discussions with Jim Reynolds, a pumping rate of 20 to 25 gpm (gallons per minute) was selected as the test rate. This was achieved through adjustment of a globe valve in the piping manifold at the well house. Average pumping rate over the 36-hour test period was 23.1 gpm.

Pre-test static water level was 23.3 feet below ground surface. By 90 minutes after test startup, the water level had stabilized at a depth of approximately 112 feet below ground surface. Variations in the pumping water level were noted after the 300-minute point of the pumping test (see Figure 3). This is interpreted to have been due largely to variations in pumping rate, though there may also have been some effect of dewatering fractures which contributed to the variation. During the test, line pressure averaged about 200 psig, with some variation.

After the pump was switched off following the 36-hour pumping period, water level in Hodgdon No. 1 recovered to 25 feet below ground surface within 60 minutes, which is within 1.7 feet of the pre-test static level (see Figure 4).

The test results indicate that Hodgdon Well No. 1 is, in our opinion, capable of sustained pumping at a rate of up to 25 gpm for periods of several weeks duration. This is based on the measured 36-hour specific capacity of the well, approximately 0.27 gallons per minute per foot of drawdown, and the driller's log of the rock types encountered. We would expect the pumping water level, at 25 gpm, to be about 115 feet, under the conditions we observed. In wells completed in fractured-rock aquifers, as the Hodgdon Meadows and White Wolf wells are, the specific capacity tends to drop as the well is pumped at higher rates. This means that at higher pumping rates, water levels may decline more quickly.

The driller's log of the rocks encountered indicates a fracture zone at 90 to 115 feet, and at 170 to 173 feet (see Appendix A). During the pumping test, cascading water (water free-falling down the wellbore from a point above the pumping water level) began at about 71 feet. It is our interpretation that most of the production comes from the fracture zone in the 90-115 interval, with small contributions from 71 feet. Production from the 170-173 interval probably is small. For this reason, it is our opinion that the pumping rate may be sustainable for relatively long periods at 25 gpm, but water levels likely would decline quickly at 30 gpm or higher rates.

Overall, from the wellhead appearance and pumping conditions we observed, Hodgdon Meadows Well No. 1 appears to be in good condition. Well records show that the wellbore annulus is grouted with cement grout from 50 feet to ground surface, which is in compliance with current California well standards. The well reportedly is an open, uncased borehole from 50 feet to the total depth of 205 feet. According to Mr. Jim Reynolds, the pump intake is at a depth of 165 feet.

Though no particulate matter, rock grains, etc., were noted in the discharged water, current standard well design would call for lining the borehole with slotted PVC casing or well screen to guard against the possibility of a loose rock fragment dislodging and wedging the pump or drop pipe in the borehole. The well has been in service on a continuous basis since April, 1982, without problems of this nature, so installation of a PVC borehole liner would be a precautionary measure rather than a necessity.

The controls, wiring, and pipe/valve manifold appear to be in good condition, are monitored and managed adequately, and provide for submersible motor protection against electrical surges and overvoltage. It would be advisable to add a short section (about one foot length) of electrical conduit at the wellhead, to avoid having the three-wire pump cable exposed to the sunlight. This could be added with minimal expense, and would help preserve the insulating qualities of the neoprene insulation against breakdown due to exposure to sunlight.

Voltage and amperage measurements made during the pumping test at Hodgdon Well No. 1 show that the Grundfos 5 hp pump and Franklin motor combination were pumping at an overall efficiency of about 52 percent during the pumping test, which indicates that the pump/motor combination are in fairly good condition. Periodic (perhaps quarterly or semiannual) checks of overall pumping system efficiency should be made to monitor the pump performance.

Measurements of specific conductance and temperature taken during the test show that the total dissolved solids concentration of the Hodgdon well no. 1 water is less than 100 mg/l, which is indicative of a moderately chemically-active water which may be somewhat corrosive. The Ryznar Index is a method by which pH, TDS, bicarbonate, and calcium-ion concentrations are compared, to arrive at a general indication of whether a water is chemically corrosive, neutral, or encrusting. We recommend that pipes, fittings, and downhole pumping-system components be checked on a regular basis, perhaps semiannually, for corrosion.

1.1.2 Hodgdon Meadows Well No. 2

Hodgdon Meadows well no. 2 was tested during the period 9:00 a.m., September 21, through 9:00 p.m., September 22. The pumping rate throughout the 36-hour test remained relatively constant at approximately 14 gpm. Prior to test startup, Hodgdon well no. 2 had not been pumped for at least six weeks, according to Mr. Jim Reynolds. Pre-test static water level was approximately 23.5 feet below ground surface.

During the 36-hour pumping period, water levels were measured in well 2 and also in well 1, 200 feet east. There was no drawdown in well 1 due to pumping well 2, a phenomenon which would be highly unusual in a granular aquifer (e.g. sand or gravel) but which is relatively common in fractured crystalline rock. It is evident that there is little or no interconnection between the fractures which transmit water to each of the two Hodgdon wells.

Figure 5 is a log-linear graph of time versus drawdown in Hodgdon well no. 2 over the course of the 36-hour test. The drawdown curve represented by the water-level measurements can be seen to decline rapidly for the first 25 minutes, then begin to level out at a pumping water level depth of about 310 feet. At about 210 minutes into the test, the water level again declined abruptly to about 340 feet; rose slowly to about 330 feet, declined again between approximately 1100 and 1500 minutes; and stabilized with a possible rise again to about 355 to 360 feet from 1500 minutes to the end of the test at 2160 minutes. Throughout the test, a considerable volume of cascading water entered the wellbore at a depth of about 107 feet, which is the depth to which the annular seal around the conductor casing in the well reportedly was grouted (Appendix A).

The "stairstep" shape of the time-drawdown curve probably was caused by dewatering of fractures. For example, the well appeared to produce water under fairly stable water-level conditions from 25 to 210 minutes, indicating that a fracture at about the 315-foot depth level was yielding significant water to the well. After 210 minutes, however, the fracture likely became dewatered; that is, all of the immediately-drainable water in storage in the fracture had already entered the wellbore.

Following fracture dewatering, the water level in the well declined relatively rapidly until a new temporary equilibrium was established by another fracture yielding water at about the 330-foot level, and so on. We do not believe that the stairstep changes in water level were due to variations in pumping rate, because this was kept quite constant throughout the test period by adjustment of a globe valve. The slow rise in water levels measured at about 400-1000 minutes and 1500-2150 minutes may have been due to delayed release of ground water from fractures above the pumping water level which were filled with porous rock material. Occasional mineral grains and turbidity were seen in the discharged water during the times when the water level was rising slightly.

Following cessation of pumping after the 36-hour pumping period, we measured water-level recovery in Hodgdon well no. 2. Water levels recovered to about 105 feet below ground surface within 15 minutes after pumping ended; stayed at about the 105-foot level until about 25 minutes after pump shutdown; then recovered to approximately 25 feet after one hour (Figure 6). We interpret this to be indicative of a water-bearing fracture intersected by the well at 105 feet, which had been partially dewatered in the pumping test, and which was taking a period of minutes to fill again with water after pumping ceased. Also, during the pumping test, cascading water could be heard in the well once the water level had declined to 105 feet and below. Upon recovery, cascading could be heard until the water level had recovered to the 107-foot level.

Based on the pumping test results, we recommend that the long-term pumping rate of Hodgdon well no. 2 be maintained at 10 gpm or less. At larger pumping rates progressive fracture de-watering likely will cause accelerating drawdowns and consequent deepening of pumping water levels. This can be seen on the time-drawdown plot (Figure 5) as the stair-step shape of the curve.

The overall physical condition of Hodgdon well no. 2 appears, from its pumping characteristics and surface condition, to be good; we see no problems with the well being able to produce water for many years to come. Except for occasional sand grains and slight turbidity caused by fracture dewatering (a condition not expected in normal, day-to-day pumping), no discoloration of the pumped water was noted. The driller's well-completion report (Appendix A) indicates that the well was drilled to a total depth of 400 feet, and encountered its only reported flow (10 gpm, according to Yosemite Falls Well Drilling) at 122-125 feet depth. The borehole/casing annulus in the well reportedly was sealed with cement in the interval 0-107 feet.

The well is equipped with a 3hp Grundfos submersible pump/motor combination (Model 16S30-24) which reportedly was set at a pump-intake depth of about 200 feet. This apparently is erroneous, however, because we measured pumping water levels down to approximately 360 feet. Measurements of power consumption during the testing indicate that the Hodgdon well no. 2 pump was operating at about 64 percent overall pumping system efficiency, which is excellent.

Measurements of specific conductance and temperature taken during the pumping test indicate a total dissolved solids content of less than 100 mg/l in the Hodgdon well no. 2 water, which is indicative of a chemically-active water which may be corrosive. This is corroborated by a water-quality report provided us by Mr. Jim Reynolds, from a sample taken in November, 1991 (Appendix A). The Ryznar Index calculated from this data shows that the ground water is highly undersaturated with respect to Calcium, so that the water appears to be quite corrosive. As with Hodgdon well no. 1, the no. 2 pumping-system equipment should be checked periodically, perhaps semiannually, for corrosion wear.

From on-site discussions with NPS personnel, a high (but not quantified) radioactivity reading was reported in Hodgdon Well No. 2. This appears to be an anomalous reading, because the system water-quality reports (see Appendix for 1992 report) show that natural background radioactivity is less than half the allowable level of 15 picocuries per liter. Radioactivity is a natural result of decay of uranium which is commonly present in trace amounts in the type of rock present in Yosemite. It is likely that the anomalous high reading either was a laboratory error, or was caused by the well not having been pumped sufficiently prior to sampling. This does not appear to be a problem, but to be safe, we recommend that radioactivity in the water system be checked annually after having pumped the wells for at least one day prior to sampling.

1.1.3 White Wolf Well No. 1

A planned 36-hour test of White Wolf well no. 1 began at 8:50 a.m. on September 23, 1993. However, after 20 minutes of pumping at a rate of 23 gpm, it became evident that the well would not sustain open-discharge pumping for more than a few hours. The pump was switched off, and the water level in the well was allowed to recover for about 1.5 hours. With the pumping rate reduced by means of a globe valve located in the pump house approximately 300 feet northwest of the well, the test was restarted at 10:28 a.m. on September 23.

Though the test was planned for a 36-hour duration, the motor-generator set being used to power the pump motor ran out of fuel approximately 12 hours into the test period. Because pumping water levels yield the most data in the earliest part of a test, and progressively less data in the later portion of a test, it was decided not to rerun the test. Due to the time-logarithmic nature of water-level changes in pumping wells, the 12-hour test period before the generator quit yielded about 85 percent of the data which would have been collected from a 36-hour test. It is our opinion that the test performed, though not as long as planned, was sufficient to allow data analysis to establish the sustainable yield of the well.

Pre-test static water level in White Wolf well no. 1 was 2.8 feet below ground surface. At an average pumping rate of 7 to 8 gpm, which, according to Mr. Jim Reynolds, is about the rate at which the well pumps into the White Wolf water system, the water level in the well stabilized at 95 feet below ground surface (Figure 7). Approximately 330 minutes after test startup, the water level dropped abruptly from 95 to 104 feet. In a response to pumping similar to Hodgdon well no. 2, the water level then rose gradually to a new stable pumping water level of about 100 feet below ground surface. This is interpreted to have been due to dewatering of a water-bearing fracture at the 95-foot level, with subsequent delayed release of water from fine-grained fracture-infilling material.

Following shutdown of the pump when the motor-generator set ran out of fuel, water level in White Wolf well no. 1 recovered to within 10.0 feet of ground surface after two hours (Figure 8). From analysis of the pumping-test data, the specific capacity of the upper 100 feet of the well is approximately 0.08 gallons per minute of production per foot of water-level drawdown. This specific capacity is not expected to be sustained at greater drawdowns, due to fewer water-bearing fractures with greater depth in the well. It is our opinion that White Wolf well no. 1 can be pumped at a rate of about 10 gpm continuously for periods of several weeks, with an expected pumping water level in the range of 150 to 175 feet. Larger pumping rates are not recommended, because the well does not appear to be capable of sustained pumping at greater than about 10 gpm.

According to the driller's completion record for White Wolf well no. 1, contained in a report entitled "Test Well Drilling in Yosemite National Park, California" by Mitten, H.T., USGS Water Resources Division, 1968 (Appendix A), the well is cased to a depth of only 15 feet, and grouted to only 10 feet below ground surface, which does not meet current California well-completion standards (which requires a 50-foot minimum grout depth). We observed cement grout around the outside of the casing by probing with a steel rod. During the test, we noted considerable water cascading into the wellbore from 15 feet to 20 feet, and again at about 95 feet. Also, below 15 feet the well is an open borehole. Though the well apparently has been in use for about 25 years without significant problems, current standard water-well design would call for a perforated liner, of PVC or other inert material, to be placed in the borehole as a preventive measure against loose rock material falling in and wedging the pump or drop pipe in place. Because White Wolf Well No. 1 was completed in 1968, before current standards were enacted (in 1981), it is our understanding that this well can be used as presently constructed so long as testing shows no microbial contamination.

The pump installed in White Wolf well no. 1 is a 1.5 hp Grundfos submersible, according to Mr. Jim Reynolds. Electric power measurements made during the pumping test show that the overall pumping-system efficiency is approximately 53 percent under system-pressure operating conditions. This is acceptable for pumping systems of this type. We recommend semiannual checks of pumping-system efficiency to give warning of future pump wear or other system problems.

During the test, no turbidity or discoloration of the pumped water was noted, though during the first attempt at open-discharge pumping, at 23 gpm, mineral grains were present in the discharged water. At the test rate of 7 to 8 gpm, no mineral grains were noted. From surface observations and the pumping test results, the overall condition of the well and pumping system appears to be good. As noted above, however, the well does not comply with current California well-grouting standards for public water supply wells. Though the existing pitless unit and well cap appear to be sufficient to protect the well against surface inflow of water, the casing height of about three feet above ground is more than necessary (by 1.5 feet) to meet State standards. If desired, visual intrusiveness of this well could be reduced slightly simply by cutting off the casing 1.5 feet above ground and reinstalling the existing well cap.

During the test period, regular measurements of specific conductance indicate a total dissolved solids concentration of less than 100 mg/l in the pumped water. Water quality data from a sample taken in August, 1968, provided by NPS personnel (Appendix A), show that the TDS concentration was only 46 mg/l at the time the well was new. As with both Hodgdon Meadows wells, this indicates a potentially corrosive condition due to chemically active water. Ryznar Index calculations made from the 1968 water-quality report indicate that the water is highly undersaturated with respect to Calcium. This means that the water is corrosive, and care should be taken on a regular basis to check pipes, fittings, valves, and other system components to guard against corrosion-induced failure.

Though undesirably high levels of dissolved iron would be suspected in the wet-meadow location of White Wolf well no. 1, excessive iron levels have not been reported. It is often the case that near-surface soils in meadow/wetland areas are oxygen-poor and chemically-reducing conditions prevail. Under such anaerobic conditions, we have commonly seen undesirably high reduced (ferrous) iron and manganese concentrations in nearby wells.

It is our hypothesis that the reduced iron and manganese are mobilized into nearby pumping wells due to drawdown-induced downward water movement from the near-surface meadow soils. Once the iron-enriched pumped water comes into contact with oxygen in a water-supply system, the iron oxidizes to the relatively insoluble ferric (Iron III) form, where it can cause orange or brown fixture staining and encrustation. Fortunately, and for reasons of which we are unsure, the dissolved iron concentration in White Wolf well no. 1 never has been high enough to be a problem.

Paradoxically, White Wolf well no. 2, located on a granodiorite outcrop in a campground loop adjacent to the Middle Fork of the Tuolumne River about 1/3 mile north of well no. 1, does show an undesirably high iron concentration. Though we did not test White Wolf well no. 2 as part of the current work effort, we did notice that there is considerable rusty discoloration in the bed of the Middle Tuolumne adjacent to well no. 2. It may be the case that well no. 2 captures dissolved iron from the surface stream, which appears to have mobilized and concentrated dissolved iron from further upstream. A full analysis of the well no. 2 iron problem is, however, beyond the scope of the present investigation.

1.2 SITE SELECTION FOR TEST WELL DRILLING

As part of the present efforts in securing supplemental ground water for the White Wolf water system, and to move toward replacement of the Tuolumne Meadows surface-intake on the Dana Fork of the Tuolumne River, HRS Water Consultants, Inc., has selected sites for test wells at each of these two areas. Site selection was a four-part process, including 1) review of area geologic maps, reports, and existing well records; 2) fracture mapping on aerial photographs of the areas; 3) onsite geologic mapping; and 4) meeting with personnel of the National Park Service (from the Western Team Design Branch and Yosemite National Park) to ascertain, and avoid, culturally and environmentally sensitive areas.

Geologic maps reviewed included U.S. Geological Survey maps at scales of 1:62,500 (Hetch Hetchy Reservoir quad, covering the White Wolf area; and the Tuolumne Meadows quad) and 1:125,000 (covering the entire Yosemite area). Aerial photos of both White Wolf and Tuolumne Meadows were provided by NPS, including stereopair coverage of White Wolf in normal Ektachrome prints at a scale of 1:12,000 and Ektachrome Infrared stereopair prints of Tuolumne Meadows at a scale of 1:20,000.

The procedure used was to construct clear acetate overlays of key aerial photos for both White Wolf and Tuolumne Meadows. On the overlays we depicted major streams and tributaries, surface bedrock outcrops, springs and seep areas, and interpreted fracture patterns based on persistent patterns of linear features seen on the aerial photos, as corroborated by the published geologic maps. Later, after meeting with NPS personnel, wilderness area boundaries, mapped archaeological sites, and water systems were added to the overlays.

On September 22, 1993, we met with personnel from Yosemite National Park and the Western Team Design Branch in Tuolumne Meadows and White Wolf. The purpose of the meeting was to discuss the Park's preferences and constraints for test well sites with regard to visual impact, the existing water system, archaeological sites, wilderness areas, minimization of pumping lift for possible solar power, proximity to potential contamination sources, drilling-equipment access, and wetland/meadow protection. These sensitive areas and site constraints also were placed on the working aerial-photo overlays for consideration along with the hydrogeology.

Following the Hodgdon and White Wolf pumping tests in September, 1993, HRS personnel visited the White Wolf and Tuolumne Meadows areas to observe hydrogeologic conditions including rock type, fracture characteristics of the bedrock (where evident) and areas of ground water discharge. From the set of geologic and cultural information developed in this manner, we then selected preliminary well sites for consideration by Arber Associates and NPS personnel in Yosemite and the Western Team Design Branch. The preliminary well sites then were presented to NPS and Arber in a memorandum with draft site maps on September 27, 1993. Four sites in Tuolumne Meadows and two in the White Wolf area were presented for consideration (see Figures 2 and 9).

At the request of National Park Service personnel, an onsite meeting was held in Tuolumne Meadows and White Wolf on October 14, 1993, to discuss the well sites and make final site selections. Present at the meeting were personnel of Yosemite and the Western Design Branch, HRS, and Yosemite Falls Well Drilling of Mariposa, California, the firm which had been selected to perform the test well drilling. The test drilling documentation is in Section 2 of this report.

1.2.1 White Wolf Recommended Well Sites

After consideration of the preferences and constraints discussed at the onsite meetings, two sites in the White Wolf campground area were approved by NPS for test drilling. Site 1, which hydrogeologically was the more preferable of the two, was located approximately 2500 feet north of the intersection of the Tioga Pass road (Highway 120) and the White Wolf access road, immediately east of the White Wolf access road adjacent to the southernmost of several meadows (Figure 2). The second site was located in the vicinity of the White Wolf road crossing of the Middle Tuolumne River, approximately 1300 feet north of the White Wolf lodge building.

Based on our aerial-photo analysis and field reconnaissance, the best site solely with regard to hydrogeology, in our judgment, is located approximately 600 feet due west of the White Wolf lodge building, at a meadow area which has significant warm-water seepage and springflow. This area coincided with a northeast-trending linear feature on the aerial photographs, which was interpreted to be a zone of bedrock fracture. However, this site not only is located within the wilderness area, to drill at the site would require a drilling rig mounted on an all-terrain vehicle.

The meadow adjacent to White Wolf test-well site 1 appears to be coincident with a north-south linear feature interpreted to be associated with bedrock fracturing. Also, this meadow is a ground water discharge area, as evidenced by the presence of minor springflow and seepage. A bedrock outcrop immediately south of the meadow shows relatively well-developed near-vertical fracture planes oriented approximately north-south. Though the best location for maximizing ground water production at this site would be in the central to southern portion of the meadow, this would not only disturb the wetland, but also is too wet and boggy to allow access to heavy drilling equipment. For rig-access and meadow-impact considerations, the agreed-upon test well site was moved approximately 200 feet west to a point adjacent to the White Wolf road.

White Wolf site no. 2, as discussed above, was located to try to take advantage of the inaccessible northeast-trending fracture, at a point near the Middle Tuolumne River. However, drilling-rig access is poor due to lack of a suitably flat, level area, and also due to the presence of large glacial boulders which would serve to make drilling very difficult.

During the test-well drilling efforts of October, 1993, White Wolf site no. 1 was drilled. The results are discussed in a Section 2 of this report.

1.2.2 Tuolumne Meadows Recommended Well Sites

Within the Tuolumne Meadows area the best hydrogeologic conditions for maximizing production from a pumping well appear, based on aerial-photo analysis and onsite reconnaissance, to be located at the intersection of several prominent near-vertical fractures located approximately one mile west-northwest of Soda Springs, about one-quarter mile north of the meadow itself. This site is inappropriate for test drilling, however, because it is located within the wilderness area. Also, it would be necessary to use drilling equipment mounted on all-terrain vehicles to gain access to this site.

The majority of Tuolumne Meadows, particularly the northwestern portion of the area where evidence of bedrock fracture is strongest, either is wilderness or is in the open meadow where visual impact or the possibility of wetlands degradation precludes approval to drill. Acceptable drilling sites therefore do not reflect the best sites for producing ground-water.

Upon consideration of hydrogeologic and cultural factors, four preliminary test-drilling sites in Tuolumne Meadows were selected for review by NPS. In order of decreasing priority, these sites were located as follows. Site 1 was located adjacent to Campground Loop A, approximately 200 feet south of the Tioga Pass Road, in the first clearing east of the Loop A road, about 150 feet northeast of the campground kiosk, and about 50 feet away from the Tuolumne River. Site 2 was located approximately 150 feet east of the Unicorn Creek bridge and 50 feet north of the Tioga Pass Road. Site 3 was located about 100 feet north of the Soda Springs road in a clearing approximately 700 feet northwest of the intersection of that road with the Tioga Pass road. Site 4 was located immediately off the north shoulder of the Tioga Pass Road approximately 100 feet west of an unnamed tributary creek of the Dana Fork, which is about 2600 feet northeast of the water-storage tank uphill from the Tuolumne Lodge building (see figure 9).

To reduce visual intrusion, NPS personnel preferred that sites 1, 2, and 3 be moved. Site 1 was relocated approximately 150 feet west, to the west side of campground loop road A. Site 2 was relocated approximately 300 feet south and 50 feet east, to a point near the west end of campground loop road D. Site 3 was relocated approximately 150 feet southeast.

During October, 1993, Tuolumne Meadows test well sites 1 and 2 were drilled, without success in obtaining usable amounts of ground water. The test-well drilling is discussed in Section 2 of this report.

1.2.3 Alternative Site-Selection Methods

The following discussion addresses possible methods by which followup exploration could be performed if Arber and NPS elect to pursue further efforts in obtaining ground water at Tuolumne Meadows. Though further test drilling continues to be an option, it may be cost-effective to consider other less costly exploration options such as surface geophysical methods, prior to a second phase of test drilling.

In order to locate subsurface water-bearing fractures in the granitic rocks of the Tuolumne Meadows area by nondestructive geophysical methods, it is necessary to remotely measure any of several physical characteristics which are different from unfractured rock to fractured rock. These characteristics may include acoustic-wave velocity, magnetic-field intensity, and electrical resistivity. There are surface geophysical methods by which areal contrasts in each of these characteristics can be measured.

Seismic refraction could be used to target the reduction in acoustic (sound wave) velocity in the subsurface associated with a zone of bedrock fracture. Such a survey employs either a sledge hammer or, for surveys deeper than about 100 feet, blasting caps or explosives, to induce a sound wave to travel through the subsurface. A portion of the wave energy is refracted back upward, where it is received by an array of geophones (seismic detectors) and amplified in a seismograph instrument. Interpretation of the recorded waveform results in a record of the sound-wave velocity of the subsurface bedrock. Zones of weathered and fractured bedrock tend to exhibit lower seismic velocities than hard, unfractured rock. A seismic-refraction survey typically consists of a two- or three-person crew using a field-portable instrument and cable arrays. For the Tuolumne Meadows area, it would be necessary to survey a series of profiles in order to build up data continuity to be able to identify areal patterns of subsurface velocity changes.

A magnetometer survey would be able to detect anomalies (local changes or variations) in the earth's magnetic field due to subsurface disruption in the mineral grains and rock continuity caused by bedrock fracturing. By walking a series of parallel profile lines while taking readings with a handheld magnetometer, it is possible to generate a contour map of the magnetic field of the area under study. The results generally are interpreted qualitatively, in terms of visual identification of disruptions in the magnetic-field contours. There is no particular limitation on depth of investigation; the broader the anomaly pattern, generally the deeper the source of the magnetic anomaly.

The electrical resistivity method measures changes in how easily subsurface rocks conduct a current of electricity. In general, fractured bedrock is less resistive (or, conversely, more conductive) to electricity than is unfractured, fresh rock. This is because the fracture openings tend to be fluid-filled. Ground water tends to be more conductive of electricity than the surrounding unfractured granitic rocks. There are several types of instruments which can be used for resistivity and conductivity surveys.

For the Tuolumne Meadows area, the most suitable method may be the use of a two-loop conductivity instrument. Two persons stand about ten meters apart; each person holds a portable coil of wire connected to appropriate electronics. One coil is excited with an alternating current, which induces an electromagnetic field around the coil. The field in turn induces an electric field in the subsurface rocks. The receiver coil, held by the other person, picks up the induced electric field and displays the field strength in terms of the resistivity or conductivity of the subsurface rocks between the two coils. As with the other methods, the best strategy in Tuolumne Meadows would be to walk a series of parallel traverse lines, taking continuous readings. From the data, a contour map of the subsurface resistivity or conductivity would be generated. Fractures in the subsurface would show up as high-conductivity (low resistivity) disruptions in the contour pattern. Depth of investigation varies with distance between coils, frequency of the induced field, and resistivity of the subsurface rocks.

Of these three geophysical methods, the seismic method would be the most time-consuming and expensive but would yield the more quantifiable set of information. A drawback is that it requires laying out cables, digging holes, and using explosive charges. It would require a week to ten days, approximately, for a two or three-person crew to survey Tuolumne Meadows. The magnetometer survey would be relatively inexpensive, in that it can be done relatively quickly (perhaps two to three days) by one person. Using the two-loop conductivity method, a two-person crew could traverse the majority of Tuolumne Meadows in three or four days time.

Overall, we feel that the two-loop conductivity survey would be the most cost-effective in terms of the best information for the least expenditure.

1.3 CONCLUSIONS AND RECOMMENDATIONS: WELL TESTING AND TEST-WELL SITE SELECTION

On the basis of the pumping tests performed, the three existing wells should be able to be pumped for extended periods at rates not to exceed the following:

Well	Maximum Recommended Pumping Rate
Hodgdon well no. 1	25 gpm
Hodgdon well no. 2	10 gpm
White Wolf well no. 1	10 gpm

All three of the pumping systems for each of these wells appear from our testing to be in relatively good condition, and have acceptable pumping-system efficiencies. All three wells show signs of near-surface water, by the prevalence of cascading water during the tests. Only White Wolf well no. 1 does not comply with current California well standards with respect to grouting depth. The surface casing is in place to 15 feet, and appears to be grouted only from ground surface to 10 feet below ground surface. Current California well standards call for a minimum 50-foot grout depth in public water supply wells. Provided that no microbial contamination is found in White Wolf Well No. 1 in the future, it is our understanding that the well does not need to be repaired, because it predates the current grouting standard.

Sites for four test wells in Tuolumne Meadows and two at White Wolf were selected on the basis of aerial-photo analysis, geologic mapping, and review of published reports and maps. Of these sites, two at Tuolumne and one at White Wolf were drilled. Unfortunately, none of the three produced enough water to be usable for the Park. We recommend that subsequent efforts in developing ground water as a source of supply should focus on one or more of several criteria:

1. Deep wells must be located with precision to intersect existing water-bearing near-vertical bedrock fractures. Such fracturing is evident from aerial photos; however, our efforts in test drilling show that sites near, but not precisely on, fractures do not yield usable quantities of water. The granodioritic rock is very hard, and secondary fractures do not appear to propagate away from primary fracturing to any degree.

2. It is recommended that surface geophysical survey methods such as two-loop conductivity, and/or a magnetometer survey, be used to help locate subsurface fractures in the bedrock. These methods are nondestructive and can be performed relatively quickly. They are best performed in a complementary manner, by using both methods and comparing the results along with geologic mapping to pinpoint future test-well sites.

3. The dominant water-bearing fractures encountered both at Tuolumne Meadows and at White Wolf are most likely nearly-horizontal exfoliation fractures that are evident in many of the domes in the Tenaya Lake and Tuolumne Meadows areas. This type of fracturing does not appear to propagate deeper than about 20 to 30 feet, but these fractures do appear to contain and transmit water. It is recommended that consideration be given to obtaining a variance from Tuolumne County and/or the State of California to complete shallow wells which draw water from these near-surface fractures. Though pressure-filtration, or other purification, may be necessary, the drilling cost will be much less than for the deep drilling. It is our understanding that a variance from the 50-foot well-grouting standard may be approved by the State, contingent upon adequate water purification before distributing water for human consumption.

2.0 INTRODUCTION: TEST-WELL DRILLING AND COMPLETION

The test-well drilling in Yosemite National Park authorized by Richard P. Arber Associates and the National Park Service (NPS) has been completed. This work was performed under two separate authorizations resulting in a contract between HRS Water Consultants, Inc., and Richard P. Arber Associates. The first authorization was for a scope of work to include testing of two existing wells at Hodgdon Meadows and one existing well at White Wolf as well as site-selection and drilling of one new test well at White Wolf. The second authorization was for site-selection and drilling of two new test wells at Tuolumne Meadows.

This report details the drilling of three test wells: two of these wells were drilled in the Tuolumne Meadows Campground and one was drilled near the White Wolf Campground. G. Eric Saenger, Certified Professional Geologist, was the HRS field representative onsite during the entirety of the drilling work. He performed drilling observation and drilling-contractor liaison, and was in once- or twice-daily contact with Eric J. Harmon, P.E., who was the HRS project manager in charge of coordinating the drilling effort and updating Arber and NPS personnel. Onsite work for the test-well drilling took place during the period October 21 through November 5, 1993.

Yosemite Falls Well Drilling of Mariposa, California, was the drilling contractor selected to perform the test-well drilling and testing. Due to the need for very rapid mobilization to the drill sites because of the prospect of the onset of winter weather in the Yosemite high country, HRS did not hold a formal advertisement/bidding process for contractor selection. Yosemite Falls was selected on the basis of equipment suitability, experience in hard-rock downhole pneumatic-hammer drilling, licensed California driller, and availability for rapid mobilization to the job sites. Prior to selecting this contractor we spoke to three other local drilling contractors (two in Sonora and one in Merced), and gained an understanding of cost ranges for the type of test wells desired in the Yosemite area. In this way, we verified that Yosemite Falls' price offerings were competitive with other local drilling contractors. HRS entered into a contract for the test drilling with Yosemite Falls on October 14, 1993, during an onsite meeting for final test-well site selection.

All three test wells were drilled using a drilling method called downhole pneumatic hammer drilling (also called "air hammer" or "downhole hammer" drilling). High-pressure compressed air from a drilling-rig mounted compressor is forced down the hollow center of a heavy-wall steel drill pipe. A carbide-tipped drill bit hammers the rock at the bottom of the borehole several times per second while the entire drill pipe is rotated by a hydraulic motor on the drilling rig. The up-and-down bit motion is caused by a compressed-air powered piston to which it is connected. The compressed air is forced out through ports at the piston and bit, where it cools the bit and lifts the drill cuttings upward, out of the borehole.

This drilling method was selected because of its suitability for drilling the extremely hard rocks of Yosemite National Park, and for its speed and cost advantages. Two alternative methods, cable-tool drilling and dual-wall hammer drilling, were rejected. Cable-tool drilling typically requires two to four times as long to drill a given depth as does the downhole hammer method used. The dual-wall hammer method may have obviated the near-surface collapse problem, but costs approximately twice what downhole-hammer drilling costs per foot of well drilled.

In order to allow flexibility in final site selection, at the direction of NPS personnel, five well permits were applied for and obtained from the Department of Health of Tuolumne County, within which both Tuolumne Meadows and White Wolf are located. These well permits are included as Appendix A of this report.

2.1 TEST-WELL SITE PROTECTION AND CLEANUP

At the request of NPS personnel from Yosemite National Park, certain precautions were taken to ensure that the test-well sites at Tuolumne Meadows and White Wolf would be disturbed as little as possible. The nature of water-well drilling is such that some site disturbance takes place. However, the contractor was successful in effecting the requested precautions and site clean-up procedures so that site disturbance and visual impact were minimal.

For each of the three test wells black plastic sheeting was placed on the ground such that all equipment was on the plastic. Hay bales and drill cuttings (rock material removed from the borehole by the drilling process) were used to contain the produced water so that most fine-grained drill cuttings would settle out before the water left the plastic. This arrangement was also effective in trapping any fluids leaking from the drilling rig or other equipment.

When any drilling or support equipment was driven off access roads, 3/4-inch thick plywood was placed on top of the plastic sheeting. This procedure was successful in preventing undue compaction of the native soil and vegetation at the well sites.

All drill cuttings from each well were loaded into a large dumpster and hauled out of the park for disposal. All plastic sheeting, plywood, absorbent material, and hay bales were also hauled out of the park for disposal. A backhoe was rented to facilitate onsite transport of abandonment materials for Tuolumne Meadows test wells no. 1 and 2 and to load drill cuttings into the dumpster for site cleanup.

2.2 TUOLUMNE MEADOWS TEST WELL DRILLING

2.2.1 Tuolumne Test Well No. 1

This test well was located immediately west of the loop road A in Tuolumne Meadows campground, south of the main entrance gate into the campground (see Figure 10). Drilling commenced on October 21, 1993, and ended on October 27, 1993. All depths noted in this report are from ground level unless otherwise specified.

An 8-inch diameter hole was drilled to a depth of 80 feet in preparation for reaming the hole and installing 8-inch steel surface casing. Loose glacial-derived soil with gravel and large boulders was drilled from ground level to eight feet. Granite was drilled from eight feet to a total depth of 400 feet. Water was encountered at a depth of 15 to 16 feet in a fracture zone with an estimated flow rate of five gallons per minute (gpm). Because current California well-construction standards for public water-supply wells call for a minimum grout interval of 50 feet below ground surface to ensure sanitary protection to the ground-water supply, this shallow ground water had to be sealed off by surface casing and grout (impermeable slurry) in the annular space between surface casing and the borehole wall.

After reaming the hole diameter from 8 to 12 inches to a depth of 25 feet, a visual inspection of the hole showed a large cavity forming in the depth interval four to eight feet. This was due to the loose soil washing away from the gravel and boulders by the compressed-air drilling process. This condition threatened the stability of the borehole. Therefore, drilling was stopped until 16-inch casing could be brought to the site and installed to prevent borehole collapse. A 14-inch bit was used to ream the hole in preparation for setting the 16-inch casing. While attempting to push the 16-inch casing into the borehole by the weight of the drilling rig, several unstable boulders fell into the hole. These had to be drilled up with the 8-inch bit to allow casing placement. The 16-inch casing was placed in the hole to the top of the bedrock at 8 feet. No cement or grout was placed outside the 16-inch casing.

The bedrock hole diameter was reamed to a depth of 25 feet from 12 to 14 inches. At this time, the 8-inch hammer did not appear to be operating correctly. After procuring a new hammer and trying it with no better results, the problem was finally traced to a lack of sufficient air volume from the air compressor. This is most likely due to the elevation and the attendant loss of compressor horsepower and air volume. A decision was made to ream the rest of the hole from an 8-inch to a 12-inch diameter to a depth of 50 feet. After cleaning the hole of all the rock debris produced from breaking up the boulders and gravel, the hole was reamed to 12-inches down to 55 feet to allow placement of 8-inch steel casing for the near-surface sealed interval.

Steel surface casing (8 5/8-inch O.D.) was installed from two feet above ground surface to 55 feet depth. Two sets of three casing centralizers each were welded to the casing at approximately 52 feet and 12 feet. Cement grout (API Type I-II) with finely-ground bentonite added was pumped via a tremie pipe, which was a 3/4-inch PVC tube set to 50 feet. The annular space between the borehole and 8-inch casing was filled from 55 feet to approximately eight feet below ground. A total of 25 sacks of cement and 0.5 bags of bentonite were used. Bentonite (4 bags of Ben Seal) was poured into the annulus from eight feet to ground level to facilitate later planned installation of a pitless adapter.

Drilling resumed after letting the cement grout cure overnight. When drilling resumed, no air or water was seen to be coming up the annular space that was cemented, which is evidence that a good seal was made. From eight feet to 400 feet unweathered granite-like rock, probably Cathedral Peak Granodiorite, was drilled with no apparent change in lithology throughout this interval. Only one possible fracture was encountered at 110 feet, with no measurable ground water production. See Table 1 for a lithologic description of Tuolumne test well no. 1. Because no usable ground-water production was encountered, HRS personnel directed the contractor to cease drilling at 400 feet. Fracture size and prevalence tend to decrease with depth due to the weight of the overlying rock and the lack of near-surface weathering and frost action, so that the probability of encountering usable flows of ground water from water-bearing fractures becomes very low below depths of 400 to 500 feet.

With the exception of the shallow ground water from 15-16 feet, which was sealed off behind the surface casing, no other ground water was encountered. Three days after reaching total depth, no water was measured by dual-conductor water-level sounder (M-scope) in the borehole down to 300 feet. The static water level of the shallow water was 7.9 feet below ground level (BGL) prior to installation of the surface casing.

On October 28, the decision was made to abandon this well. This decision was rescinded on the 29th with a decision to leave the well for possible future research work. The 16-inch conductor casing was cut off six feet below ground level and a cap was welded on the 8 5/8-inch steel casing. The site was cleaned up and leveled to original grade. Figure 11 is a cross-sectional schematic diagram of Tuolumne test well no. 1.

2.2.2 Tuolumne Test Well No. 2

Tuolumne test well no. 2 was drilled in the Tuolumne Meadows campground near the northern portion of the D-loop road, immediately north of the loop road between the west gate and the restrooms (see Figure 10). This is adjacent to a small meadow east of Unicorn Creek. The well was located just outside the east edge of the meadow, in a relatively unobtrusive location at the edge of a stand of lodgepole pines.

Drilling commenced on October 28. Prior to drilling, based on our experience at Tuolumne test well no. 1, a decision was made to install 8-inch steel casing into bedrock as a temporary measure to stabilize the loose near-surface soils and alluvium. An 8-inch hole was drilled to 18 feet and reamed to 12 inches diameter. Water was encountered at 15 feet in a near-surface fracture zone which we interpret to be near-horizontal exfoliation fractures due to unloading of preexisting rock and glacial-ice weight by melting and erosion, and also possibly due to frost action. The static water level was 6 feet BGL.

Due to numerous boulders in the near-surface alluvial material from ground surface to 9 feet, 16-inch conductor casing had to be installed to stabilize the borehole. Three hours were spent cleaning the hole in order to be able to install the 16-inch casing. Prior to installation of the 16-inch casing, large voids could be seen downhole where the soil had been washed out from around boulders, destabilizing them. The 8-inch steel casing was installed to a depth of 18 feet to help seal off the borehole from the near-surface ground water. Bentonite was poured in the annulus between the 8-inch and 16-inch casing to help maintain the seal. The steel casing was intended to be temporary until it was known if enough water could be obtained from below 50 feet to warrant completion of the test well as a production well.

An 8-inch borehole was drilled from 18 feet to 400 feet. Light gray granite-like rock (probably Cathedral Peak Granodiorite) with zones of pale-pink orthoclase (potassium feldspar), probably Johnson Granite Porphyry, was drilled. No noticeable fractures were encountered below 15 feet. No increase in water was seen below 15 feet. See table 2 for a lithologic description of the materials encountered. As with test well 1, a decision was made to cease drilling at a depth of 400 foot, based on the likelihood of not encountering any water-bearing fractures below that depth given the unfractured nature of the rock above 400 feet.

At the direction of HRS, the drilling rig and support equipment were moved offsite on November 1. Abandonment of this well was done on November 2, following discussion between HRS and NPS personnel and agreement that abandonment should be performed. The 8- and 16-inch casing were removed from the hole and pea-sized gravel was poured into the hole. The borehole was filled with gravel from 400 feet up to approximately 15 feet. Fifteen sacks of API Type I-II cement were poured into the hole from 15 feet to approximately one foot BGL. Drill cuttings were used to fill the rest of the hole. This abandonment procedure meets current California standards for well abandonment. Figure 12 is a cross-sectional schematic diagram of Tuolumne test well no. 2.

Because of the lack of usable production, neither of the two test wells drilled at Tuolumne Meadows were test-pumped.

2.3 WHITE WOLF TEST WELL DRILLING

2.3.1 White Wolf Test Well No. 1

This well is located on the east side of the White Wolf entrance road, about 2500 feet north of the Tioga Pass road, approximately 25 feet east of the entrance road (see Figure 13). A large marshy meadow is present to the east with the well located on the southwest side of the meadow.

Drilling commenced on November 1, 1993. An 8-inch borehole was drilled to a depth of ten feet. Water was encountered at seven feet. Prior to drilling the bedrock, 16-inch casing was driven into the soil to refusal at 9.4 feet. Before driving the casing, a hardened-steel drive shoe was welded on the bottom of the casing to facilitate driving the casing and to keep the casing from collapsing should it have hit a boulder. Bedrock was encountered at 9.4 feet BGL.

Once the 16-inch conductor casing was installed, Yosemite Falls commenced drilling an 8-inch hole into bedrock. Steel casing of 8 5/8-inch diameter was installed in the interval from two feet above ground surface to 50 feet, and was grouted in place. While drilling to 50 feet, fracture zones were encountered at 18 to 19 feet, 40 to 43 feet, and 47 to 48 feet. All of these fractures were water-bearing, but a good measurement of flow could not be obtained due to the transition from 8-inch to 16-inch borehole. Total flow from these fractures was visually estimated at 10 to 15 gallons per minute. The 8-inch borehole was reamed to 12 inches, and the annular space between the 12-inch borehole and 8 5/8-inch steel casing was grouted using 35 sacks of API Type I-II cement. This cement grout was brought up to 10 feet and then bentonite was poured in the annulus to ground level. The cement grout was left overnight to cure prior to resuming drilling.

An 8-inch borehole was drilled from 50 to 400 feet. Dark gray to greenish-gray granodiorite was drilled from 9 to 400 feet. Below the 50-foot casing level, fractures were encountered at 58 to 60 feet, 100 to 101 feet, 104 to 105 feet, and 278 feet. The only water-bearing fracture encountered was from 58 to 60 feet with a flow rate visually estimated at less than two gpm. After overnight recovery, at an interim total depth of 300 feet prior to drilling to 400 feet, the static water level was two feet BGL and the water was clear when the water was removed by compressed air. See Table 3 for a lithologic description of White Wolf test well no. 1.

On November 4, the decision was made to cease drilling any deeper, due to the low probability of intersecting any water-bearing fractures below that depth, and to leave the test well as is for possible future testing. The 16-inch casing was left in place to avoid disturbing the annular grout seal. A steel cap was welded on the 8-inch casing and the site was cleaned up. The drilling and support equipment were demobilized from White Wolf test well no. 1 on November 4 and 5, 1993. Figure 14 is a cross-sectional view of White Wolf test well no. 1.

Due to the relatively low estimated production rate from White Wolf test well no. 1, no pumping test was performed. The test well can, however, be test-pumped in the future should Arber or NPS elect to do so. Because of the high static water level, testing this well should be strongly considered. The compressed air flow may have been inhibiting some water flow into the borehole. By test-pumping, several pieces of data would be obtained: 1) production volume; 2) recovery rate; and 3) water quality (especially iron content). This data would help determine if more drilling would be feasible in the White Wolf vicinity, and would give a more accurate estimate of production than did the airlifting done following drilling.

2.4 CONCLUSIONS AND RECOMMENDATIONS: TEST-WELL DRILLING AND COMPLETION

With the exception of an estimated two gpm from a fracture at the 58-60 foot depth interval in White Wolf test well no. 1, no water-bearing bedrock fractures were encountered below 50 feet in any of the three test wells. Each of these three test-well sites was selected through a process of published-data review, mapping of wilderness areas and culturally or environmentally-sensitive areas, aerial-photo analysis of fracture location, field checking, and subsequent adjustment of the selected locations based on proximity to existing water lines, minimization of meadow or wetland disturbance, drilling-equipment access, and minimization of visual impact. The final test-well site selections were made cooperatively by HRS personnel and NPS personnel from Yosemite National Park as well as the Western Branch Design Team from the Denver Service Center.

The crystalline granodiorite bedrock which comprises the vast majority of the rock in the Tuolumne Meadows and White Wolf areas is an extremely massive, hard rock. Aerial-photo analysis and field observations indicate that the majority of the fractures are near-vertical. From the test-well drilling, however, it is also apparent that there is little or no zonation (broadening) of fractures, or secondary fracturing, so that well locations must be in direct contact with fractures and not just in the vicinity.

In order to successfully develop ground water as the sole water supply in Tuolumne Meadows, and as a supplementary water supply at White Wolf, HRS recommends two alternative strategies:

1. Locate future test-well drilling sites precisely, using a combination of aerial-photo analysis, detailed geologic mapping, and geophysical survey methods performed on the ground surface (as explained in part 1 of this report). This may mean selection of drilling sites either in areas accessible only to a track-mounted drilling rig, or in areas deemed environmentally or culturally sensitive, or both.

2. Consider pursuing a variance with the State and County authorities from the 50-foot minimum grouting depth. As discussed in this report, water-bearing near-horizontal exfoliation fractures were encountered in all three of these test wells at depths of less than 20 feet. Though it would not be practical to alter Tuolumne test well no. 1 or White Wolf test well no. 1, we feel that this strategy could be used successfully to obtain shallow ground water at Tuolumne Meadows and White Wolf by drilling wells designed for that purpose. From observations made during the test drilling, individual well production rates of 5 to 20 gpm appear to be achievable, provided that shallow wells are located in fractured rock near a source of ground water recharge.

TABLE 1

Tuolumne Meadows Campground
Well Site 1

Lithologic Description

Depth Below Ground Level (feet)	Description
0 - 8	Soil: tan to reddish with gravel and boulders.
8 - 400	Granodiorite: light gray (salt & pepper), quartz, feldspar and dark minerals; hard flat chips to powder.
15 - 16	Fracture - gravel size pieces with flat faces, iron stain on faces; water flowing from north side of fracture into borehole under some pressure - approximately 5 gpm.

Note: Static water level prior to cementing 8-inch casing was 8 feet BGL: water appeared to be somewhat muddy; don't know source of turbidity, suspect due to near-surface soils.

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TABLE 2

Tuolumne Meadows Campground
Well Site 2

Lithologic Description

Depth Below Ground Level (feet)	Description
0 - 9	Soil: reddish brown, with gravel and boulders.
9 - 240	Granodiorite: light gray (salt & pepper), trace to some pinkish and tan; quartz, feldspar, and dark minerals; hard-flat chips to powder.
240 - 260	Granodiorite: as above, good increase in pinkish color - potassium feldspar, hard, more angular chips.
260 - 400	Granodiorite: same as 9-240 feet.
15 - 16	Fracture zone: angular rock fragments, flat faces with iron stain; water - static level 6 feet BGL; no measure of flow rate; probably similar to Well Site 1.

TABLE 3

White Wolf
Well Site 1

Lithologic Description

Depth Below Ground Level (feet)	Description
0 - 9.4	Soil: brown, sandy, wet below 7 feet.
9.4 - 400	Granodiorite: dark gray to greenish gray; quartz, biotite and other dark minerals and feldspar; hard-flat chips to powder.
18 - 19	Fracture: no returns of drill cuttings at surface, water encountered.
40 - 43	Fracture: angular rock fragments, flat faces with iron stain, water.
47 - 48	Fracture; as above, water - ? gpm.
58 - 60	Fracture: as above, water - <2 gpm.
100 - 101	Fracture: as above, possible water.
104-105	Fracture: as above, possible water.
278	Fracture: increase in pink rock (K feldspar) may be change in lithology or fracture filled with crystals, increase in drill rate for 6" to 1'; no water.

Note: Static water level was 2 feet BGL after setting overnight with total depth of 300 feet.

Total flow rate at 400 feet was estimated to be no more than 2 gpm.

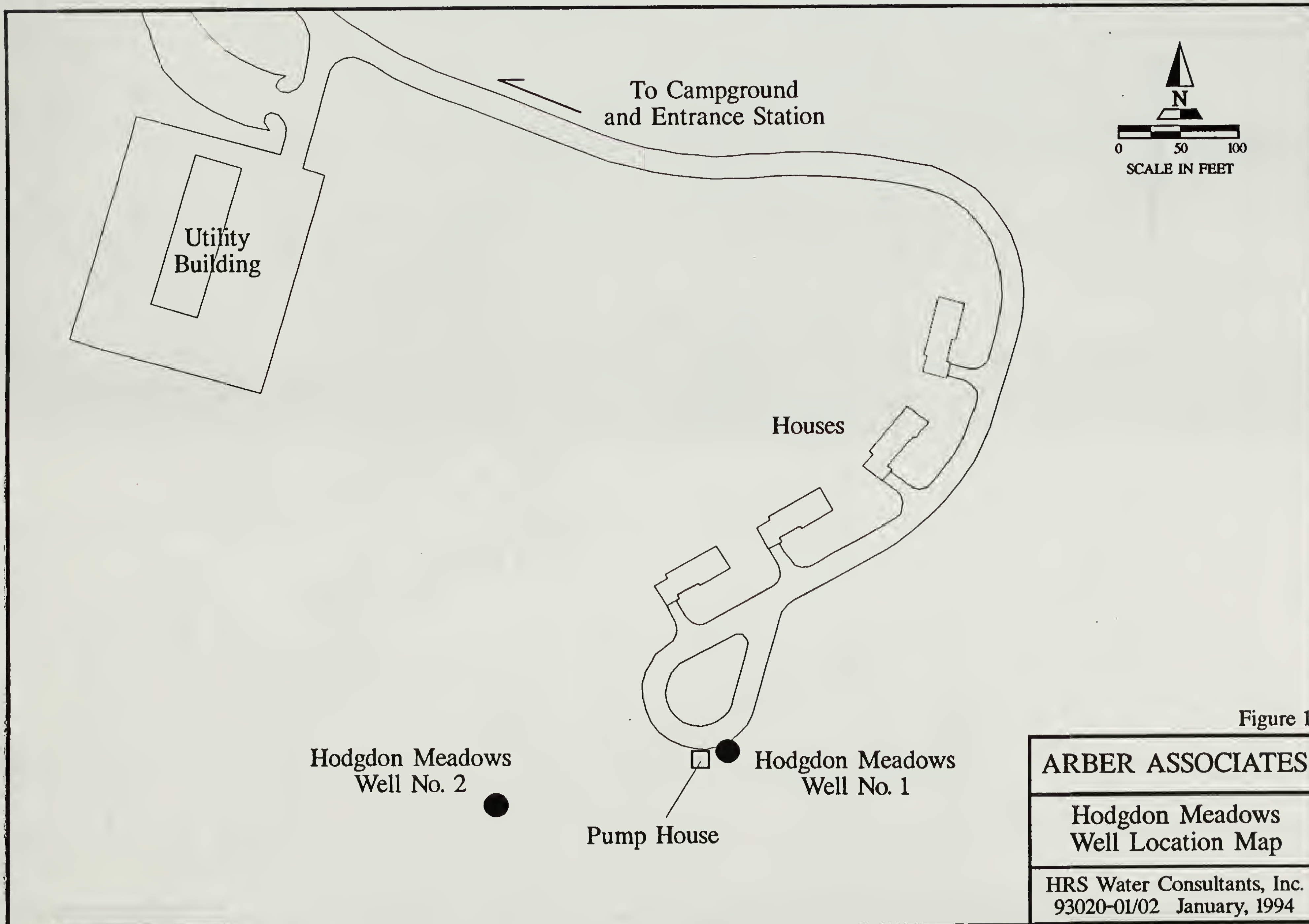

Figure 1

ARBER ASSOCIATES

Hodgdon Meadows
Well Location Map

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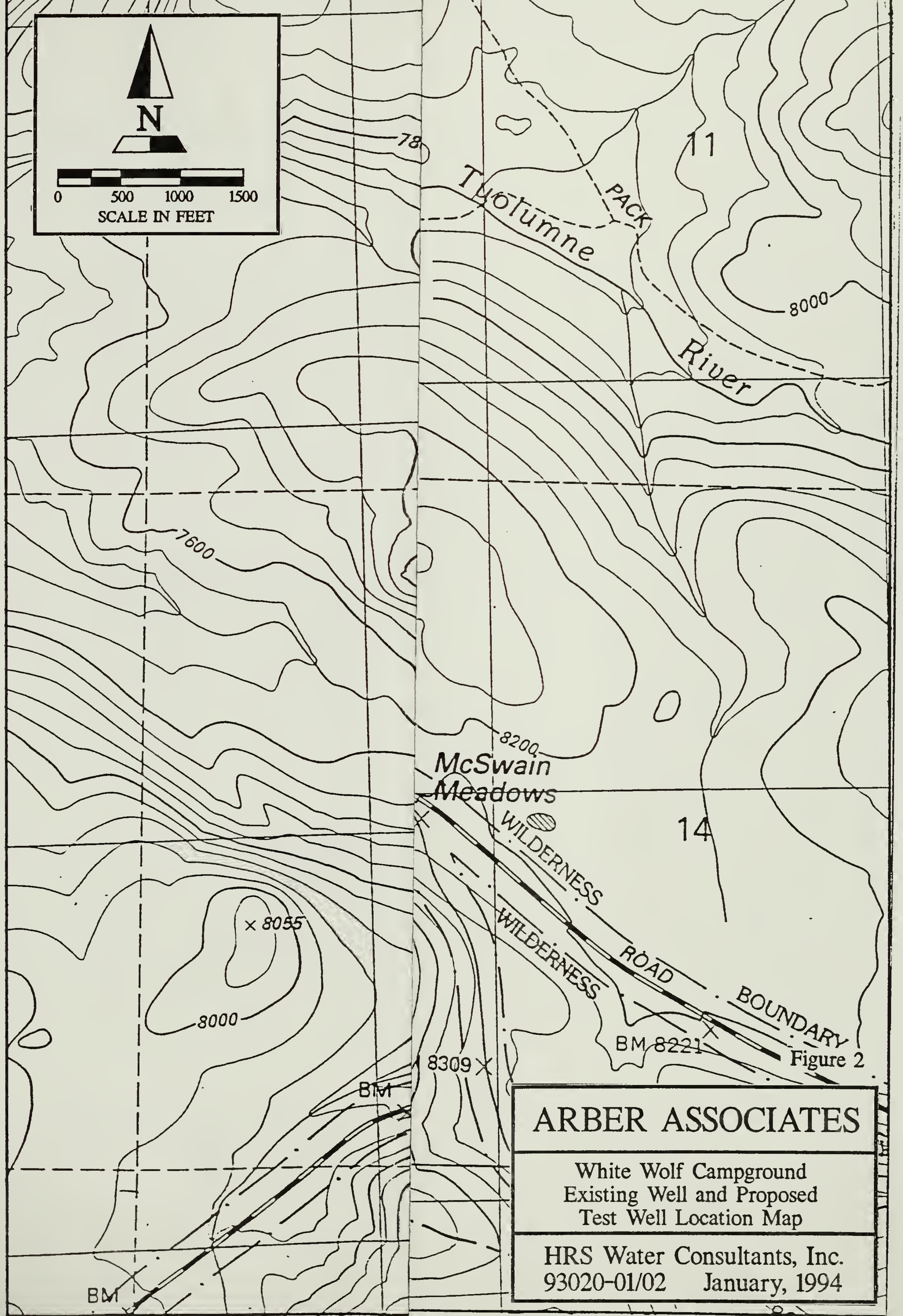

Figure 2

ARBER ASSOCIATES

White Wolf Campground
Existing Well and Proposed
Test Well Location Map

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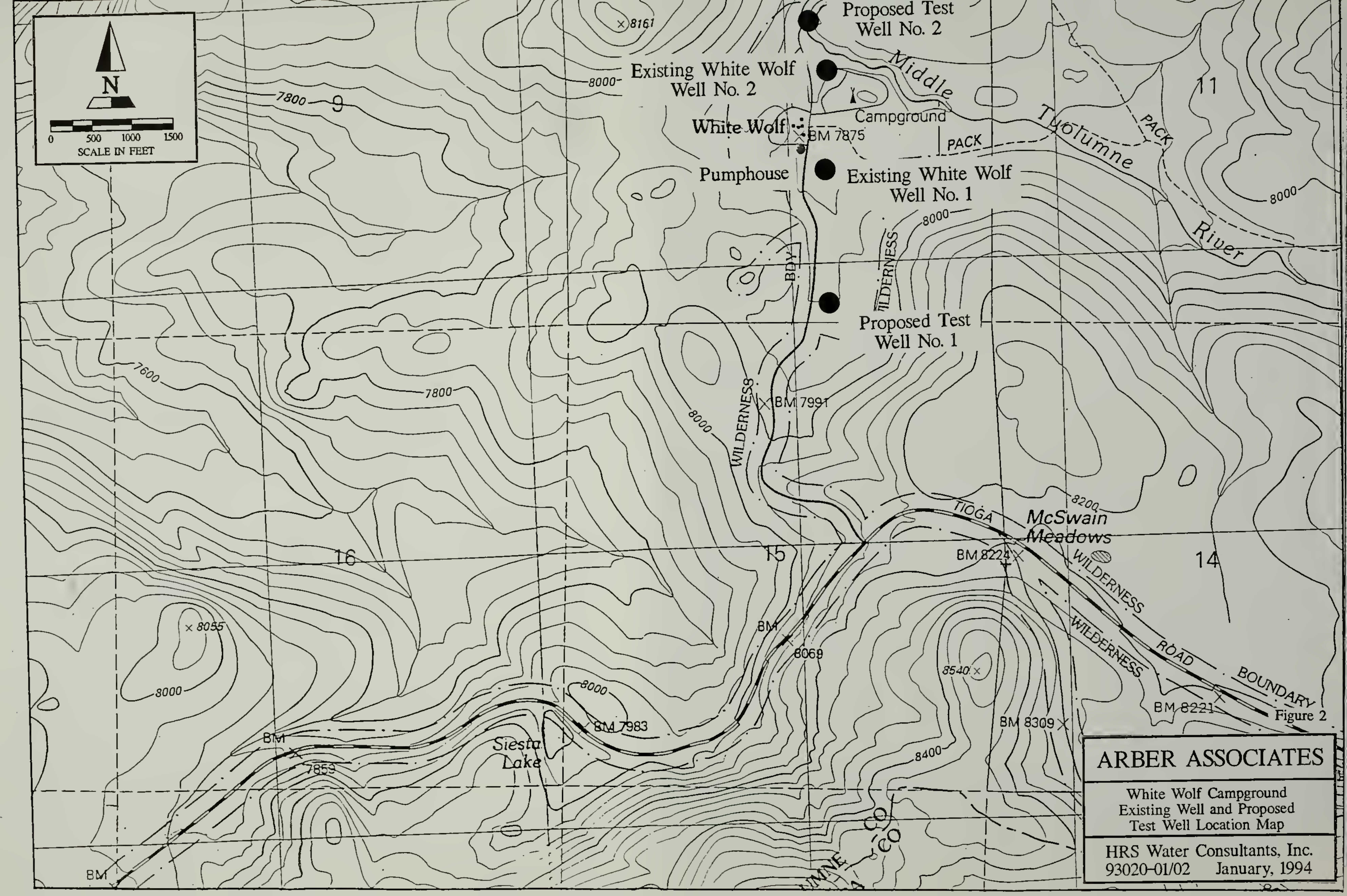
N
0 500 1000 1500
SCALE IN FEET
Proposed Test Well No. 2
Existing White Wolf Well No. 2
White Wolf
BM 7875
Campground
Pumphouse
Existing White Wolf Well No. 1
Proposed Test Well No. 1
Middle Tuolumne River
PACK
BDY
WILDERNESS
BM 7991
TIOGA ROAD
McSwain Meadows
BM 8224
WILDERNESS BOUNDARY
BM 8221
BM 8309
8540
8069
BM 7983
Siesta Lake
BM
7859
8055
8161
7600
7800
8000
8200
8400
9
11
14
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16
ARBER ASSOCIATES
White Wolf Campground Existing Well and Proposed Test Well Location Map
HRS Water Consultants, Inc.
93020-01/02 January, 1994
Figure 2

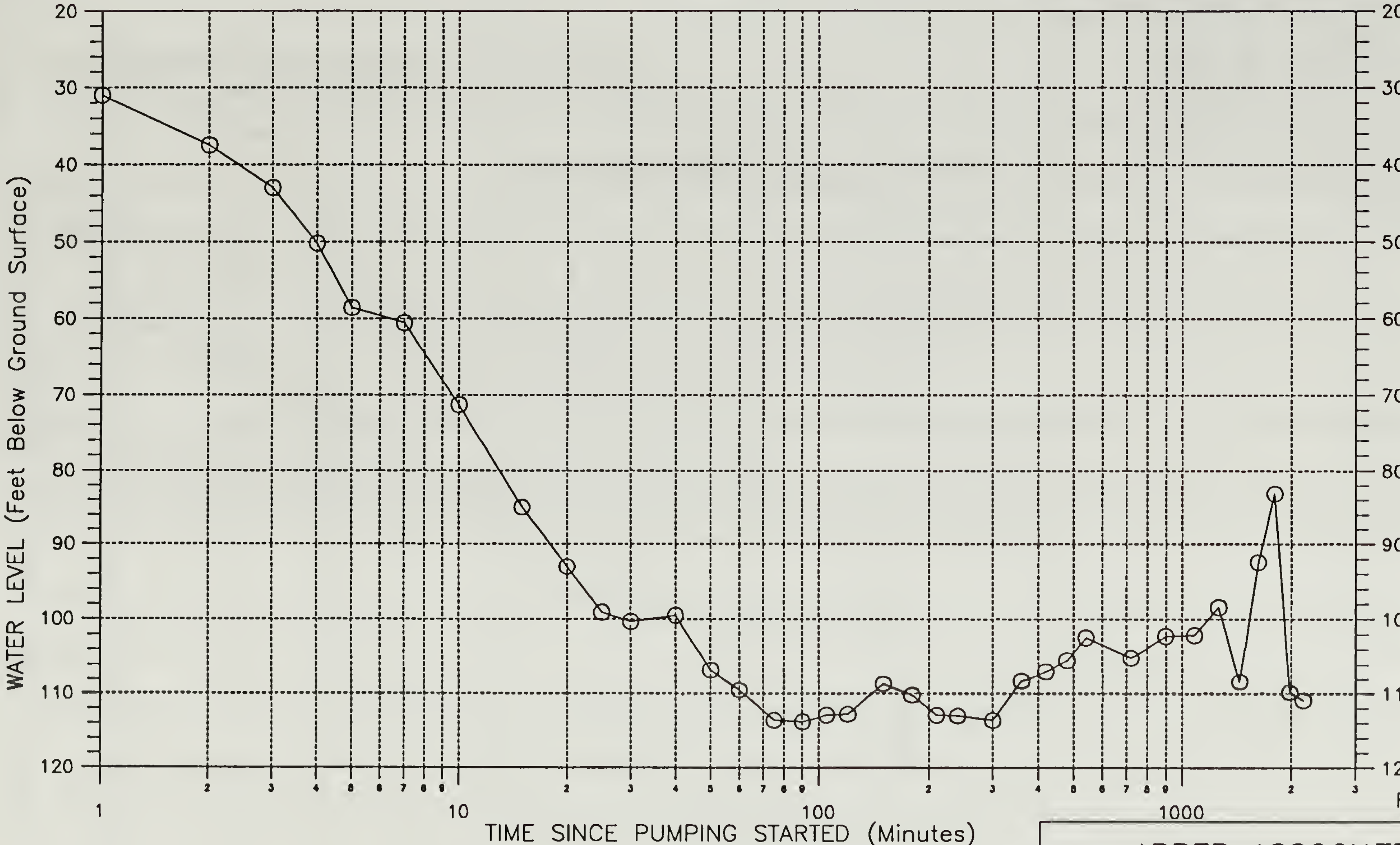

Figure 3

Average Pumping Rate During Test Period = 23 gpm
Calculated Transmissivity = 90 gpd/ft

ARBER ASSOCIATES
YOSEMITE NATIONAL PARK HODGDON MEADOWS WELL #1 PUMPING TEST TIME vs DRAWDOWN
HRS WATER CONSULTANTS, INC. 93020-01/02 JANUARY, 1994

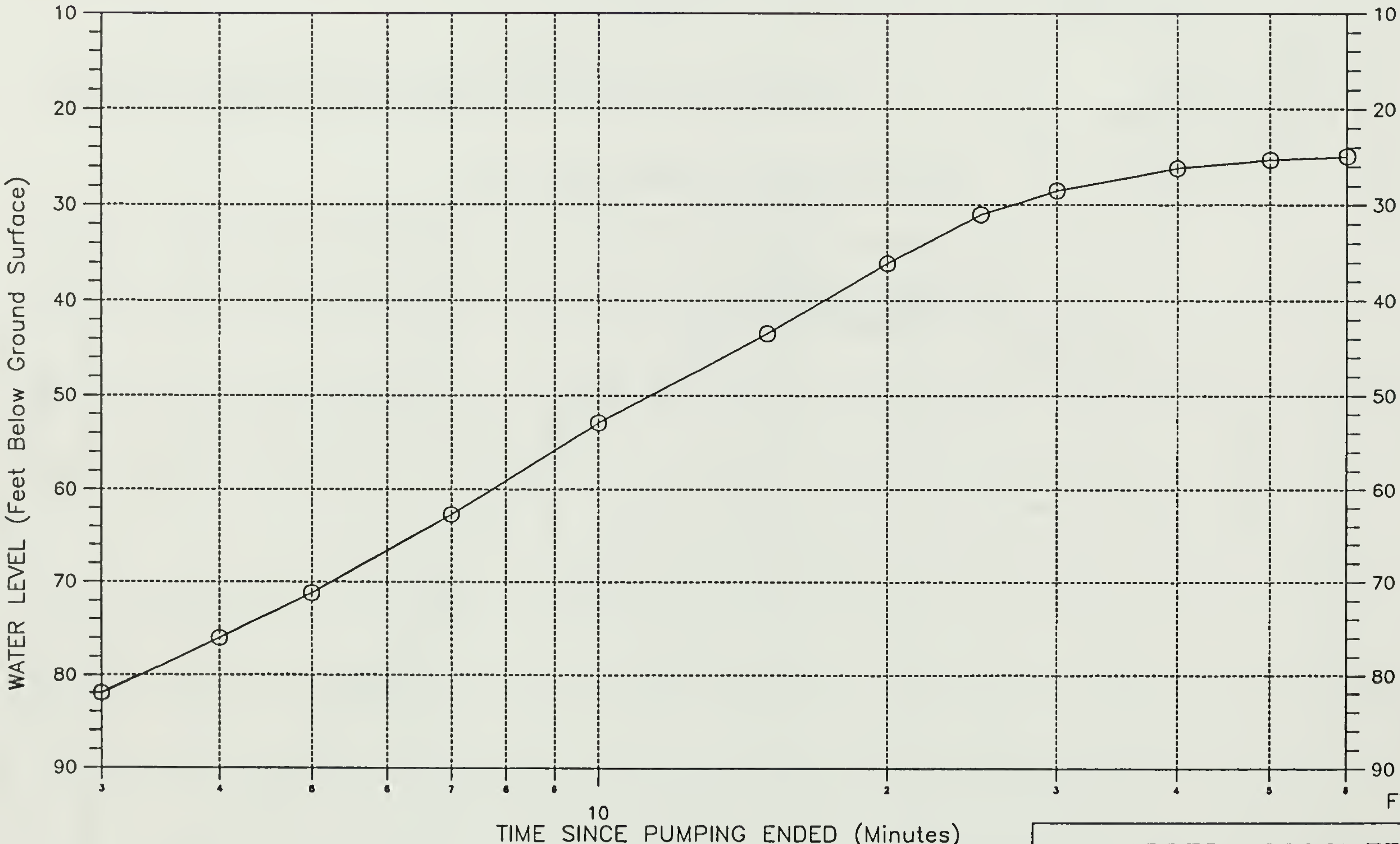

Figure 4

Average Pumping Rate During Test Period = 23 gpm
Calculated Transmissivity = 100 gpd/ft

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YOSEMITE NATIONAL PARK
HODGDON MEADOWS
WELL #1 PUMPING TEST
TIME vs RECOVERY

HRS WATER CONSULTANTS, INC.
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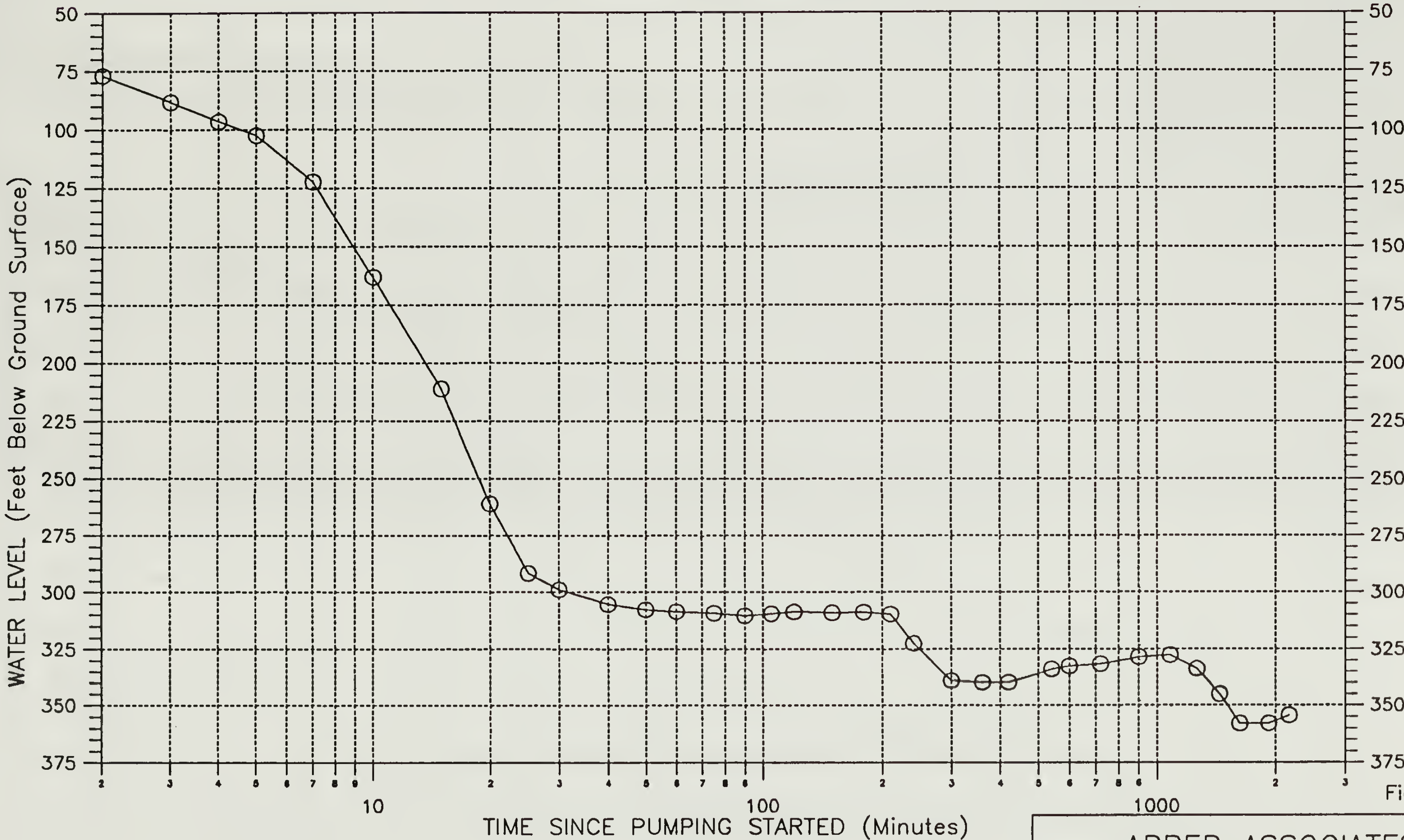


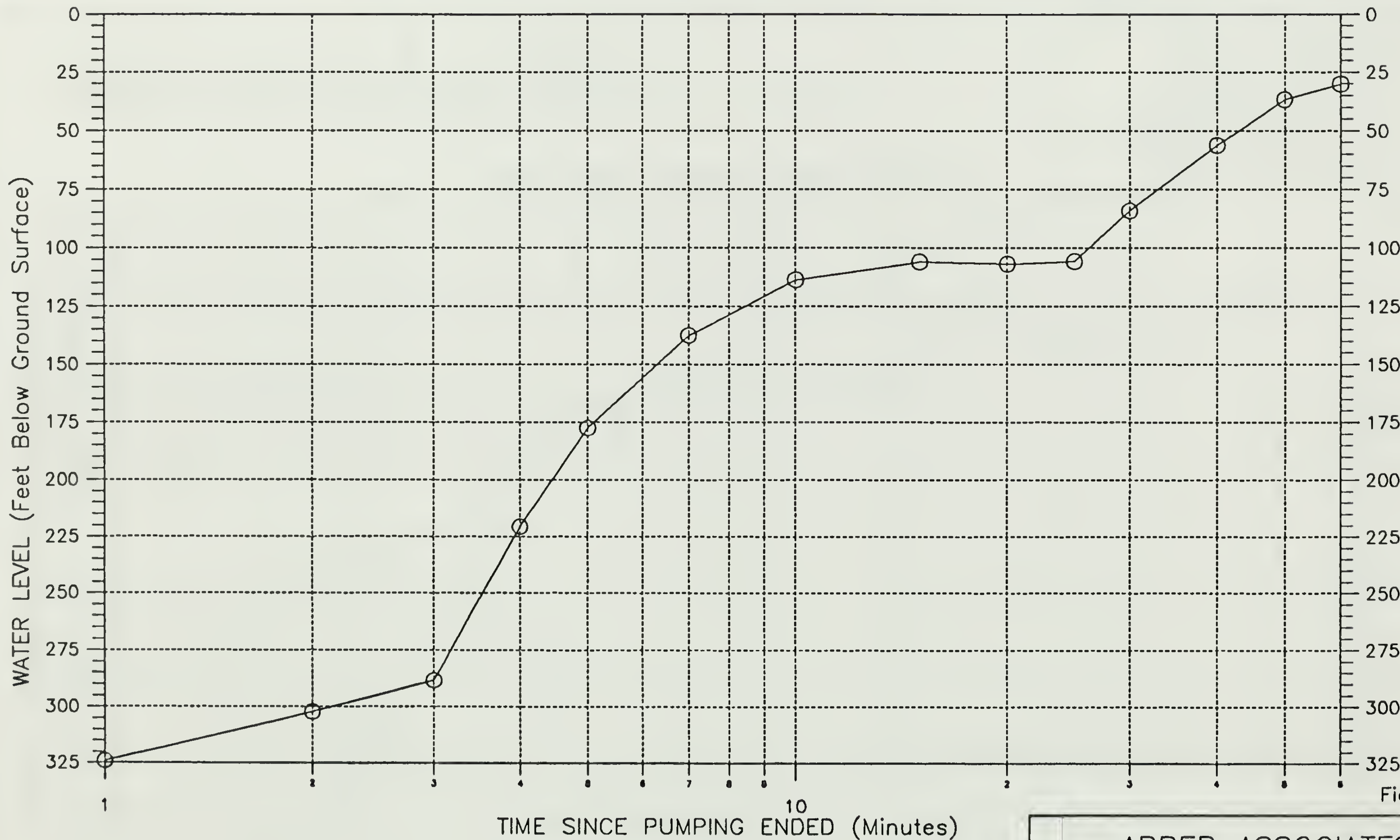
Figure 5

Average Pumping Rate During Test Period = 14 gpm
Calculated Transmissivity = 10 gpd/ft

ARBER ASSOCIATES

YOSEMITE NATIONAL PARK
HODGDON MEADOWS
WELL #2 PUMPING TEST
TIME vs DRAWDOWN

HRS WATER CONSULTANTS, INC.
93020-01/02 JANUARY,1994



Average Pumping Rate During Test Period = 14 gpm
Calculated Transmissivity = 16 gpd/ft

Figure 6

ARBER ASSOCIATES

YOSEMITE NATIONAL PARK
HODGDON MEADOWS
WELL #2 PUMPING TEST
TIME vs RECOVERY

HRS WATER CONSULTANTS, INC.
93020-01/02 JANUARY, 1994

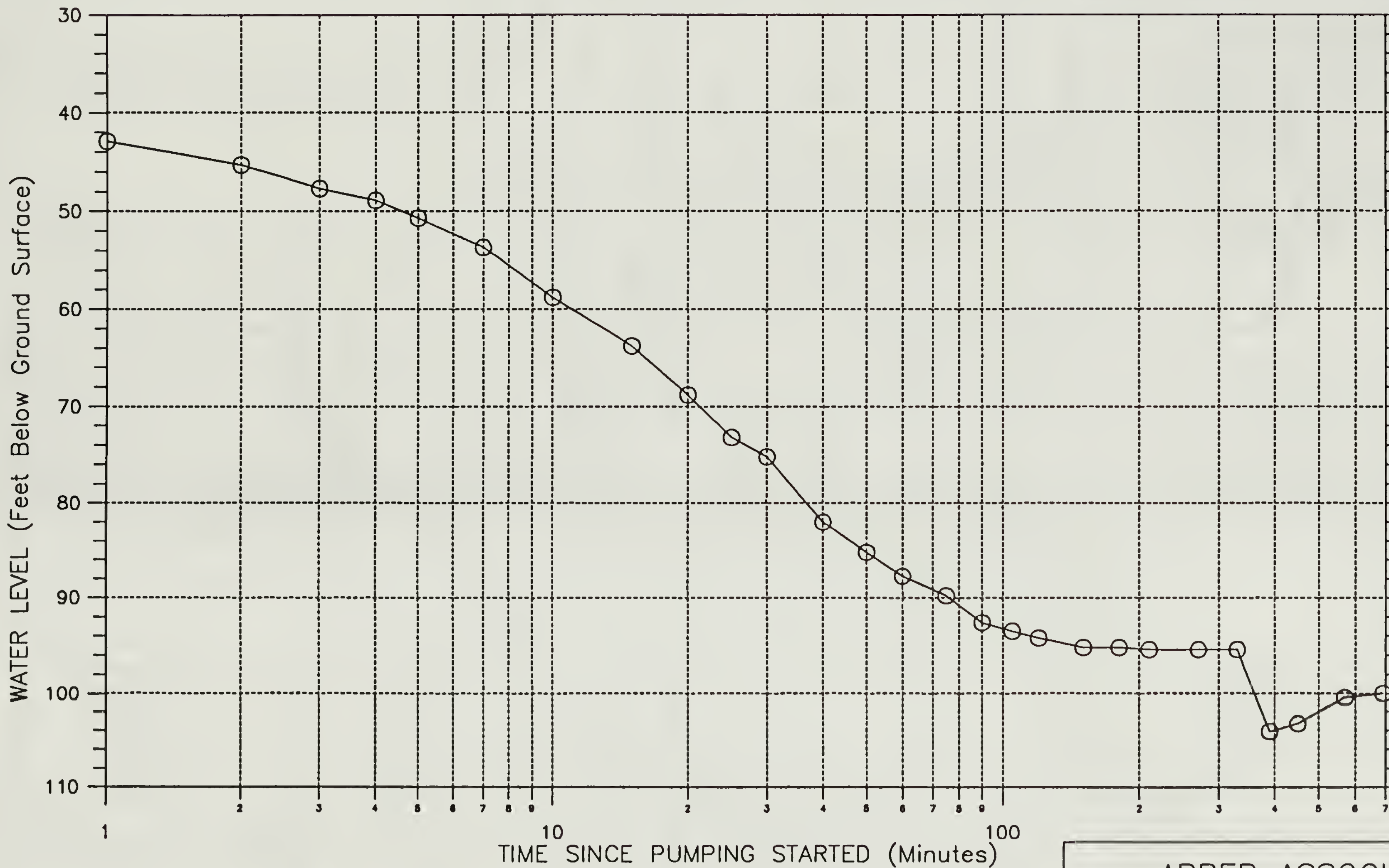


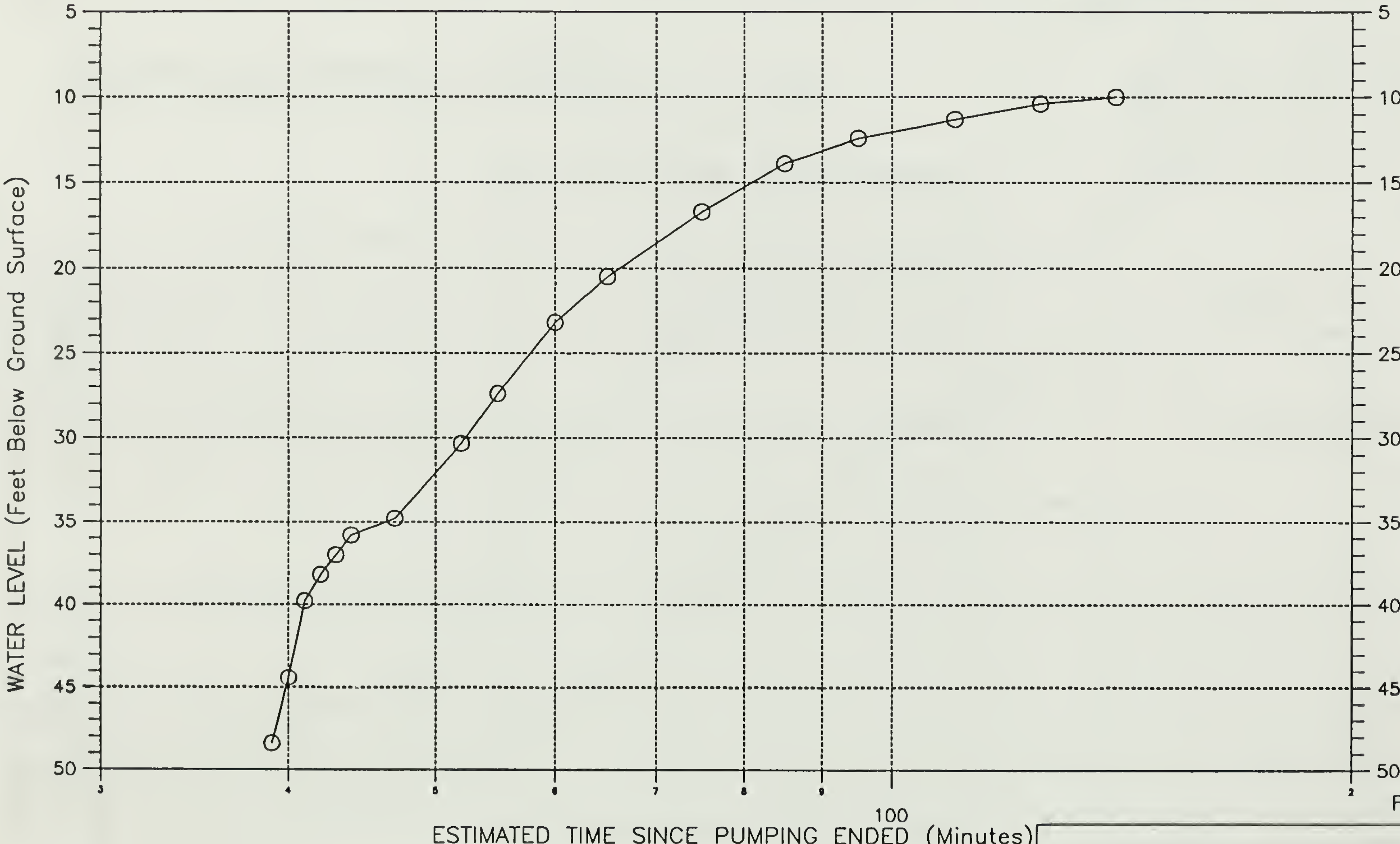
Figure 7

Average Pumping Rate During Test Period = 7 gpm
Calculated Transmissivity = 45 gpd/ft

ARBER ASSOCIATES

YOSEMITE NATIONAL PARK
WHITE WOLF CAMPGROUND
WELL #1 PUMPING TEST
TIME vs DRAWDOWN

HRS WATER CONSULTANTS, INC.
93020-01/02 JANUARY, 1994



Average Pumping Rate During Test Period = 7 gpm
Transmissivity Not Calculated

Figure 8

ARBER ASSOCIATES

YOSEMITE NATIONAL PARK
WHITE WOLF CAMPGROUND
WELL #1 PUMPING TEST
TIME vs RECOVERY

HRS WATER CONSULTANTS, INC.
93020-01/02 JANUARY,1994

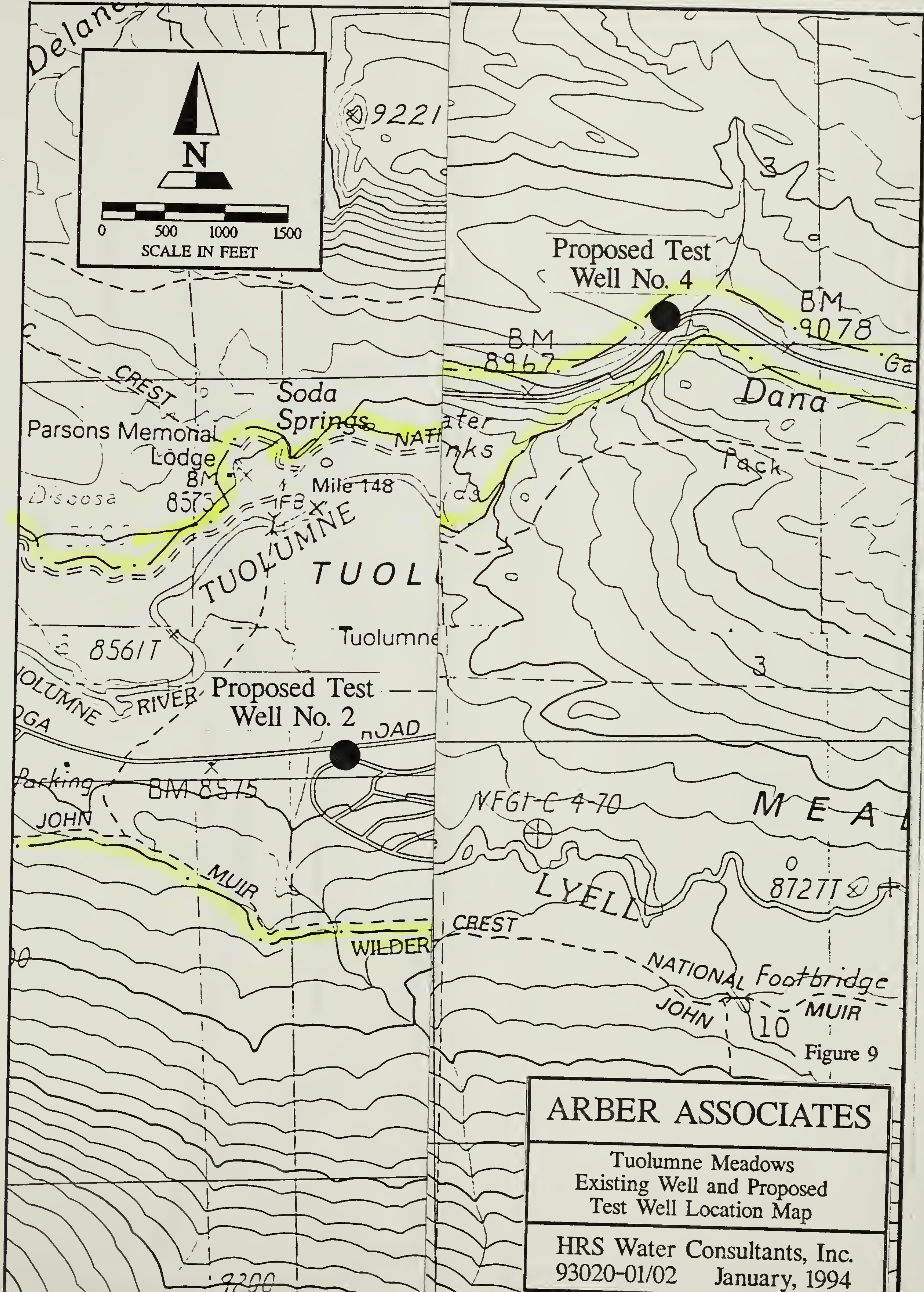
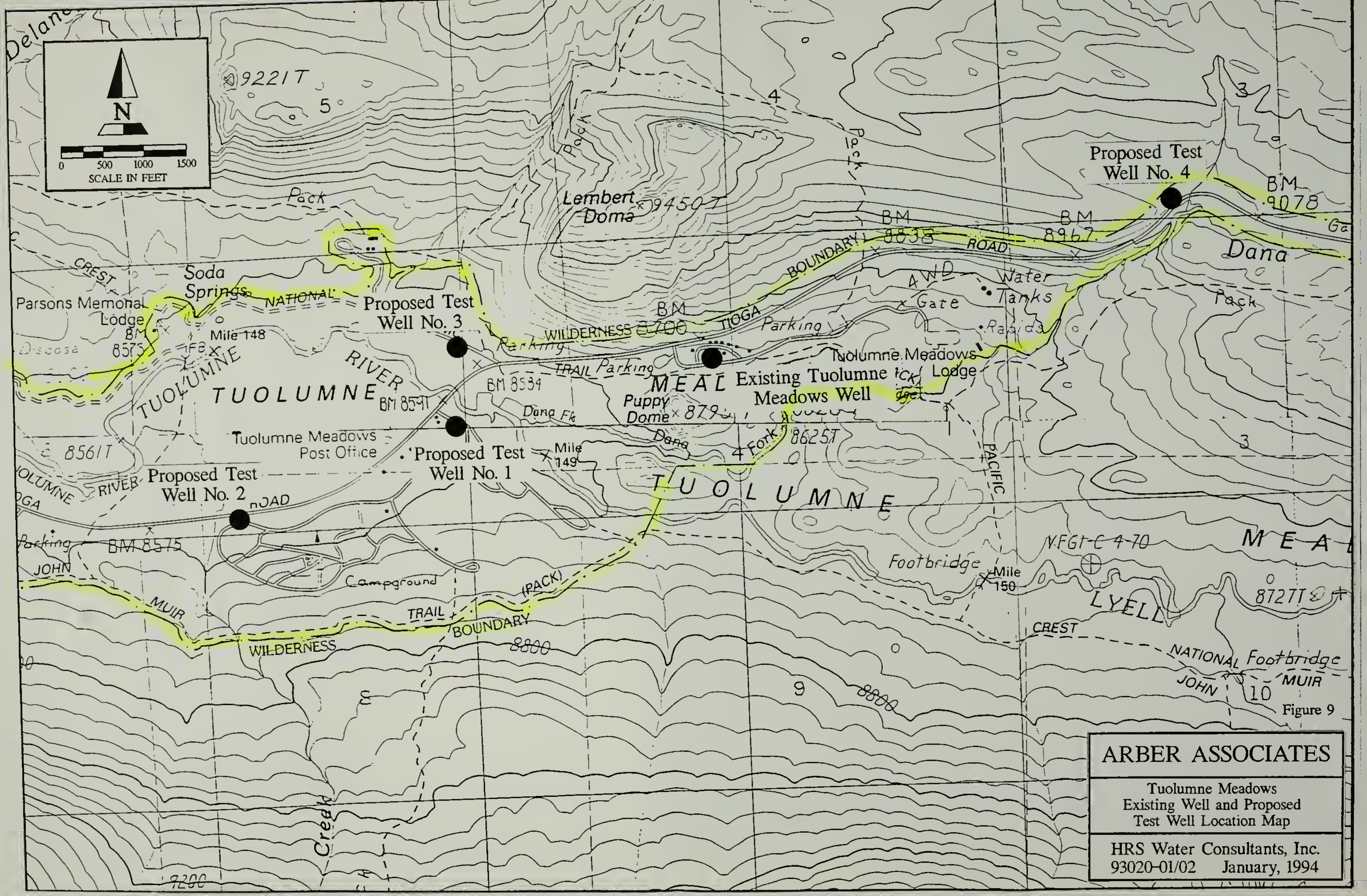


Figure 9

ARBER ASSOCIATES

Tuolumne Meadows
Existing Well and Proposed
Test Well Location Map

HRS Water Consultants, Inc.
93020-01/02 January, 1994



ARBER ASSOCIATES

Tuolumne Meadows
Existing Well and Proposed
Test Well Location Map

HRS Water Consultants, Inc.
93020-01/02 January, 1994

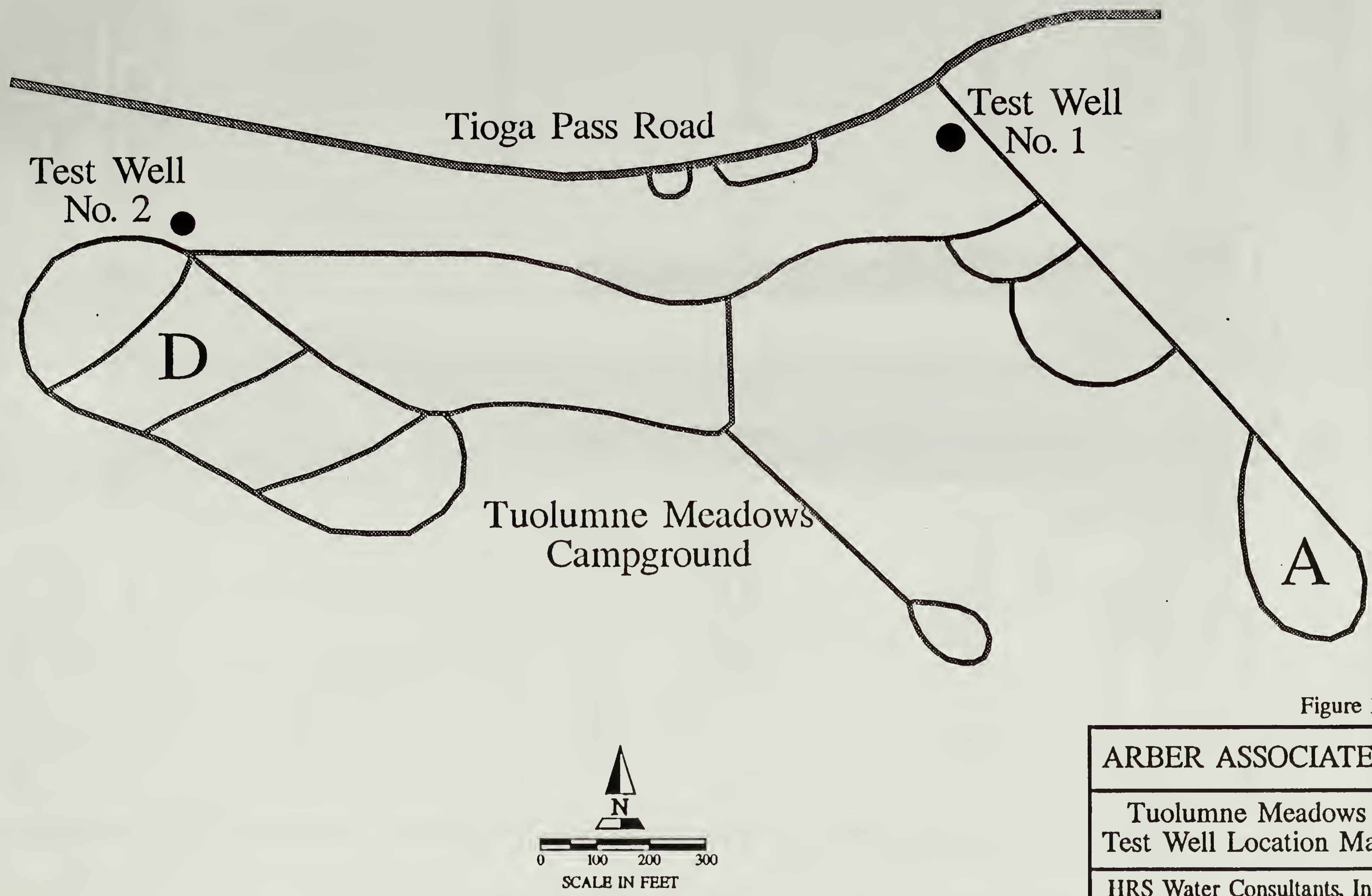


Figure 10

ARBER ASSOCIATES

Tuolumne Meadows
Test Well Location Map

HRS Water Consultants, Inc.
93020-01/02 January, 1994

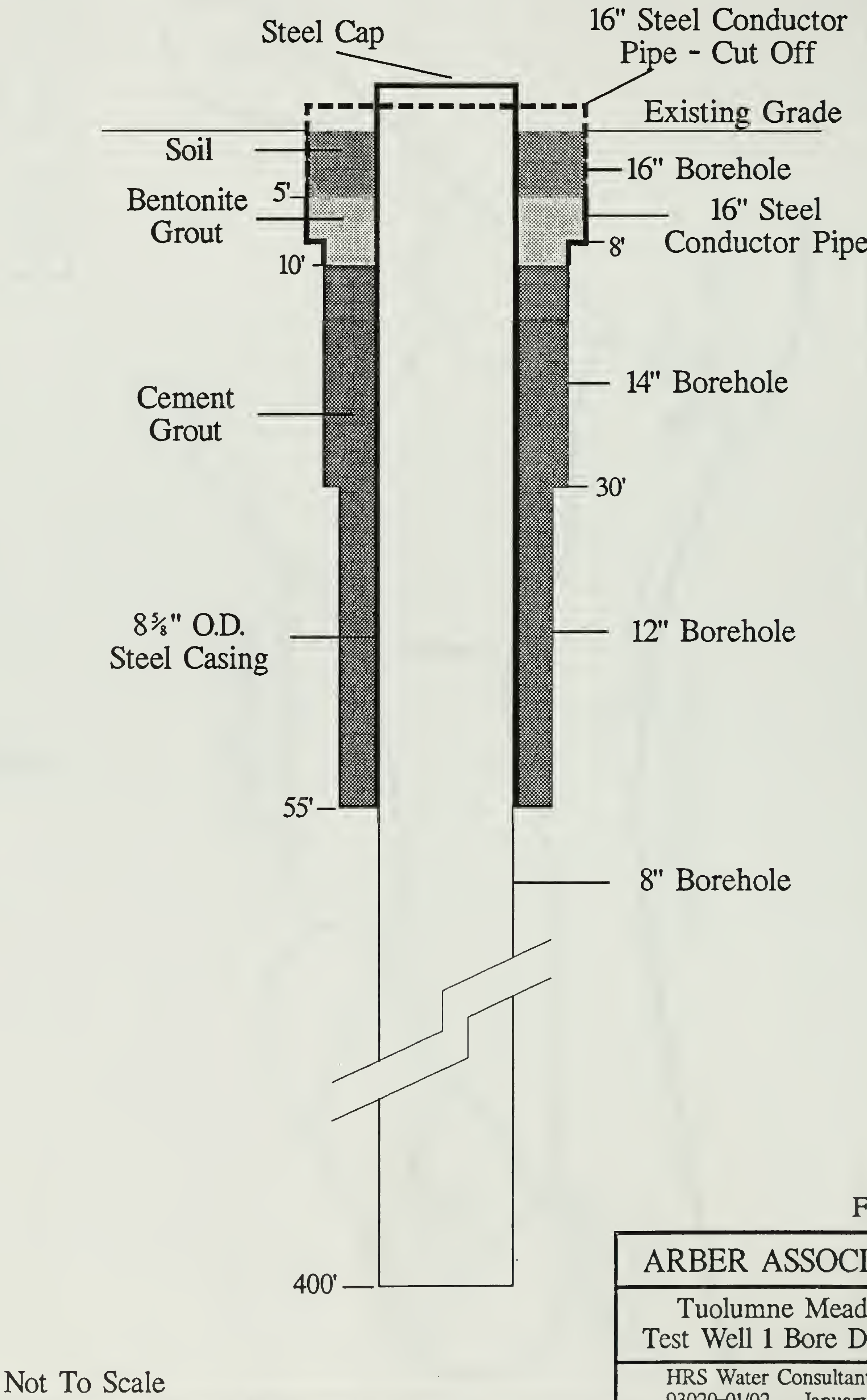


Figure 1

ARBER ASSOCIATES

Tuolumne Meadows
Test Well 1 Bore Diagram

HRS Water Consultants, Inc.
93020-01/02 January, 1994

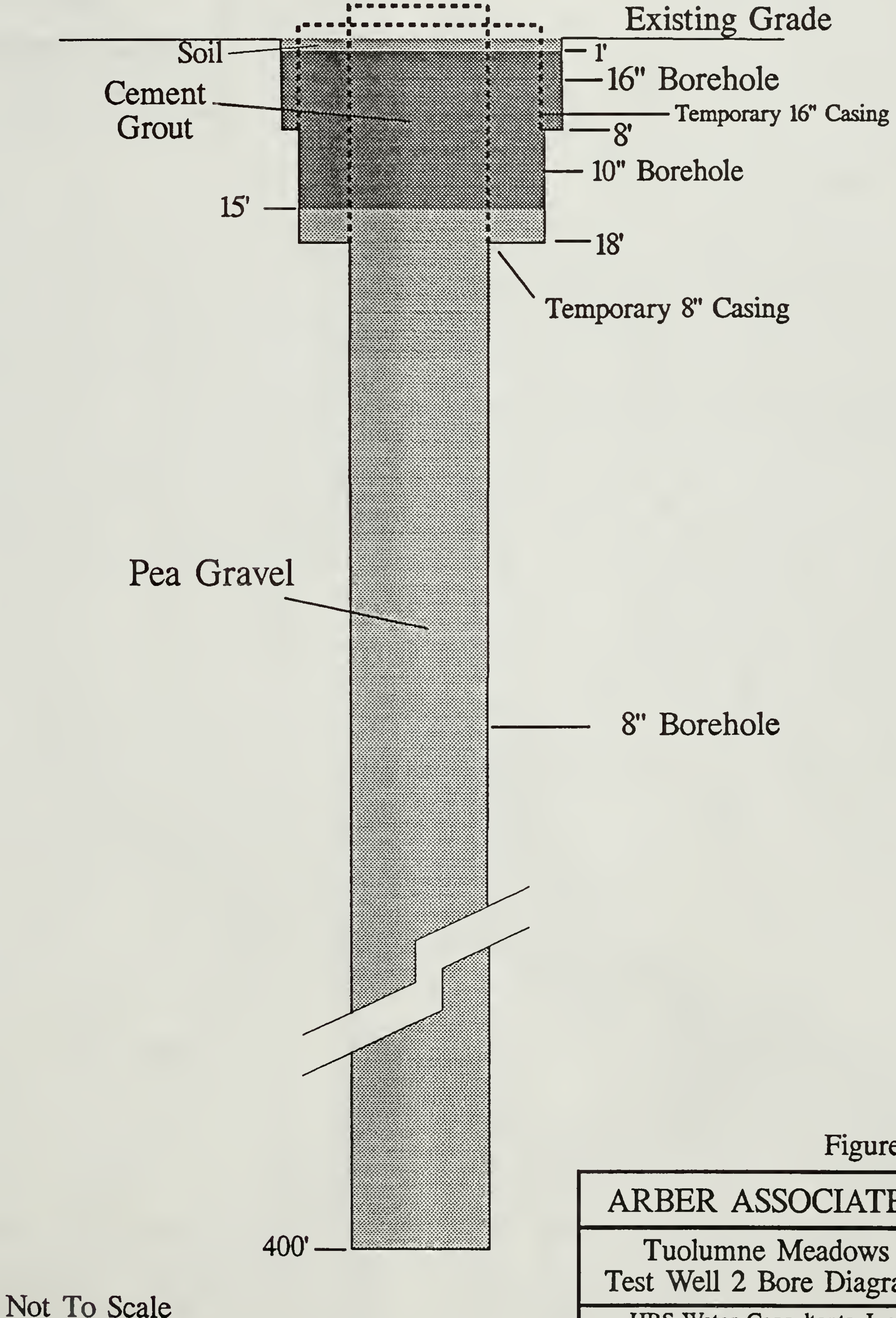


Figure 12

ARBER ASSOCIATES

Tuolumne Meadows
Test Well 2 Bore Diagram

HRS Water Consultants, Inc.
93020-01/02 January, 1994

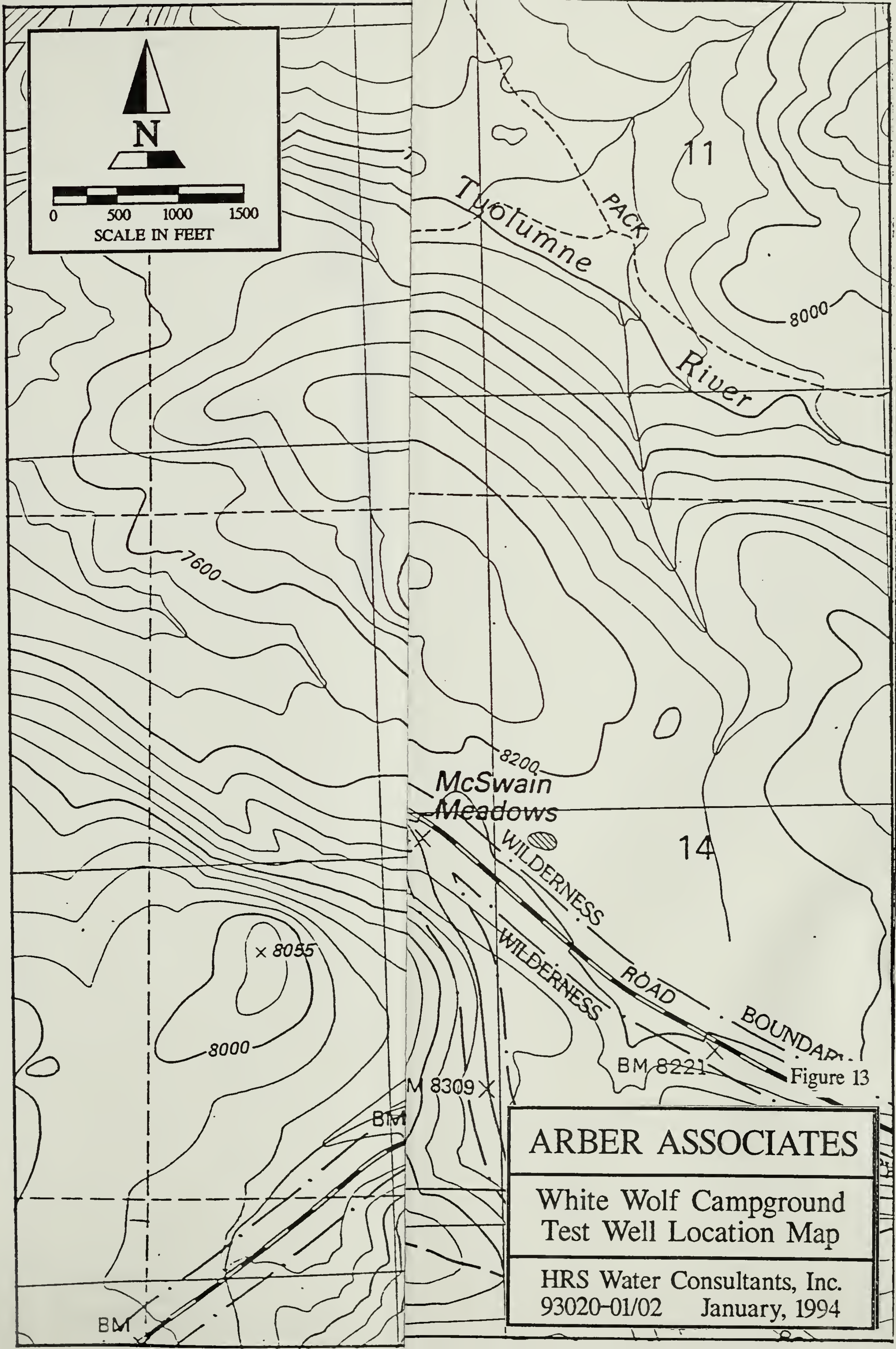
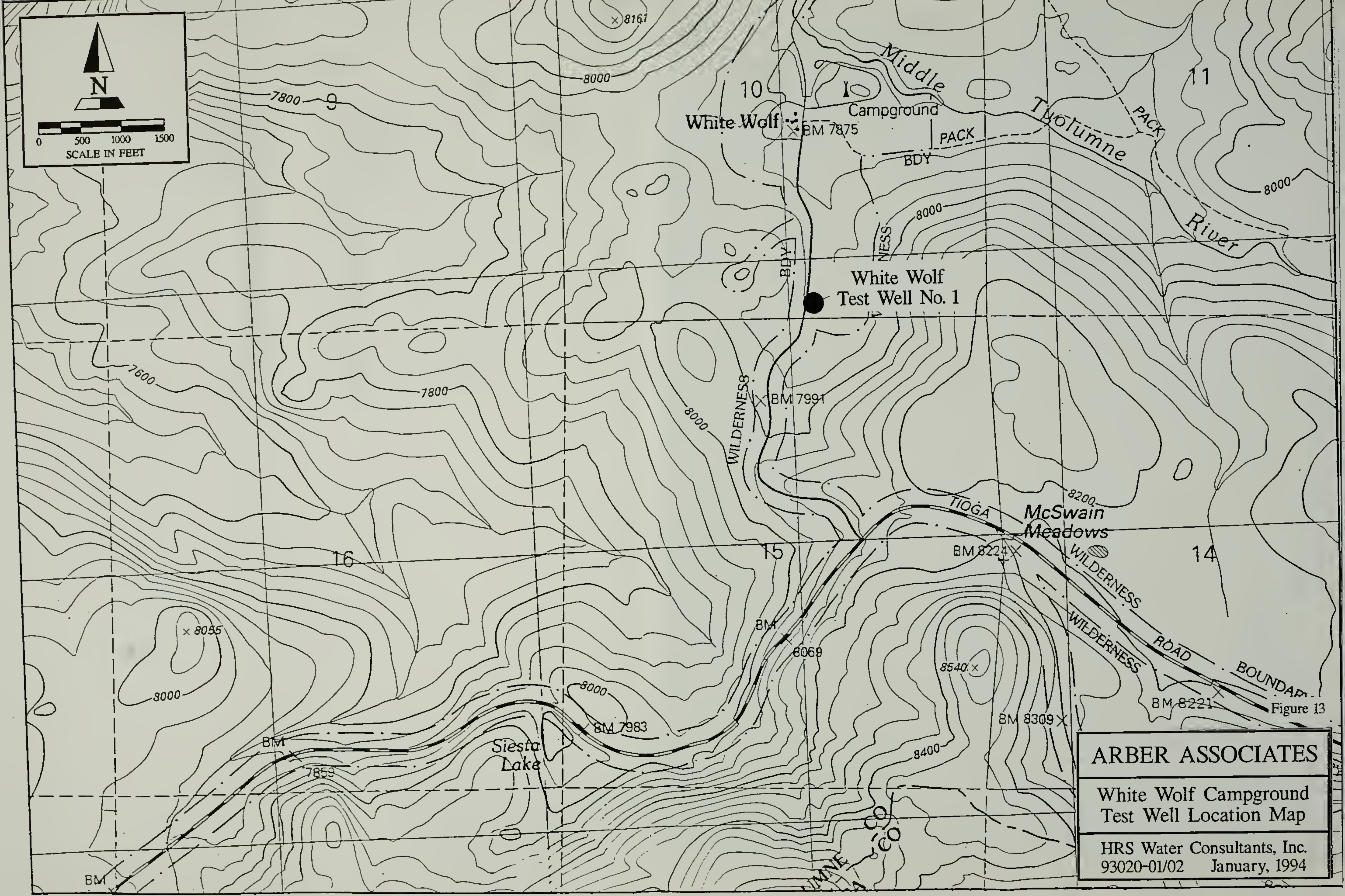


Figure 13

ARBER ASSOCIATES

White Wolf Campground
Test Well Location Map

HRS Water Consultants, Inc.
93020-01/02 January, 1994



ARBER ASSOCIATES

White Wolf Campground
Test Well Location Map

HRS Water Consultants, Inc.
93020-01/02 January, 1994

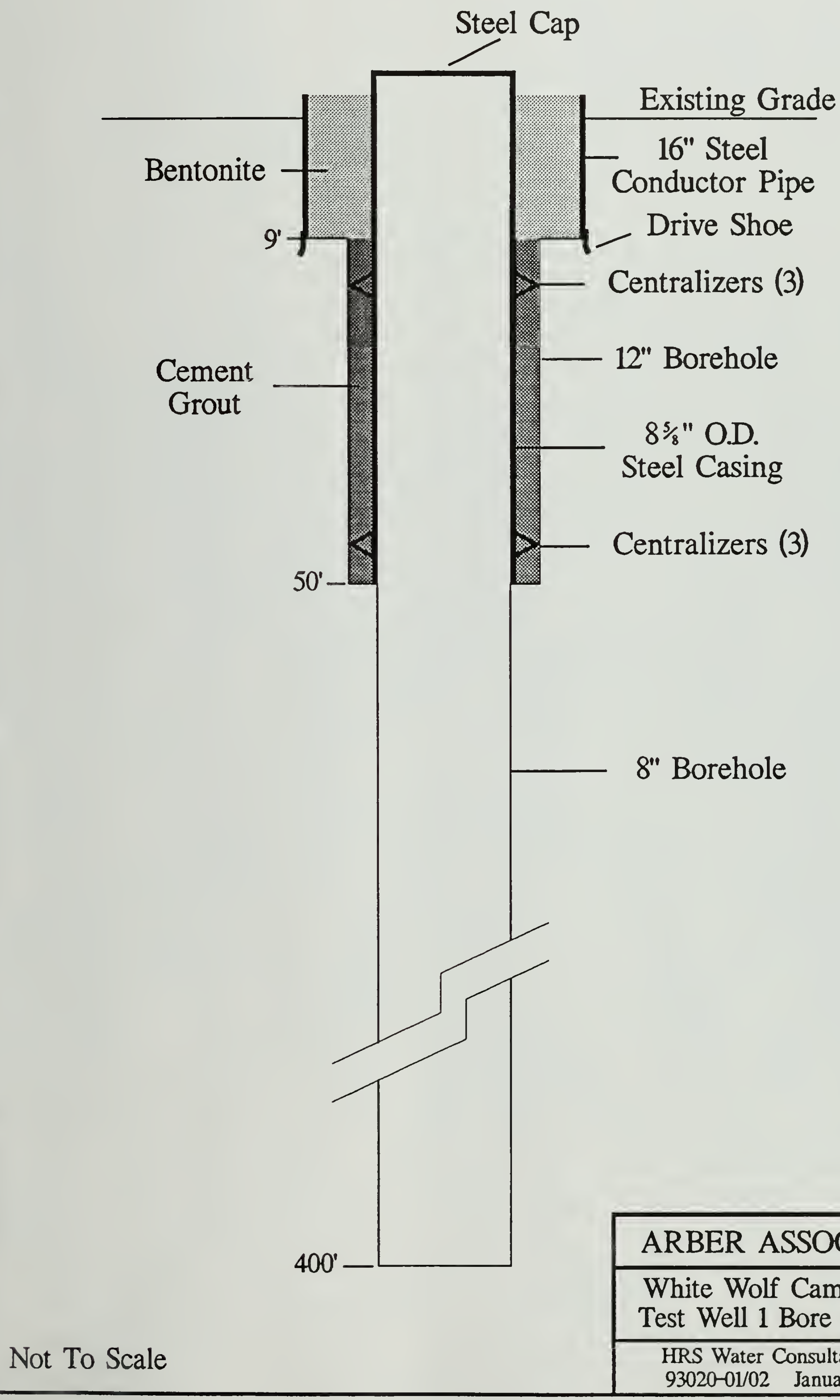


Figure 14

ARBER ASSOCIATES
White Wolf Campground Test Well 1 Bore Diagram
HRS Water Consultants, Inc. 93020-01/02 January, 1994

APPENDIX A

Records of Existing Wells

File with DWR

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

THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
WATER WELL DRILLERS REPORT

Do no

No. 13997

State Well No. ____
Other Well No. ____

(1) OWNER: Name US National Park Service
Address 450 Golden Gate Ave
City San Francisco, CA Zip 94102

(2) LOCATION OF WELL (See instructions):
County Tuolumne Owner's Well Number 1
Well address if different from above Hodgon Meadow
Township 1S Range 19E Section 33
Distance from cities, roads, railroads, fences, etc. at end of turn around in front of residence houses

WELL LOCATION SKETCH

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

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

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

(6) GRAVEL PACK:
Yes ☐ No ☒ Size ____
Diameter of bore ____
Packed from ____

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

From ft.	To ft.	Dia. in.	Gage or Wall
194	+2	8	.322
	*8-5/8" OD		

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

From ft.	To ft.	Slot size
184	144	3/16"
84		1/2"

(9) WELL SEAL:
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 50 ft.
Were strata sealed against pollution? Yes ☐ No ☐ Interval NA ft.
Method of sealing Cement grout

(10) WATER LEVELS:
Depth of first water, if known ____ ft.
Standing level after well completion 20 ft.

(11) WELL TESTS:
Was well test made? Yes ☒ No ☐ If yes, by whom? driller
Type of test: Pump ☐ Bailer ☐ Air lift ☐
Data recorded and on file w/ Nat'l Park Ser
Depth to water at start of test ____ ft. At end of test ____ ft.
Discharge ____ gal/min after ____ hours Water temperature ____
Chemical analysis made? Yes ☐ No ☒ If yes, by whom? ____
Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

(12) WELL LOG: Total depth 194 ft. Depth of completed well ____

from ft.	to ft.	Formation (Describe by color, character, size or material)
0-	5	Gravish silty sand
5-	90	Slightly cemented tan sa[nd]
90-	115	Hard granite w/ fractures
115-	170	Hard granite
170-	173	Hard granite w/ fractures
173-	205	Hard granite

all slots are 2½" long, machine cut, 6 rounds, 37 cuts/round

Work started 28 Oct 1981 Completed 18 NOV 19__

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

SIGNED [signature] (Well Driller)
NAME Lawrence Drilling Co (Person, firm, or corporation) (Typed or printed)
Address 2335 Radio Lane
City Redding, CA Zip 96001
License No. 334700 Date of this report 4/12/82

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

well will yield 42 gpm with 120 feet of drawdown
static water level = 10 feet below land surface datum.

DEPARTMENT OF HEALTH SERVICES

WELL DATA

(1) Place and Owner Yosemite National Park

Source of Information Well Driller's Logs

Collected by C. Forbes Date 5/26/82

(3) Number or Name	Arch Rock Well	Hoggon Meadow Well	Cascades Well
Date drilled	11/25/81	11/1/81	Jan. 1982
(4) Location: Neighborhood	Mountainous	Mountainous	Mountainous
Size of lot			
Distance to: Sewer			
Sewage disposal			
Abandoned well	None		None
Nearest property line			
(5) Housing: Type	None		None
Condition	--		--
Pit depth (if any)	None		None
Floor (material)	None		None
Drainage	Away		Away
Well Depth	93'	194'	80'
Casing: Depth	93'	194'	80'
Diameter	6"	8"	8"
Kind	Steel	Steel	Steel
Height above floor	--	--	--
Distance to highest perforations	73'	144'	60'
Surface sealed (yes or no)	Yes	Yes	Yes
Gravel pack (yes or no)	No	No	Yes
Second casing depth	--	--	--
Second casing diameter	--	--	--
Annular seal (depth)	50'	50'	50'
Impervious Strata: Penetrated — Thickness	See log	See log	See log
Impervious Strata: Penetrated — Depth to	See log	See log	See log
(9) Water Levels: Depth to — Surface			
Static	7'	20'	15'
When pumping			
Pump: Make			
Type	Submersible	Submersible	Submersible
Capacity, g.p.m.	51gpm@9.5' draw down	42gpmw/120' D.D.	44gpm w/7.25' D.D.
Lubrication	Water	Water	Water
Power	Elect.	Elect.	Elect.
Auxiliary power	None	None	None
Control	Auto	Auto	Auto
Discharge location	Below ground		
Discharge to	System		Below ground
Frequency of Use	Daily	Daily	Daily
Flood Hazard			
Remarks and Defects (Use other side if necessary)	Well equipped with a pitless adaptor unit		Well equipped w/pitless adaptor unit

Show well log on other side.

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC HEALTH

13744-450 8-67 10M CSP

(REV. 1-1-51)
FORM 228-1402

DUPLICATE
Driller's Copy

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

Do not fi

No. 326379

Notice of Intent No. PX 8800-8-1679
Local Permit No. or Date

State Well No.
Other Well No.

(1) OWNER: Name YOSEMITE NATIONAL PARK
Address P.O. BOX 700
City ELPORTAL CALIF ZIP 95318

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

Hodgdon Meadow
Unit 2 Tr

WELL LOCATION SKETCH

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

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

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

(6) GRAVEL PACK:
Yes ☐ No ☐ Size
Diameter of bore
Packed from to ft.

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

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

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot size
0	107	6	125			

(9) WELL SEAL:
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 107 ft.
Were strata sealed against pollution? Yes ☒ No ☐ Interval ft.
Method of sealing CEMENT

(10) WATER LEVELS:
Depth of first water, if known 125 ft.
Standing level after well completion 20 ft.

(11) WELL TESTS:
Was well test made? Yes ☒ No ☐ If yes, by whom? DRILLER
Type of test Pump ☐ Bailer ☐ Air lift ☒
Depth to water at start of test 125 ft. At end of test 400 ft.
Discharge 10 gal/min after 6 hours Water temperature
Chemical analysis made? Yes ☐ No ☒ If yes, by whom?
Was electric log made Yes ☐ No ☒ If yes, attach copy to this report

(12) WELL LOG: Total depth 400 ft. Completed depth 400

from ft.	to ft.	Formation (Describe by color, character, size or material)
0	107	DIRT& SAND
107	122	GRANITE
122	125	QUARTZ 10 GPM
125	400	GRANITE
		TOTAL WATER 10 GPM

CONFIDENTIAL
NOT FOR PUBLIC USE
WATER CODE SEC. 13752

Work started 12/8/ 19 88 Completed 12/12/ 19 8

WELL DRILLER'S STATEMENT:

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

Signed [signature]
(Well Driller)
NAME YOSEMITE FALLS WELL DRILLING
(Person, firm, or corporation) (Typed or printed)
Address 4620 BENHUR
City MARIPOSA CA ZIP 95338
License No. 553379 Date of this report 2/10/88

DWR 188 (REV. 12-86) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

86 9

D-297
Badger Pass +
White Wolf
File: Yosemite

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Water Resources Division

TEST-WELL DRILLING IN YOSEMITE NATIONAL PARK
CALIFORNIA, 1968

Prepared in cooperation with the
National Park Service
U.S. Department of the Interior

BASIC-DATA COMPILATION

Menlo Park, California
1969

3A

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Water Resources Division

TEST-WELL DRILLING IN YOSEMITE NATIONAL PARK

CALIFORNIA, 1968

By

Hugh T. Mitten

Prepared in cooperation with the
National Park Service
U.S. Department of the Interior

BASIC-DATA COMPILATION

Menlo Park, California
April 9, 1969

A scene at Badger Pass ski area.

CONTENTS

ILLUSTRATIONS

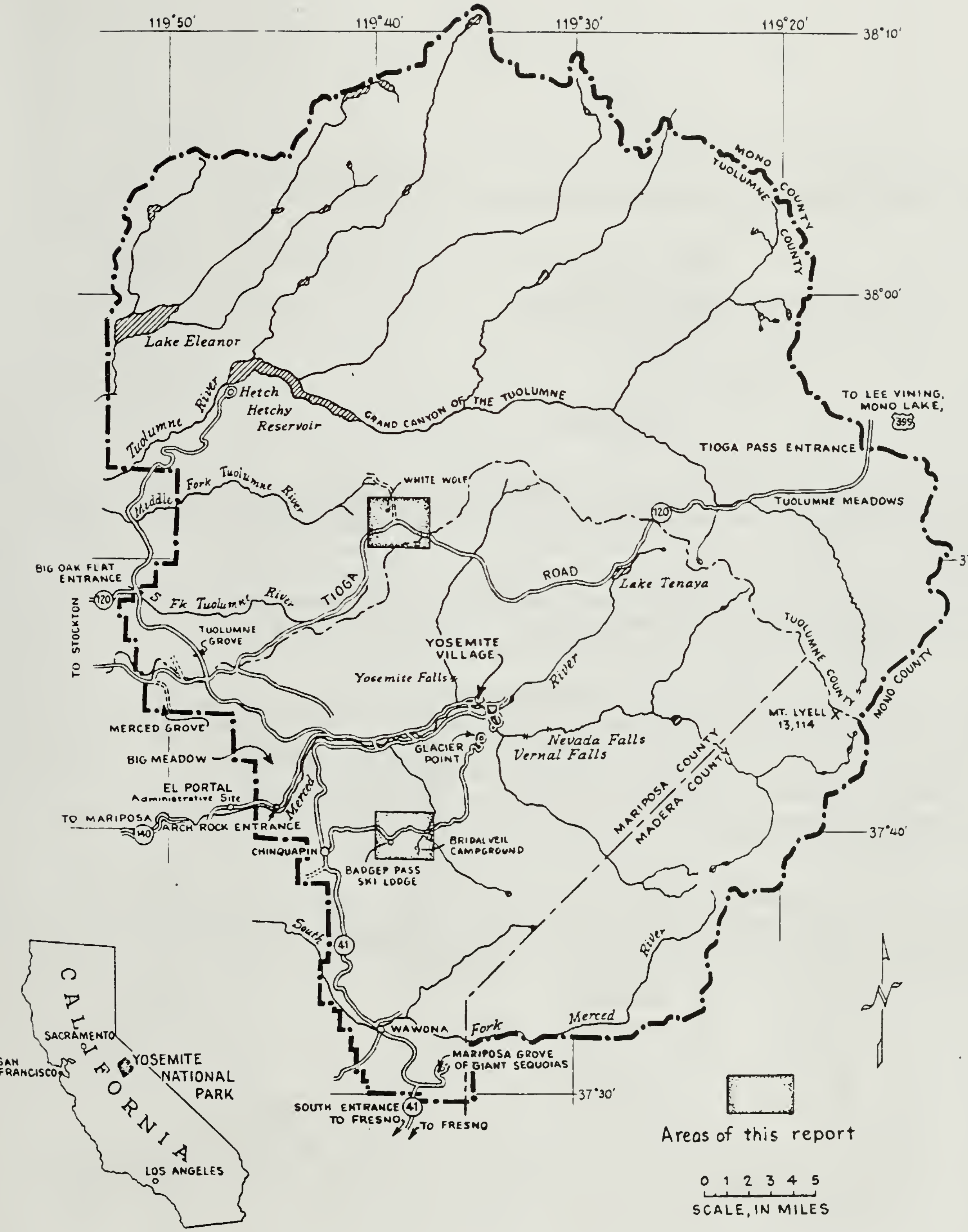


FIGURE 1.— Index map.

TEST-WELL DRILLING IN YOSEMITE NATIONAL PARK, CALIFORNIA, 1968

By Hugh T. Mitten

INTRODUCTION

Three wells were drilled in Yosemite National Park during the period from July to September 1968. The wells, at the Badger Pass ski area, near Bridalveil campground, and at White Wolf (fig. 1), were drilled by Bill Belknap, of Reedley, Calif., under contract to the National Park Service. Drilling and testing were supervised by the author, and water samples were collected for subsequent analysis of mineral content in the Geological Survey laboratory in Sacramento.

This report was prepared by the Geological Survey, Water Resources Division, in cooperation with the National Park Service as part of an investigation of water resources in Yosemite National Park. The work was done under the general supervision of R. Stanley Lord, district chief in charge of water-resources investigations in California, and under the immediate supervision of Willard W. Dean, chief of the Sacramento subdistrict office.

The site for the well at Badger Pass was selected by the author during a field reconnaissance of the area in 1965. Sites for the wells at Bridalveil campground and White Wolf were selected in 1966 during a field reconnaissance by J. S. Bader and J. R. Mullen.

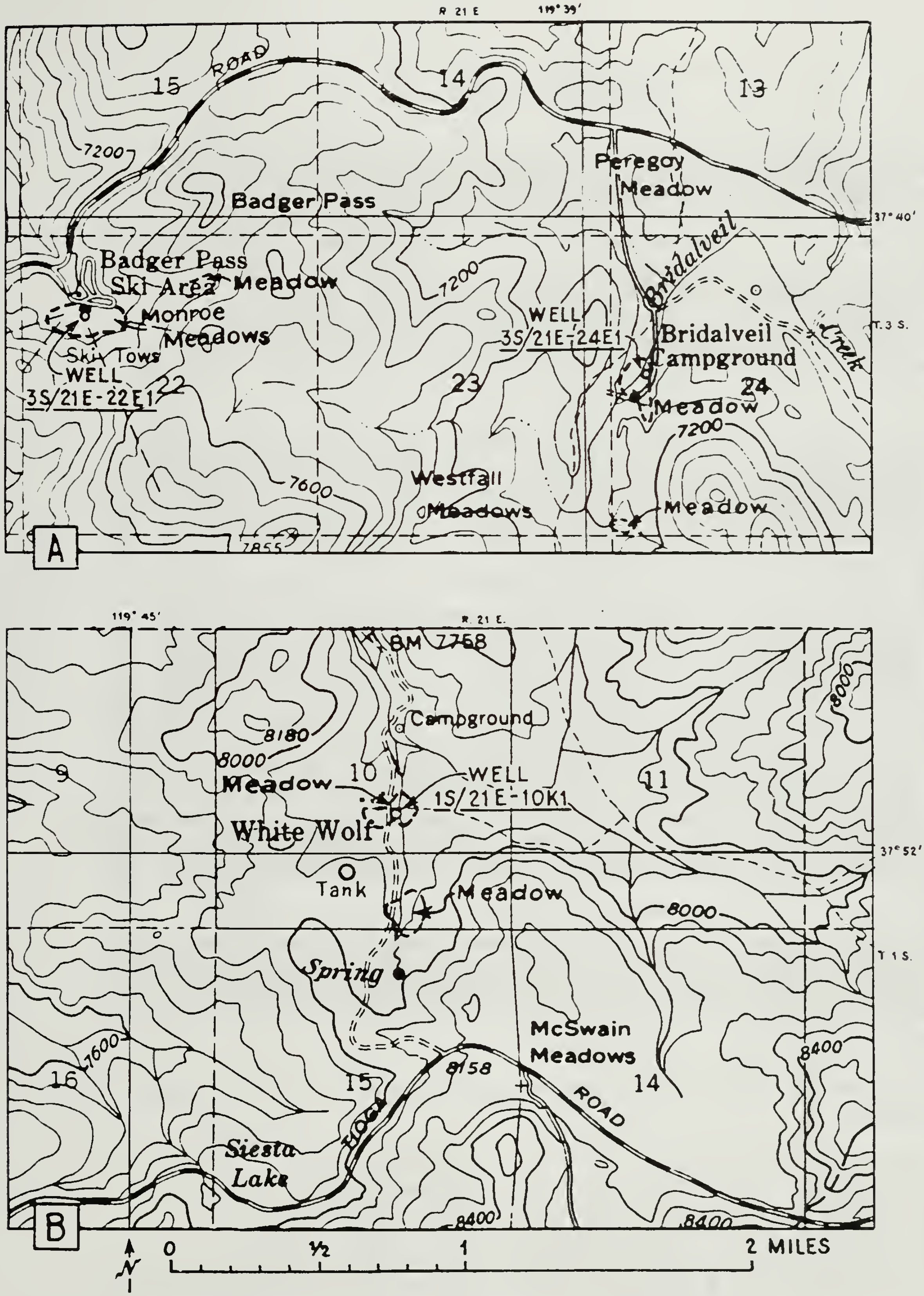


FIGURE 2.—Maps showing location of wells at Badger Pass Ski Area and near Bridalveil Campground [A], and well at White Wolf [B].

RESULTS OF DRILLING

At each of the three sites, a well was drilled through unconsolidated material consisting of soil, sand, gravel, and boulders and into igneous rock, diorite or granodiorite. The unconsolidated material was drilled with a hydraulic rotary drill and the underlying igneous rock was drilled with an air-percussion rig. In each of the three wells part, or all of the water obtained is yielded from fractures in the igneous rock.

The sites of the wells are shown in figure 2 and graphic logs of the wells are in figure 3. Lithologic logs of the wells are given at the end of the report.

While drilling was in progress, two meadows were noted where additional similar wells probably could be developed. One meadow is about half a mile south of the well near Bridalveil campground, and the second is about 0.3 mile south of the well at White Wolf (fig. 2).

RESULTS OF TEST PUMPING

In each well, casing was installed when drilling reached the top of the igneous rock. The casing was perforated in the wells at Badger Pass and near Bridalveil, and brief bailing tests were made on the wells before drilling continued into the igneous rock. The estimated yield of the unconsolidated part of the section of the well at Badger Pass was about 5 gpm (gallons per minute) with 75 feet of drawdown, and about 10 gpm at the well near Bridalveil campground with about 30 feet of drawdown. At White Wolf, the unconsolidated material was 12 feet thick, yielded only small quantities of water, and was cased off.

After completing the wells in the igneous rocks, the wells were pumped and surged until clear water was obtained. Step drawdown tests were made at each well by pumping at successively higher rates, allowing the water level in the well to stabilize at each rate. The results of the step drawdown tests are shown in figure 4.

The recommended pumping rates for sustained use of each of the three wells are as follows:

At Badger Pass ski area------------------about 15 gpm
Near Bridalveil campground---------------about 15 gpm
At White Wolf----------------------------about 10 gpm

The storage capacity available to the wells has not been estimated because each of the wells is all or in part dependent on water yielded from fractures in the igneous rock. The extent and orientation of the fracture systems is not known.

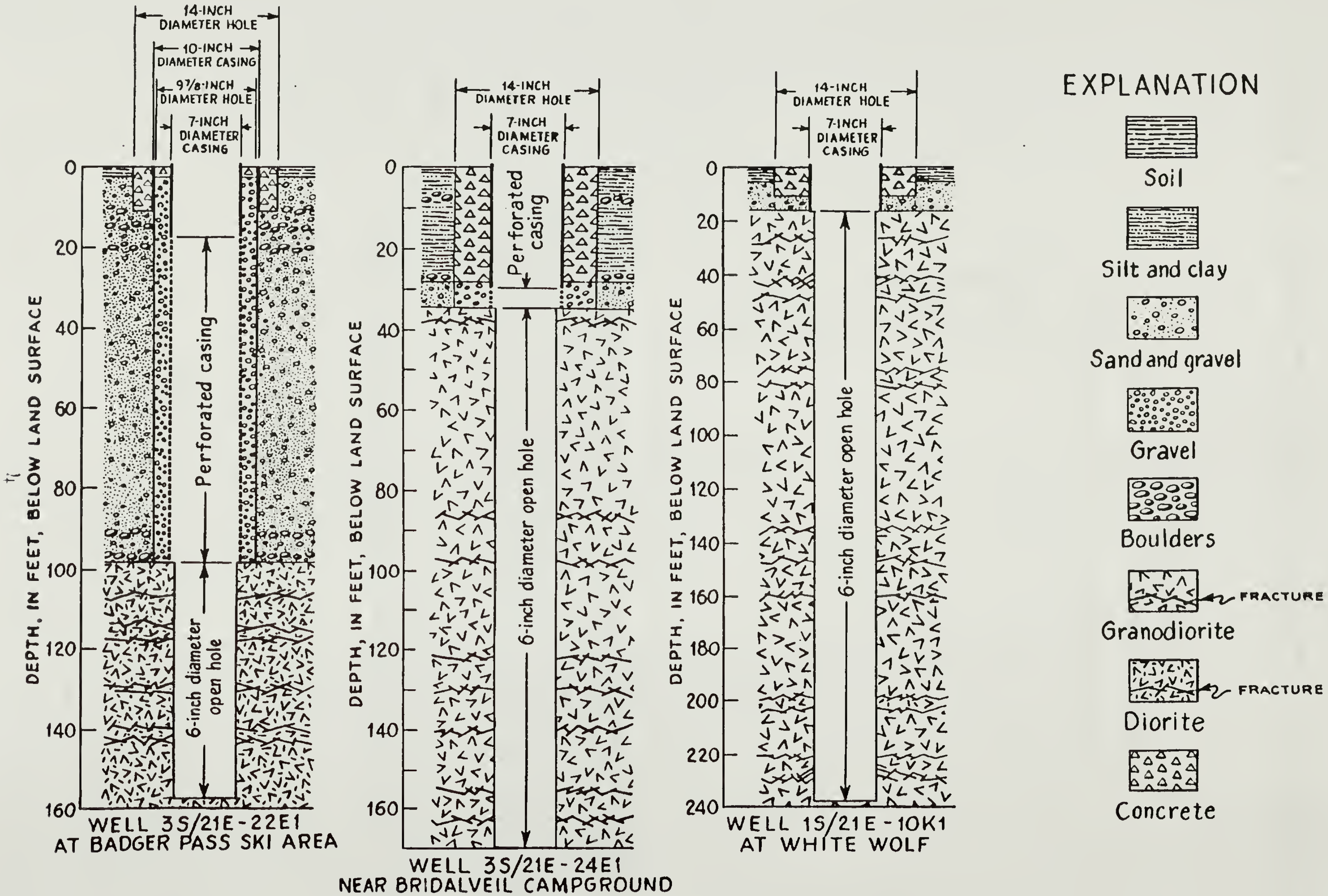


FIGURE 3.—Diagrammatic logs of wells.

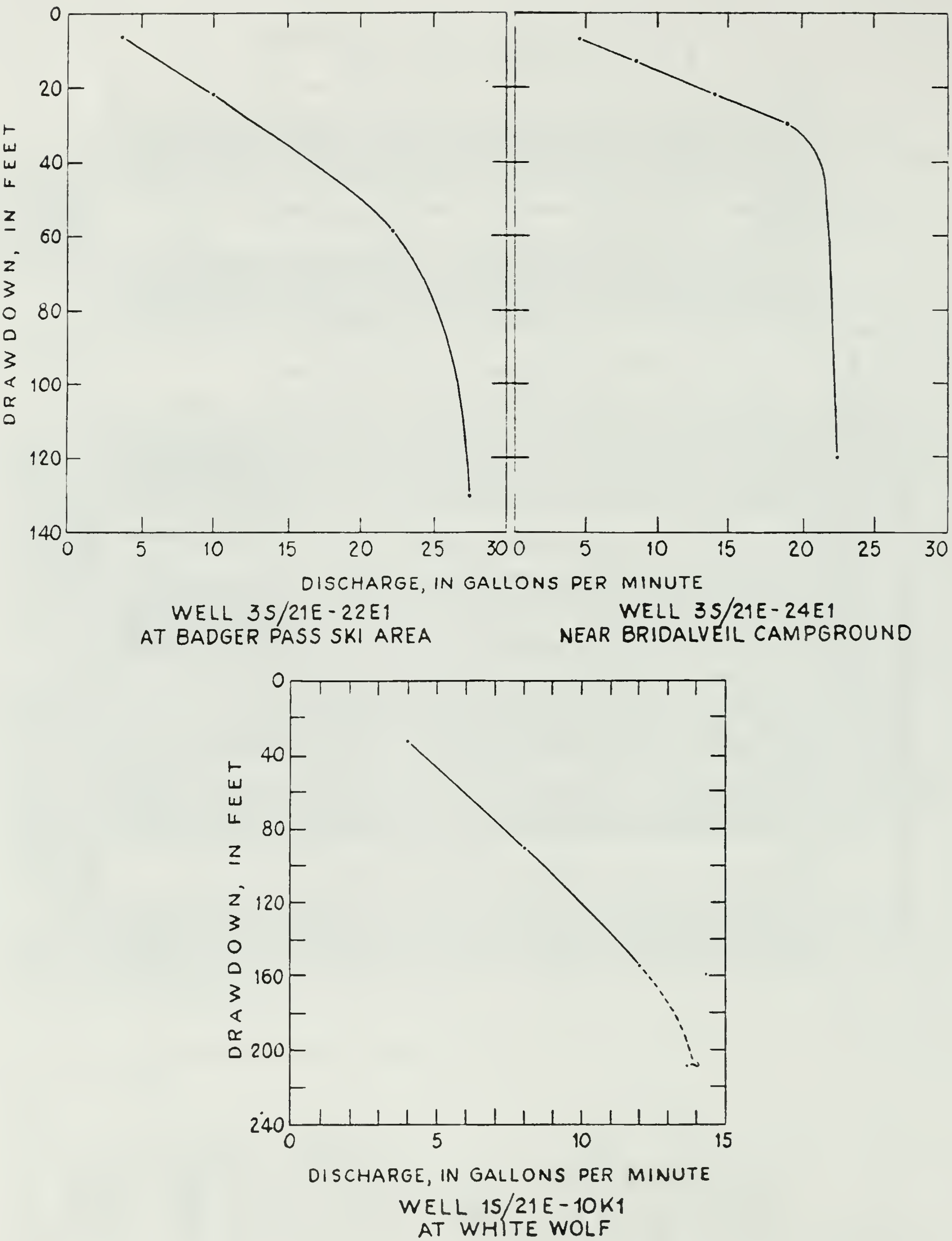


FIGURE 4.—Graph showing relation of drawdown to discharge for wells.

The well at Badger Pass yielded water with some sand during test pumping. The sand probably is from the interval from 17 to 20 feet below land surface, the same section that probably yields much of the water obtained from the unconsolidated material penetrated by the well. The inflow of sand probably will continue for some time, and a sand trap is suggested as part of the installation when the well is put into service.

RESULTS OF CHEMICAL ANALYSIS OF WATER SAMPLES

Water samples were collected at each well before test pumping was completed, and the samples were analysed for mineral constituents. Results of the analyses, given in the following table, indicate that the water at each site is of excellent chemical quality.

Near each of the three well sites, septic tanks are being used down gradient from the wells. As each of the wells yields some water from fractures in the igneous rock, and the extent and orientation of the fractures are not known, there is a possibility of biological contamination of the water in the wells. Contamination probably will not occur because of the gradient relation between the wells and septic tanks, but to insure that it has not, the water should be sampled regularly for bioanalysis when the wells are put into service.

Results of chemical analysis of water samples from wells

(Concentration of constituents in milligrams per liter)

	Well sites		
	Badger Pass ski area	Bridalveil campground	White Wolf
Date of collection	7/31/68	8/10/68	8/29/68
Laboratory number	57592	57591	57711
Water temperature	8°C	7°C	8°C
Silica (SiO_2)	29	19	15
Iron (Fe)	.22	.00	.01
Calcium (Ca)	13	12	6.1
Magnesium (Mg)	3.1	4.7	1.0
Sodium (Na)	6.9	4.5	4.6
Potassium (K)	3.1	1.2	1.2
Bicarbonate (HCO_3)	71	50	32
Carbonate (CO_3)	0	0	0
Sulfate (SO_4)	3.0	1.0	2.0
Chloride (Cl)	.2	.2	.2
Fluoride (F)	.0	.0	.0
Nitrate (NO_3)	1.5	1.1	.1
Boron (B)	.00	.00	.05
Dissolved solids (calculated)	88	95	46
Hardness as $CaCO_3$	33	45	19
Noncarbonate as $CaCO_3$	0	0	0
Percent sodium	22	23	33
Specific conductance (micromhos at 25°C)	85	102	51
pH	7.9	7.0	7.1

Lithologic logs of three wells

Well 3S/21E-22E1, at Badger Pass ski area

[Altitude about 7,230 ft. Drilled in July 1968. 10-in. casing from land surface to 10 ft, 7 in. 7-in. liner perforated from 17-98 ft, open hole from 98-157 ft. Log by Geol. Survey]

Description	Thickness (feet)	Depth (feet)
Soil	2	2
Sand, brown and gray, fine- to coarse-grained, and gravel	7	9
Boulders, granodiorite	2	11
Sand, brown and gray, fine- to coarse-grained, angular, and gravel	4	15
Boulders, granodiorite	2	17
Sand, brown and gray, fine- to coarse-grained, angular, and gravel	2	19
Boulders, granodiorite	1	20
Sand, brown and gray, fine- to coarse-grained, angular	71	91
Boulders, granodiorite	1	92
Sand, brown and gray, fine- to coarse-grained, angular	4	96
Boulders	2	98
Diorite, dark gray, fine- to medium-grained	9	107
Diorite, dark gray, fine- to medium-grained, soft, fractured, and sand and silt, white	1	108
Diorite, dark gray, fine- to medium-grained	6	114
Diorite, dark gray, fine- to medium-grained, soft, fractured, and sand and silt, dark gray to black	4	118
Diorite, dark gray, fine- to medium-grained	10	128
Diorite, dark gray, fine- to medium-grained, soft, fractured, and sand and silt, dark gray to black	4	132
Diorite, dark gray, fine- to medium-grained	8	140
Diorite, dark gray, fine- to medium-grained, soft, highly fractured, and silt, dark gray to black	4	144
Diorite, dark gray, fine- to medium-grained	13	157

Well 3S/21E-24F1, near Bridalveil Campground

[Altitude about 7,030 ft. Drilled in August 1968. 7-in. casing to 34.5 ft, perforated from 30.5-34.5 ft, open hole from 34.5-170 ft. Log by Geol. Survey]

Description	Thickness (feet)	Depth (feet)
Soil	1	1
Silt and clay, sandy, brown to gray, fine- to coarse-grained, angular, partially weathered	6	7
Boulders	2	9
Silt and clay, sandy, brown to gray, fine- to coarse-grained, angular, partially weathered	18	27
Boulders	1	28
Sand, silty, brown to gray, fine- to coarse-grained, angular	2	30
Sand and gravel, gray, medium- to coarse-grained, angular	4	34
Granodiorite, gray, medium-grained	3	37
Granodiorite, gray, medium-grained, soft, fractured	1	38
Granodiorite, gray, medium-grained	48	86
Granodiorite, gray, medium-grained, soft, fractured	[illegible]	[illegible]
Granodiorite, gray, medium-grained	[illegible]	[illegible]
Granodiorite, gray, medium-grained, soft, fractured	10	130
Granodiorite, gray, medium-grained	1	140
Granodiorite, gray and yellow, medium-grained, soft, weathered, fractured	1	141
Granodiorite, gray, medium-grained, some pink feldspar	15	156
Granodiorite, gray, medium-grained, soft, fractured	1	157
Granodiorite, gray, medium-grained, some pink feldspar	6	163
Granodiorite, gray, medium-grained, soft, fractured; silt white to light gray, some pink feldspar	7	170

Well 1S/21E-10E1, at White Wolf

[Altitude about 7,900 ft. Drilled in July and August 1968. 7-in. casing to 16 ft, open hole from 16-232 ft. Log by Geol. Survey]

Description	Thickness (feet)	Depth (feet)
Soil	4	4
Sand, brown, fine to coarse, angular; gravel, brown to yellow, angular, weathered granodiorite	8	12
Sand, brown, fine to coarse, angular	2	14
Sand, brown, fine to coarse, angular; gravel, brown to yellow, angular, weathered granodiorite	1	15
Sand, brown, fine to coarse, angular	1	16
Granodiorite, gray, medium-grained	10	26
Granodiorite, gray, iron oxide stained, medium-grained, fractured	1	27
Granodiorite, gray, medium-grained, soft, fractured	16	43
Granodiorite, gray, iron oxide stained, medium-grained, soft, fractured	4	47
Granodiorite, gray, iron oxide stained, medium-grained, fractured	3	50
Granodiorite, gray, medium-grained	5	55
Granodiorite, gray, iron oxide stained, medium-grained	1	56
Granodiorite, gray, medium-grained	14	70
Granodiorite, gray, iron oxide stained, medium-grained, fractured	1	71
Granodiorite, gray, medium-grained	[illegible]	81
Granodiorite, gray, iron oxide stained, medium-grained, fractured	1	82
Granodiorite, gray, medium-grained	52	134
Granodiorite, soft, fractured	1	135
Granodiorite, gray, iron oxide stained, medium-grained, fractured	3	138
Granodiorite, gray, medium-grained	6	144
Granodiorite, gray, medium-grained, some brown feldspar	3	147
Granodiorite, gray, medium-grained, soft, fractured	2	149
Granodiorite, gray, medium-grained	11	160
Granodiorite, gray, medium-grained, soft, fractured	13	173
Granodiorite, gray, medium-grained	25	198
Granodiorite, gray, medium-grained, soft, fractured	5	203
Granodiorite, gray, iron oxide stained, medium-grained, soft, fractured	2	205
Granodiorite, gray, medium-grained	16	221
Granodiorite, gray, iron oxide stained, medium-grained, soft, fractured	1	222
Granodiorite, gray, medium-grained, soft, fractured	10	232

U.S. GEOLOGICAL SURVEY FIGURE

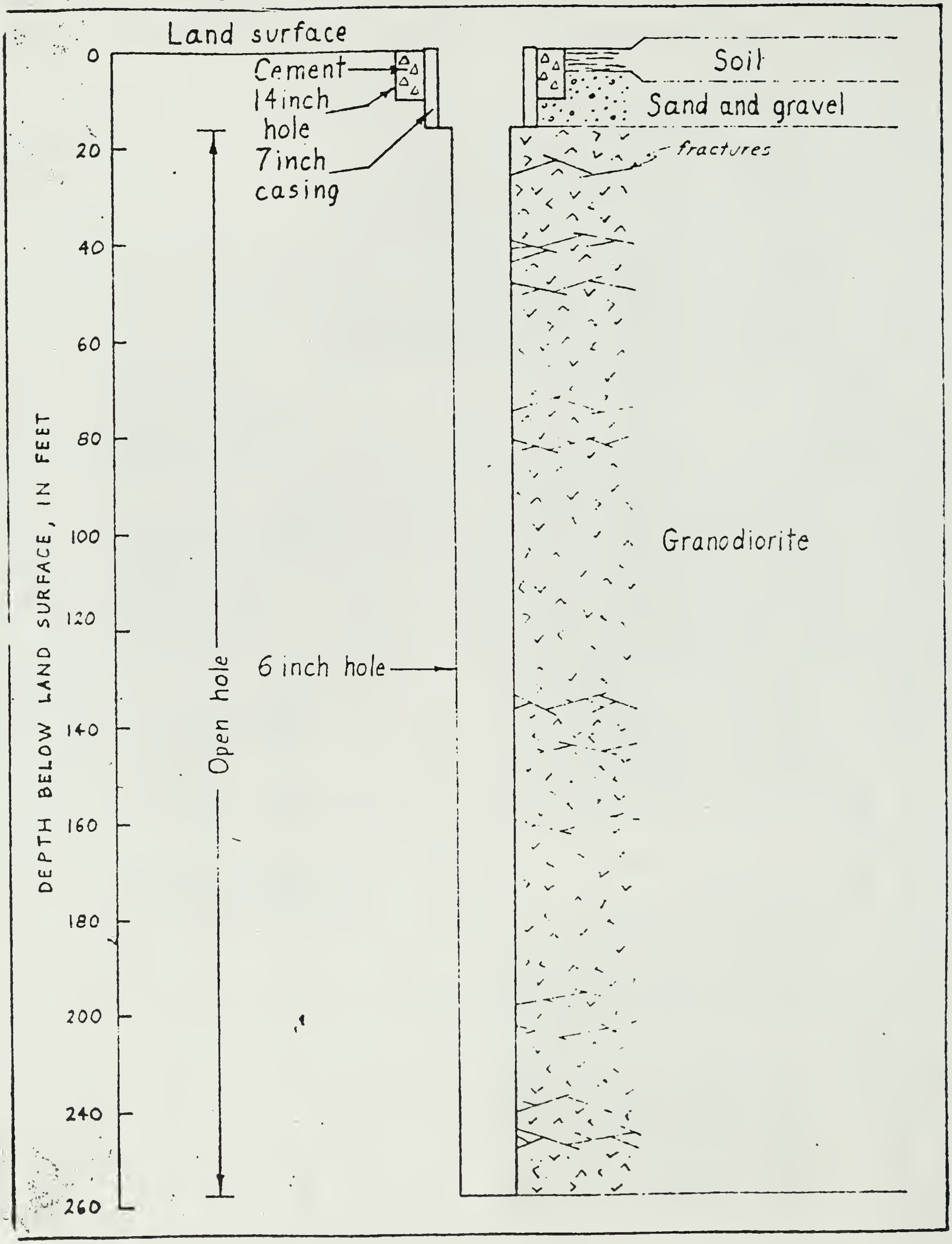


Figure . —Graphic log of well 1S/21E-10K1, at White Wolf.

/

9-083
(...ember 1949)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

No.

OTHER NOS.

WELL LOG

...te .... County .... Subarea ....

...ner ....

...cation White Wolf .... 10 gp

...illed by .... Address ....

...te .... Casing diam. .... Land-surf. alt.

...urce of data ....

(Enter type of well, perforations, yield, and drawdown at end of log)

Correlation	Material	Thickness (feet)	Depth (feet)
	Soil	4	0
	DG Sand + gravel	8	4
	DG.	2	12
	DG Sand + gravel	1	14
	DG (Hard)	1	15
	Granite Bow	10	16
	Fractures with [illegible] in granite	1/2	26
	Granite fairly soft with feldspar	13 1/2	26 1/2
	Fracture	1/2	
	Granite Bow	1/2	
	Fracture	1/2	41
	Iron granite	2 1/2	43 1/2
	Fracture	1/2	44
	Granite Bow	2	46
	granite fairly soft.	2	48
		1	50
	Granite (B. W.	5	51

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

, No

WELL LOG

County .... Subarea

Address

Casing diam.

(Enter type of soil, perforations, yield and drawdown ...)

MATERIAL		
Vein of stained gran		
Granite B+w (Hard		
Fracture Iron stain		
Granite B+w		
Fracture Iron Stained		
Granite B+w		2
Granite B+w (Hard		
Granite B+w Soft		
Fracture		
Granite Soft stained		125
Fractured stained		
Granite - B+w Hard.	6	
Granite feldspar.		145
Fracture B+w granite water	2	147
Med Hard Brown granite	11	158

9-068
(December 1949)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

No.

WELL LOG

OTHER NOS.

State County Subarea

Owner

Location

Drilled by Address

Date Casing diam. Land-surf. alt.

Source of data

(Enter type of well, perforations, yield, and drawdown at end of log)

CORRELATION	MATERIAL	THICKNESS (feet)	DEPTH (feet)
	Hard granite	25½	173
	Fracture feldspar	½	198½
	Mid - hard granite	4	199
	Fractured Iron stained granite	2	203
	Hard granite	16	205
	Fractured Iron stained granite	1	221
	Granite B & W hard	2½	222
	Fractured feldspar	½	224½
	B & W granite	1	2
	Fractured feldspar	½	226
	B & W granite	1½	226½
	Fractured	1½	228
	Hard granite	2½	229½
	Bottom of hole		232

ANALYTICAL BSK LABORATORIES
Environmental Services

1414 Stanislaus Street
Fresno, California 93706
Telephone (209) 485-8310
FAX (209) 485-6935
1-800-877-8310

National Park Service Yosemite
Attn: John C. Clark
Post Office Box 2025, Wawona Station
Yosemite NP, CA 95389

Date Sampled : 11/07/91
Time Sampled : 1100
Date Received : 11/08/91
Report Issue Date: 11/27/91

Case Number : Ch915112
Lab ID Number : 5112-4
Project Number : 1443PX880092217
Sample Description: Hodgdon Meadows # 1

Sample Type: LIQUID

California Title 22 General Mineral, Inorganic & Physical Analyses

General Mineral Analyses

Constituent	Units	Results	DLR
Hardness (as CaCO3)	mg/L	25	1
Calcium (Ca).......	mg/L	8.5	0.1
Magnesium (Mg).....	mg/L	0.9	0.1
Sodium (Na)........	mg/L	7	1
Alkalinity (as CaCO3)	mg/L	40	1
Hydroxide (OH)......	mg/L	ND	1
Carbonate (CO3).....	mg/L	ND	1
Bicarbonate (HCO3)..	mg/L	48	1
Chloride (Cl).......	mg/L	1	1
Sulfate (SO4).......	mg/L	ND	2
Copper (Cu).........	mg/L	ND	0.05
Iron (Fe)...........	mg/L	ND	0.05
Manganese (Mn)......	mg/L	ND	0.01
Potassium (K).......	mg/L	1	1
Zinc (Zn)...........	mg/L	ND	0.05
Foaming agents (MBAS)	mg/L	ND	0.05
Dissolved Solids(TDS)	mg/L	56	5
Langelier Index	-	-2.1	-
pH	STD	6.7	-
Specific Conductivity	µmho/cm	90	1

Inorganic Analyses

Analyte	Units	Results	DLR
Aluminum (Al).	µg/L	ND	50
Arsenic (As)..	µg/L	ND	2
Barium (Ba)...	µg/L	ND	50
Cadmium (Cd)..	µg/L	ND	1
Chromium (Cr).	µg/L	ND	5
Lead (Pb).....	µg/L	ND	5
Mercury (Hg)..	µg/L	ND	0.4
Selenium (Se).	µg/L	ND	2
Silver (Ag)...	µg/L	ND	10
Nitrate (NO3).	mg/L	2	1
Fluoride (F)..	mg/L	ND	0.1

Client Supplied Temperature NM °F

General Physical Analyses

Analyte	Units	Results	DLR
Color (APHA) .	UNITS	<5	--
Turbidity	NTU	0.2	--
Odor	TON	ND	--

ND: None Detected
DLR: Detection Limit For the Purposes of Reporting
µg/L: Microgram per Liter
mg/L: Milligram per Liter
--: Not Analyzed
µmho/cm: Micromhos per centimeter at 25°C
<: Less than

STD: Standard pH units
NTU: Nephelometric Turbidity Units
TON: Threshold Odor Number
UNITS: Color Units
NM: Not Measured

Cynthia Pigman, QA/QC Supervisor

Doug Deasy
Doug Deasy, Inorganics Supervisor

910916 GMIP.R

ANALYTICAL
BSK
LABORATORIES
Environmental Services

1414 Stanislaus Street
Fresno, California 93706
Telephone (209) 485-8310
FAX (209) 485-6935
1-800-877-8310

National Park Service Yosemite
Attn: John C. Clark
Post Office Box 2025, Wawona Station
Yosemite NP, CA 95389

Date Sampled : 11/07/91
Time Sampled : 1100
Date Received : 11/08/91
Report Issue Date: 11/27/91

Case Number : Ch915112
Lab ID Number : 5112-5
Project Number : 1443PX880092217
Sample Description: Hodgdon Meadows #2

Sample Type: LIQUID

California Title 22 General Mineral, Inorganic & Physical Analyses

General Mineral Analyses

Constituent	Units	Results	DLR
Hardness (as CaCO3)	mg/L	31	1
Calcium (Ca).......	mg/L	11	0.1
Magnesium (Mg).....	mg/L	0.9	0.1
Sodium (Na)........	mg/L	8	1
Alkalinity (as CaCO3)	mg/L	50	1
Hydroxide (OH)......	mg/L	ND	1
Carbonate (CO3).....	mg/L	ND	1
Bicarbonate (HCO3)..	mg/L	60	1
Chloride (Cl).......	mg/L	ND	1
Sulfate (SO4).......	mg/L	ND	2
Copper (Cu).........	mg/L	ND	0.05
Iron (Fe)...........	mg/L	ND	0.05
Manganese (Mn)......	mg/L	ND	0.01
Potassium (K).......	mg/L	ND	1
Zinc (Zn)...........	mg/L	1.8	0.05
Foaming agents (MBAS)	mg/L	ND	0.05
Dissolved Solids(TDS)	mg/L	69	5
Langelier Index	-	-1.8	-
pH	STD	6.9	-
Specific Conductivity	µmho/cm	110	1

Inorganic Analyses

Analyte	Units	Results	DLR
Aluminum (Al).	µg/L	ND	50
Arsenic (As)..	µg/L	ND	2
Barium (Ba)...	µg/L	ND	50
Cadmium (Cd)..	µg/L	ND	1
Chromium (Cr).	µg/L	ND	5
Lead (Pb).....	µg/L	ND	5
Mercury (Hg)..	µg/L	ND	0.4
Selenium (Se).	µg/L	ND	2
Silver (Ag)...	µg/L	ND	10
Nitrate (NO3).	mg/L	ND	1
Fluoride (F)..	mg/L	ND	0.1

Client Supplied Temperature NM °F

General Physical Analyses

Analyte	Units	Results	DLR
Color (APHA) .	UNITS	<5	--
Turbidity	NTU	0.1	--
Odor	TON	ND	--

ND: None Detected
DLR: Detection Limit For the Purposes of Reporting
µg/L: Microgram per Liter
mg/L: Milligram per Liter
--: Not Analyzed
µmho/cm: Micromhos per centimeter at 25°C
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STD: Standard pH units
NTU: Nephelometric Turbidity Units
TON: Threshold Odor Number
UNITS: Color Units
NM: Not Measured

Cynthia Pigman, QA/QC Supervisor

Doug Deasy
Doug Deasy, Inorganics Supervisor

16 GMIP.R

STATE OF CALIFORNIA
Department of Health Services
Environmental Laboratory Accreditation Program
CERTIFIED ENVIRONMENTAL TESTING LABORATORY
Certificate No.: E752

EL PORTAL LABORATORY

Coliform Sampling of Drinking Water

AUGUST 1993

System ID #55-503

WATER SYSTEM	DATE TIME	TUBES	Vol mL	Lauryl Tryptose 24 hrs	Lauryl Tryptose 48 hrs	Green Bile 24 hrs	Green Bile 48 hrs	Cl2 Res	MPN
Hodgdon Meadow	08/03	10	10	-----	-----			0.3	<1.1
Routine	07:30			-----	-----				
Maintenance Shop Faucet				Coliforms Absent					
Hodgdon Meadow	08/10	10	10	-----	-----			0.3	<1.1
Routine	11:00			-----	-----				
Shop Lab Sink				Coliforms Absent					
Hodgdon Meadow	08/17	10	10	-----	-----			0.4	<1.1
Routine	10:20			-----	-----				
Well Test Faucet				Coliforms Absent					
Hodgdon Meadow	08/18	3	10	---	---			0	<3
Raw	10:00	3	1	---	---				
Well Test Faucet		3	0.1	---	---				
Hodgdon Meadow	08/24	10	10	-----	-----			0.4	<1.1
Routine	08:00			-----	-----				
Well Test Faucet				Coliforms Absent					
Hodgdon Meadow	08/26	10	10	-----	-----			0.2	<1.1
Routine	08:00			-----	-----				
Maintenance Shop Faucet				Coliforms Absent					

STATE OF CALIFORNIA
Department of Health Services
Environmental Laboratory Accreditation Program
CERTIFIED ENVIRONMENTAL TESTING LABORATORY
Certificate No.: E752

EL PORTAL LABORATORY

Coliform Sampling of Drinking Water

JULY 1993

stem ID #55-503

TER SYSTEM	DATE TIME	TUBES	Vol mL	Lauryl Tryptose 24 hrs	Lauryl Tryptose 48 hrs	Green Bile 24 hrs	Green Bile 48 hrs	Cl2 Res	MPN
dgdon Meadow	07/05	10	10	-----	-----			0.3	<1.1
utine	11:50			-----	-----				
int. Shop.Faucet				Coliforms Absent					
dgdon Meadow	07/12	10	10	-----	-----			0.2	<1.1
utine	11:55			-----	-----				
int. Shop Faucet				Coliforms Absent					
dgdon Meadow	07/12	3	10	---	---			0	<3
w	12:30	3	1	---	---				
llhouse Test Faucet		3	0.1	---	---				
dgdon Meadow	07/19	10	10	-----	-----			0.4	<1.1
utine	11:45			-----	-----				
o Sink				Coliforms Absent					
dgdon Meadow	07/26	10	10	-----	-----			0.5	<1.1
utine	13:30			-----	-----				
o Sink				Coliforms Absent					

1992 ANNUAL REPORT ON WATER QUALITY

HODGDON MEADOWS WATER SYSTEM

Dear Customer:

This constitutes the fourth annual report to customers in your district describing the quality of your water supply. It should be noted that the Hodgdon Meadows Water System consistently provides quality water above State Department of Health Services standards. **The water is totally safe to drink.** All water retailers are required by state law to test water on an annual basis in several areas. Those areas and the results applicable to the Hodgdon Meadows Water System are as follows:

MICROBIOLOGICAL

This important test measures the coliform levels in your water. The maximum allowable coliform level of this test is that 5% of the tests performed in one month cannot show positive results for coliform content. Your water was tested once a week. **At no time did the samples collected indicate any unsafe levels of coliform in your drinking water.**

ORGANIC CHEMICALS

The most common sources of organic contamination of drinking water are pesticides and herbicides, industrial solvents and disinfection by-products (trihalomethanes). Millions of pounds of pesticides are used on croplands, forests, lawns, and gardens in the United States each year. They drain off into surface waters or seep into underground water supplies. Spills, poor storage, and haphazard disposal of organic chemicals have resulted in widespread groundwater contamination. This is a critical problem since groundwater, once contaminated, may remain that way for a long time. Many organic chemicals pose health problems if they get into drinking water and the water is not properly treated.

There were no levels of these contaminants detected in the water.

INORGANIC CHEMICALS

Your water was tested for the following inorganic chemicals. The maximum allowable chemical levels in milligrams per Liter (mg/L) are noted in brackets after the chemical names. Test results for your system indicated the water was significantly below all noted allowable chemical levels for which it was tested.
Aluminum [1.0], **Arsenic** [0.05], **Barium** [1.0], **Cadmium** [0.010], **Chromium** [0.05], **Fluoride** [1.4-2.4*], **Lead** [0.05], **Mercury** [0.002], **Nitrate** [45], **Selenium** [0.01] and **Silver** [0.05].

*Fluoride standard depends on temperature.

RADIOACTIVITY

Radioactivity was tested as Gross Alpha Activity. The maximum allowable level for Gross Alpha Activity is 15 pico Curies per Liter (pCi/L); your water contained less than 7 pCi/L.

SECONDARY STANDARDS

These standards relate more to the aesthetic quality of your drinking water and the standards were established by the State of California, Department of Health Services in conjunction with the Federal Environmental Protection Agency.

Constituent	Maximum Contaminant Level	Units	Well #1	Well #2
Color	15	units	<5	<5
Odor-Threshold	3	units	ND	ND
Chloride	250	mg/L	1	ND
Copper	1.0	mg/L	ND	ND
Foaming Agents (MBAS)	0.5	mg/L	ND	ND
Iron	0.3	mg/L	ND	ND
Manganese	0.05	mg/L	ND	ND
Sulfate	250	mg/L	ND	ND
Zinc	5.0	mg/L	ND	1.8
Total Dissolved Solids	500	mg/L	56	69
Specific Conductance	1,600	umho/cm	90	110

< = less than.
ND = None Detected.
umho/cm = micro-ohms per centimeter.

In addition, and although no set standards have been recommended or adopted by the state at this time, your water was tested for the following additional constituents.

pH	(units)	6.7	6.9
Hardness	(mg/L)	25	31
Sodium	(mg/L)	7	8
Calcium	(mg/L)	8.5	11
Magnesium	(mg/L)	0.9	0.9
Total Alkalinity	(mg/L)	40	50
Carbonate	(mg/L)	ND	ND
Bicarbonate	(mg/L)	48	60
Hydroxide	(mg/L)	ND	ND
Potassium	(mg/L)	1	ND

To help promote National Drinking Water Week, Mather Utilities will have an Open House on May 4-5, 1993. Please contact the Mather Utilities office at 372-0528 or the Yosemite Valley Utilities office at 372-0560 for more details.

For additional water quality information, contact me at 372-0467.

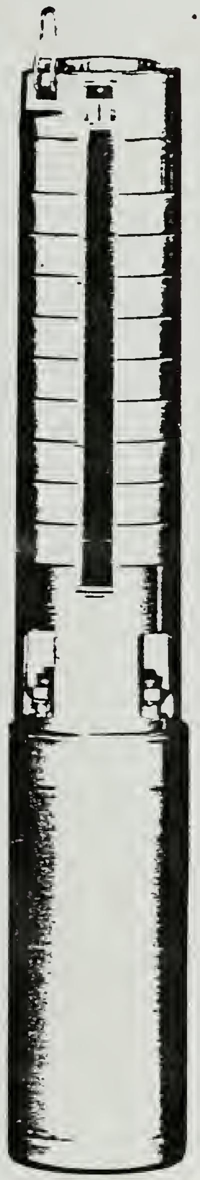
Sincerely,

John C Clark

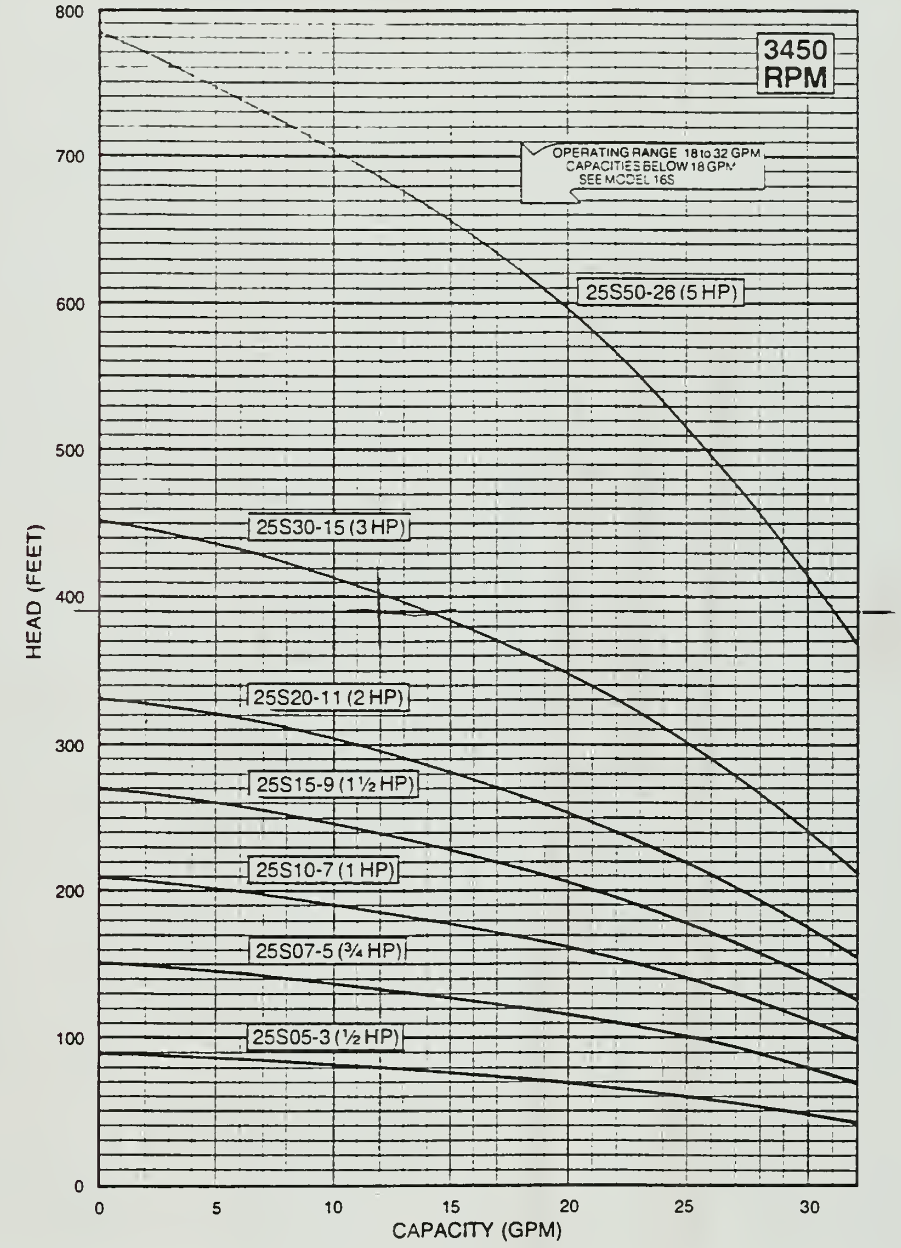
John C. Clark
Facility Management Specialist
P.O. Box 577
Yosemite National Park, CA 95389

FLOW RANGE
18 to 32 GPM

PUMP OUTLET
1½" NPT



PERFORMANCE CURVES



DIMENSIONS AND WEIGHTS

MODEL NO.	HP	LENGTH (INCHES)	WIDTH (INCHES)	APPROX. UNIT SHIPPING WT. (LBS.)
25S05-3	½	20 ¼	3 15/16	26
25S07-5	¾	22 ⅜	3 15/16	28
25S10-7	1	24 ⅞	3 15/16	29
25S15-9	1 ½	28	3 15/16	34
25S20-11	2	28 ⅞	3 15/16	37
25S30-15	3	39 ⅛	3 15/16	59
25S50-26	5	51 ⅛	3 15/16	76

Specifications are subject to change without notice.

Hodgdon #1

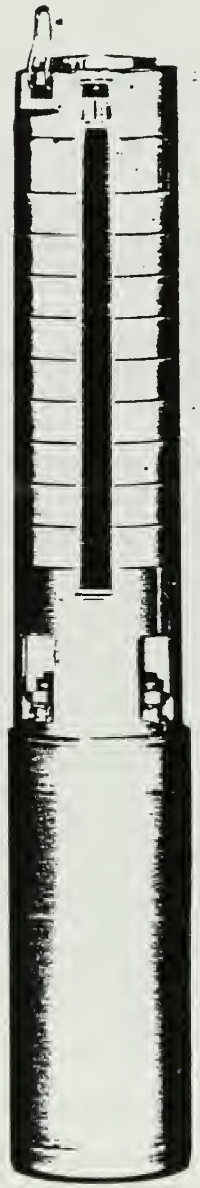
MODEL
16S

16 GPM

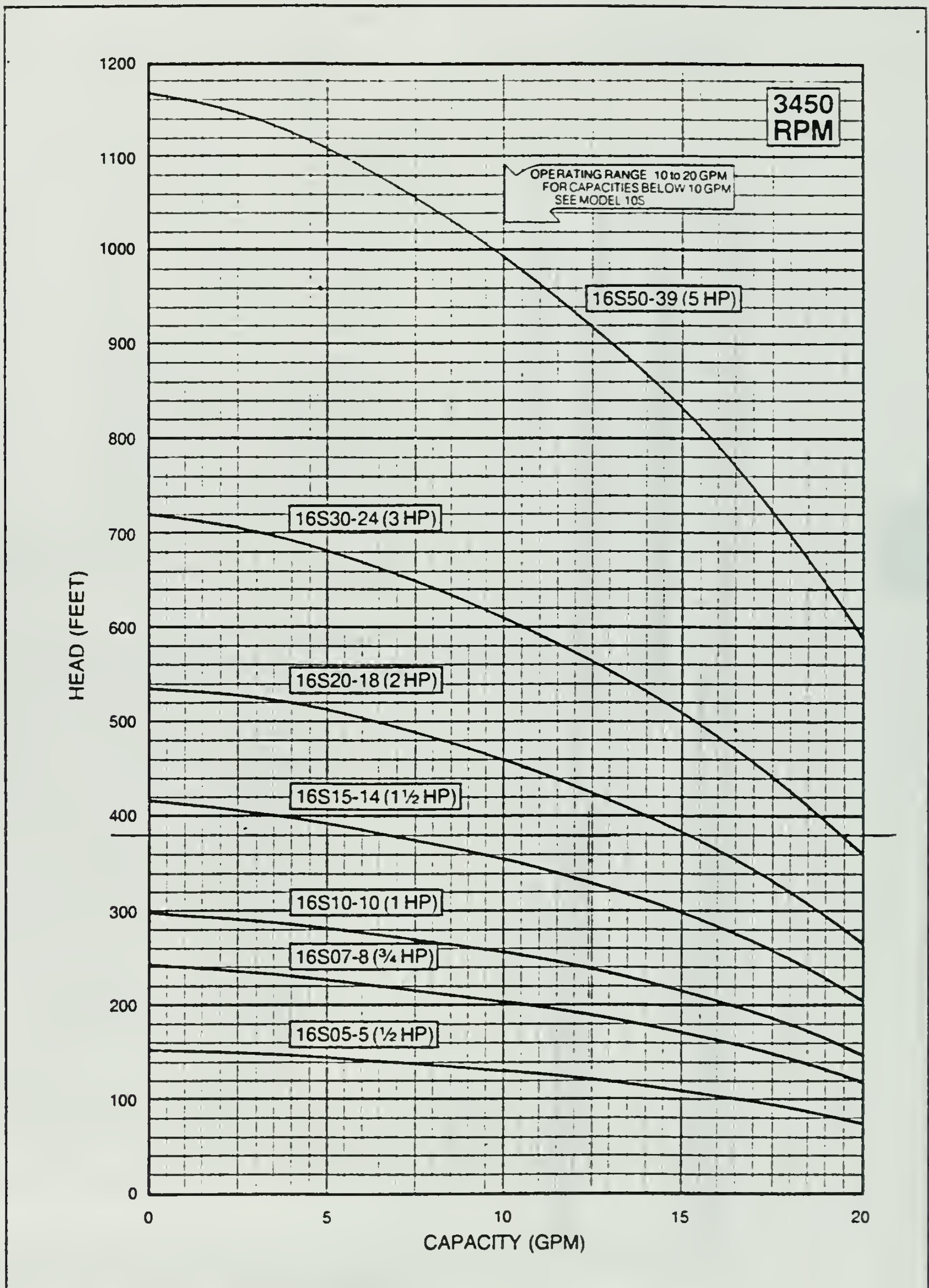
GRUNDFOS

FLOW RANGE
10 to 20 GPM

PUMP OUTLET
1¼" NPT



PERFORMANCE CURVES



DIMENSIONS AND WEIGHTS

MODEL NO.	HP	LENGTH (INCHES)	WIDTH (INCHES)	APPROX. UNIT SHIPPING WT. (LBS.)
16S05-5	½	21 ⅞	3 15/16	27
16S07-8	¾	25	3 15/16	29
16S10-10	1	27 ⅛	3 15/16	32
16S15-14	1 ½	32	3 15/16	36
16S20-18	2	34 ⅝	3 15/16	40
16S30-24	3	46 ⅝	3 15/16	64
16S50-39	5	63 ⅝	3 15/16	94

Specifications are subject to change without notice.

Hodgdon #2

15gpm X
25-26

APPENDIX B

Well Permits and Well Completion Reports

TUOLUMNE COUNTY HEALTH DEPARTMENT
DIVISION OF ENVIRONMENTAL HEALTH
2 SOUTH GREEN STREET
SONORA, CALIFORNIA 95370
(209) 533 - 5990

APPLICATION FOR A PERMIT TO CONSTRUCT, RECONSTRUCT, MODIFY OR DESTROY A WELL

Permit No. 93D-44
District

10/6/93 Application Date

Owner's Name HRS Water Consultants

Address 200 Union Blvd Suite 200 Telephone 303-989-2837

Lakewood, CO 80228

10/11/93 Proposed Starting Date

Contractor Yosemite Falls Well Drilling License No. 648378

10/29/93 Proposed Completion Date

Site Location Yosemite PARK Tuolumne meadow Camp Ground APN

TYPE OF WORK (Check) New Well ☐ Deepening ☐ Reconstruction/Modification ☐ Destruction ☐

INTENDED USE (Check) Domestic/Private ☐ Domestic/Public ☒ Industrial ☐ Cathodic ☐ Monitoring/Observation ☐ Agricultural ☐ Test/Exploration Hole ☐ Other ☐

DESTRUCTION OF WELL

Casing Diameter ______ Approx. Depth ______

Describe Materials and procedures ______

WORKMEN'S COMPENSATION INSURANCE

I am aware of the provisions of Section 3700 of the California Labor Code which requires every employer to be insured against liability for Workmen's Compensation.

☒ I have placed on file with the County of Tuolumne a certificate of Workmen's Compensation Insurance.

☐ I certify that in the performance of the work for which this permit is issued I shall not employ any person in any manner so as to become subject to the Workman's Compensation Laws of California.

I hereby state that the information above and on the attachments hereto is correct and true to the best of my knowledge.

NOTE: 1. Provide advance notice prior to installing or placing annular seal or drilling a well.
2. A satisfactory inspection or waiver by the Department, receipt of a Well Driller's report, a disinfection statement and satisfactory bacterial and chemical analysis (wells for domestic and food processing), is required for final approval of work.
3. Contact this Department within 7 days of completion of the well and sanitary well seal.
4. Scale plot plan is to be furnished for all applications, and shall show all septic tanks, leachlines, or other contamination hazards within 200 feet.

I understand that the plot plan must be approved, obtained and be on-site BEFORE any construction is begun. I also understand that approval of the water well construction does not guarantee water nor does it indicate whether this property is suitable for an individual sewage treatment and disposal system or that an approval to install such sewage system is granted.

Date: 10/6/93 Signed: [signature]

OFFICIAL USE ONLY

Received by DMC Date 10/06/93 Cash ☐ Check ☑ Receipt No. 931419
Fees Paid 707.50 Date

Health Dept. Inspection

	Date		Inspected	
Site ☑	11/4/93	by	V	
Annular ☐		by		☐ Waived
Final ☐		by		☐ Waived

Water Quality Results
Chemical/Bact. Analysis ☐
1. Quality Satisfactory ☐
2. Exceeds MCLS (Water Supply Health Advisory Notice mailed) ☐

Chemical/Bacteriological Request ☐ ______ Date ______ Disinfection Statement Returned ☐ ______ Date

Permission is hereby granted to L F D for the above work on a well in accordance with all State (Contractor/Firm) and county laws, and conditions as set forth in this permit. Permit valid for one year from date of issuance.

Drilling fluids and other drilling materials used in connection with this work shall be safely and appropriately handled and disposed of.

APPROVAL

Signature [signature]
Environmental Health Specialist

Date: 10/13/93

Approved subject to conditions 50' annular 2" [illegible]

FILE:WELLPRMT

TUOLUMNE COUNTY HEALTH DEPARTMENT
DIVISION OF ENVIRONMENTAL HEALTH
2 SOUTH GREEN STREET
SONORA, CALIFORNIA 95370
(209) 533 - 5990

APPLICATION FOR A PERMIT TO CONSTRUCT, RECONSTRUCT, MODIFY OR DESTROY A WELL

Permit No. 930-45
District ______

10/6/93
Application Date

Owner's Name HRS Water Consultants, Inc

Address 200 Union Blvd Suite 200 Telephone 303-989-2837

10/11/93
Proposed Starting Date

Lakewood, CO 80228

Contractor Yosemite Falls Well Drilling License No. 649378

10/29/93
Proposed Completion Date

Site Location Yosemite ~~Park~~ - White Wolf APN ______

TYPE OF WORK (Check) New Well ☒ Deepening ☐ Reconstruction/Modification ☐ Destruction ☐

INTENDED USE (Check) Domestic/Private ☐ Domestic/Public ☒ Industrial ☐ Cathodic ☐ Monitoring/Observation ☐ Agricultural ☐ Test/Exploration Hole ☐ Other ☐

DESTRUCTION OF WELL

Casing Diameter ______ Approx. Depth ______

Describe Materials and procedures ______

WORKMEN'S COMPENSATION INSURANCE

I am aware of the provisions of Section 3700 of the California Labor Code which requires every employer to be insured against liability for Workmen's Compensation.

☒ I have placed on file with the County of Tuolumne a certificate of Workmen's Compensation Insurance.

☐ I certify that in the performance of the work for which this permit is issued I shall not employ any person in any manner so as to become subject to the Workman's Compensation Laws of California.

I hereby state that the information above and on the attachments hereto is correct and true to the best of my knowledge.

NOTE:
1. Provide advance notice prior to installing or placing annular seal or drilling a well.
2. A satisfactory inspection or waiver by the Department, receipt of a Well Driller's report, a disinfection statement and satisfactory bacterial and chemical analysis (wells for domestic and food processing), is required for final approval of work.
3. Contact this Department within 7 days of completion of the well and sanitary well seal.
4. Scale plot plan is to be furnished for all applications, and shall show all septic tanks, leachlines, or other contamination hazards within 200 feet.

I understand that the plot plan must be approved, obtained and be on-site BEFORE any construction is begun. I also understand that approval of the water well construction does not guarantee water nor does it indicate whether this property is suitable for an individual sewage treatment and disposal system or that an approval to install such sewage system is granted.

Date: 10/6/93 Signed: [signature]

OFFICIAL USE ONLY

Received by VOMU Date 10/6/93 Cash ☐ Check ☑ Receipt No. 93419

Fees Paid 201.50 Date 10/6/93

Health Dept. Inspection

	Date	Inspected by	
Site ☐	10/8/93	by [initials]	
Annular ☐		by	☐ Waived
Final ☐		by	☐ Waived

Water Quality Results

Chemical/Bact. Analysis ☐
1. Quality Satisfactory ☐
2. Exceeds MCLS (Water Supply Health Advisory Notice mailed) ☐

Chemical/Bacteriological Request ☐ ______ Date ______ Disinfection Statement Returned ☐ ______ Date ______

Permission is hereby granted to (YFD) (Contractor/Firm) for the above work on a well in accordance with all State and county laws, and conditions as set forth in this permit. Permit valid for one year from date of issuance.

Drilling fluids and other drilling materials used in connection with this work shall be safely and appropriately handled and disposed of.

APPROVAL

Signature [signature]
Environmental Health Specialist

Date: 10/13/93

Approved subject to conditions 50' Sanitary seal. annular 2"
50' S.S. from any sewer lines.
Notified State OWR

FILE:WELLPRNT

TUOLUMNE COUNTY HEALTH DEPARTMENT
DIVISION OF ENVIRONMENTAL HEALTH
2 SOUTH GREEN STREET
SONORA, CALIFORNIA 95370
(209) 533 - 5990

APPLICATION FOR A PERMIT TO CONSTRUCT, RECONSTRUCT, MODIFY OR DESTROY A WELL

Permit No. 930-46
District ______

10/6/93 Application Date — Owner's Name HRS Water Constants
Address 200 Union Blvd Suite 200 Telephone 303-989-2837
10/11/93 Proposed Starting Date — Lakewood, CO 80228
Contractor Yosemite Falls Well Drilling License No. 649378
10/25/93 Proposed Completion Date — Site Location Yosemite Park, Tuolumne Meadows Camp ground APN ______

TYPE OF WORK (Check) New Well ☐ Deepening ☐ Reconstruction/Modification ☐ Destruction ☐

INTENDED USE (Check) Domestic/Private ☐ Cathodic ☐ Test/Exploration Hole ☐
Domestic/Public ☒ Monitoring/Observation ☐ Other ☐
Industrial ☐ Agricultural ☐

DESTRUCTION OF WELL

Casing Diameter ______ Approx. Depth ______
Describe Materials and procedures ______

WORKMEN'S COMPENSATION INSURANCE

I am aware of the provisions of Section 3700 of the California Labor Code which requires every employer to be insured against liability for Workmen's Compensation.

☒ I have placed on file with the County of Tuolumne a certificate of Workmen's Compensation Insurance.

☐ I certify that in the performance of the work for which this permit is issued I shall not employ any person in any manner so as to become subject to the Workman's Compensation Laws of California.

I hereby state that the information above and on the attachments hereto is correct and true to the best of my knowledge.

NOTE: 1. Provide advance notice prior to installing or placing annular seal or drilling a well.
2. A satisfactory inspection or waiver by the Department, receipt of a Well Driller's report, a disinfection statement and satisfactory bacterial and chemical analysis (wells for domestic and food processing), is required for final approval of work.
3. Contact this Department within 7 days of completion of the well and sanitary well seal.
4. Scale plot plan is to be furnished for all applications, and shall show all septic tanks, leachlines, or other contamination hazards within 200 feet.

I understand that the plot plan must be approved, obtained and be on-site BEFORE any construction is begun. I also understand that approval of the water well construction does not guarantee water nor does it indicate whether this property is suitable for an individual sewage treatment and disposal system or that an approval to install such sewage system is granted.

Date: 10/6/93 Signed: [signature]

OFFICIAL USE ONLY

Received by VCMU Date 10/6/93 Cash ☐ Check ☒ Receipt No. 931419
Fees Paid 207.50 Date 10/6/93

Health Dept. Inspection

	Date	Inspected by	
Site ☒	10/8/93	by M	
Annular ☐		by	☐ Waived
Final ☐		by	☐ Waived

Water Quality Results

Chemical/Bact. Analysis ☐
1. Quality Satisfactory ☐
2. Exceeds MCLS (Water Supply ☐ Health Advisory Notice mailed)

Chemical/Bacteriological Request ☐ ______ Date
Disinfection Statement Returned ☐ ______ Date

Permission is hereby granted to YFD for the above work on a well in accordance with all State (Contractor/Firm) and county laws, and conditions as set forth in this permit. Permit valid for one year from date of issuance.

Drilling fluids and other drilling materials used in connection with this work shall be safely and appropriately handled and disposed of.

APPROVAL

Signature [signature]
Environmental Health Specialist
Date: 10/13/93

Approved subject to conditions 50' Sanitary (annular) seal. 50' sanitary setback from any sewage lines.

FILE:WELLPRMT

TUOLUMNE COUNTY HEALTH DEPARTMENT
DIVISION OF ENVIRONMENTAL HEALTH
2 SOUTH GREEN STREET
SONORA, CALIFORNIA 95370
(209) 533 - 5990

APPLICATION FOR A PERMIT TO CONSTRUCT, RECONSTRUCT, MODIFY OR DESTROY A WELL

Permit No. 13047
District ____

10/6/93 Application Date — Owner's Name HRS Water Consultants, Inc

Address 200 Union Blvd Suite 200 Telephone 303-989-2837

10/11/93 Proposed Starting Date — Lakewood, CO 80228

Contractor Yosemite Falls Well Drilling License No. 649378

10/29/93 Proposed Completion Date — Site Location Yosemite Park - White Wolf APN ____

TYPE OF WORK (Check) New Well ☒ Deepening ☐ Reconstruction/Modification ☐ Destruction ☐

INTENDED USE (Check) Domestic/Private ☐ Domestic/Public ☒ Industrial ☐ Cathodic ☐ Monitoring/Observation ☐ Agricultural ☐ Test/Exploration Hole ☐ Other ☐

DESTRUCTION OF WELL

Casing Diameter 6" Approx. Depth 300'

Describe Materials and procedures ____

WORKMEN'S COMPENSATION INSURANCE

I am aware of the provisions of Section 3700 of the California Labor Code which requires every employer to be insured against liability for Workmen's Compensation.

☐ I have placed on file with the County of Tuolumne a certificate of Workmen's Compensation Insurance.

☒ I certify that in the performance of the work for which this permit is issued I shall not employ any person in any manner so as to become subject to the Workman's Compensation Laws of California.

I hereby state that the information above and on the attachments hereto is correct and true to the best of my knowledge.

NOTE: 1. Provide advance notice prior to installing or placing annular seal or drilling a well.
2. A satisfactory inspection or waiver by the Department, receipt of a Well Driller's report, a disinfection statement and satisfactory bacterial and chemical analysis (wells for domestic and food processing) is required for final approval of work.
3. Contact this Department within 7 days of completion of the well and sanitary well seal.
4. Scale plot plan is to be furnished for all applications, and shall show all septic tanks, leachlines, or other contamination hazards within 200 feet.

I understand that the plot plan must be approved, obtained and be on-site BEFORE any construction is begun. I also understand that approval of the water well construction does not guarantee water nor does it indicate whether this property is suitable for an individual sewage treatment and disposal system or that an approval to install such sewage system is granted.

Date: 10/6/93 Signed: [signature]

OFFICIAL USE ONLY

Received by DMM Date 10/06/93 Cash ☐ Check ☒ Receipt No. 931419
Fees Paid 207.50 Date

Health Dept. Inspection — Water Quality Results

	Date	Inspected	
Site ☐	10/6/93	by RJ	
Annular ☐		by	☐ Waived
Final ☐		by	☐ Waived

Chemical/Bact. Analysis ☐
1. Quality Satisfactory ☐
2. Exceeds MCLS (Water Supply Health Advisory Notice mailed) ☐

Chemical/Bacteriological Request ☐ ____ Date — Disinfection Statement Returned ☐ ____ Date

Permission is hereby granted to YFD (Contractor/Firm) for the above work on a well in accordance with all State and county laws, and conditions as set forth in this permit. Permit valid for one year from date of issuance.

Drilling fluids and other drilling materials used in connection with this work shall be safely and appropriately handled and disposed of.

APPROVAL

Signature [signature]
Environmental Health Specialist

Date: 10/15/93

Approved subject to conditions 50' Sanitary Seal (annular 2"). 50' sanitary setback from any sewer lines.

FILE:WELLPRMT

TUOLUMNE COUNTY HEALTH DEPARTMENT
DIVISION OF ENVIRONMENTAL HEALTH
2 SOUTH GREEN STREET
SONORA, CALIFORNIA 95370
(209) 533 - 5990

APPLICATION FOR A PERMIT TO CONSTRUCT, RECONSTRUCT, MODIFY OR DESTROY A WELL

Permit No. 930-48
District ______

10/6/93 Application Date
Owner's Name HRS Water Consultants, Inc
Address 200 Union Blvd Suite 200 Telephone 303-989-2837
10/11/93 Proposed Starting Date
Lakewood, Co 80228
10/29/93 Proposed Completion Date
Contractor Yosemite Falls Well Drilling License No. 649378
Site Location Yosemite Park APN ______
Tuolumne Meadows Campground

TYPE OF WORK (Check) New Well ☐ Deepening ☐ Reconstruction/Modification ☐ Destruction ☐

INTENDED USE (Check) Domestic/Private ☐ Domestic/Public ☒ Industrial ☐ Cathodic ☐ Monitoring/Observation ☐ Agricultural ☐ Test/Exploration Hole ☐ Other ☐

DESTRUCTION OF WELL

Casing Diameter ______ Approx. Depth ______
Describe Materials and procedures ______

WORKMEN'S COMPENSATION INSURANCE

I am aware of the provisions of Section 3700 of the California Labor Code which requires every employer to be insured against liability for Workmen's Compensation.

☒ I have placed on file with the County of Tuolumne a certificate of Workmen's Compensation Insurance.

☐ I certify that in the performance of the work for which this permit is issued I shall not employ any person in any manner so as to become subject to the Workman's Compensation Laws of California.

I hereby state that the information above and on the attachments hereto is correct and true to the best of my knowledge.

NOTE:
1. Provide advance notice prior to installing or placing annular seal or drilling a well.
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3. Contact this Department within 7 days of completion of the well and sanitary well seal.
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I understand that the plot plan must be approved, obtained and be on-site BEFORE any construction is begun. I also understand that approval of the water well construction does not guarantee water nor does it indicate whether this property is suitable for an individual sewage treatment and disposal system or that an approval to install such sewage system is granted.

Date: 10/6/93 Signed: [signature]

OFFICIAL USE ONLY

Received by [initials] Date ______
Fees Paid 307.50 Date 10/6/93
Cash ☐ Check ☒ Receipt No. 931419

Health Dept. Inspection

	Date		Inspected	
Site ☒	10/8/93	by	[initials]	
Annular ☐		by		☐ Waived
Final ☐		by		☐ Waived

Water Quality Results
Chemical/Bact. Analysis ☐
1. Quality Satisfactory ☐
2. Exceeds MCLS (Water Supply Health Advisory Notice mailed) ☐

Chemical/Bacteriological Request ☐ ______ Date ______

Permission is hereby granted to Y.F.W. (Contractor/Firm) for the above work on a well in accordance with all State and county laws, and conditions as set forth in this permit. Permit valid for one year from date of issuance.

Drilling fluids and other drilling materials used in connection with this work shall be safely and appropriately handled and disposed of.

APPROVAL

Signature [signature]
Environmental Health Specialist
Date: 10/13/93

Approved subject to conditions 50' sanitary seal (annular 2")
50' S.S. from any sewer lines.

FILE:WELLPRNT

TRIPLICATE
Owner's Copy
Page 1 of 1

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 570246

Owner's Well No. ____
Date Work Began 10/28/93, Ended 10/31/93
Local Permit Agency Tuolumne County Health Department
Permit No. 930-46 Permit Date 10/8/93

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

GEOLOGIC LOG

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

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0	9	Overburden w/boulders
9	15	Granite
15	16	Fractured granite/flowing water
16	400	Granite

TOTAL DEPTH OF BORING 400 (Feet)
TOTAL DEPTH OF COMPLETED WELL 400 (Feet)

WELL OWNER

Name National Park Service
Mailing Address Yosemite National Park
CITY STATE ZIP

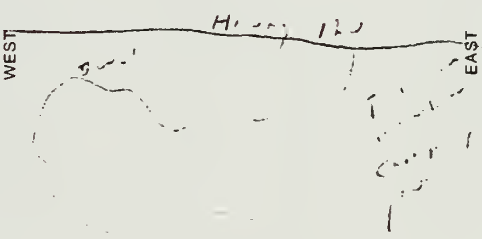
WELL LOCATION

Address Tuolumne Meadows Campground
City ____
County ____
APN Book ___ Page ___ Parcel ___
or
Township ___ Range ___ Section ___
or
Latitude ___ DEG. MIN. SEC. NORTH Longitude ___ DEG. MIN. SEC. WEST

LOCATION SKETCH

NORTH

WEST



EAST

SOUTH

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

ACTIVITY (✓)

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

PLANNED USE(S) (✓)

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

DRILLING METHOD air rotary FLUID water

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL 0 (Ft.) & DATE MEASURED ____
ESTIMATED YIELD* 0 (GPM) & TEST TYPE ____
TEST LENGTH ___ (Hrs.) TOTAL DRAWDOWN ___ (Ft.)
** May not be representative of a well's long-term yield.*

CASING(S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	400	8								

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	25	x			

ATTACHMENTS (✓)

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

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

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

NAME YOSEMITE FALLS WELL DRILLING
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

P.O.Box 1808 Mariposa CA 95338
ADDRESS CITY STATE ZIP

Signed ____ 11/10/93 649378
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV 7-90

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

TRIPLICATE
Owner's Copy
Page 1 of 1
Owner's Well No. ____
Date Work Began 10/21/93, Ended 10/23/93
Local Permit Agency Tuolumne County Health Department
Permit No. 930-48 Permit Date 10/13/93

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. 570248

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

GEOLOGIC LOG

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

DEPTH TO FIRST WATER 15 (Ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION (Describe material, grain size, color, etc.)
0	15	Overburden with boulders
15	16	Weathered granite w/ flowing water
16	111	Gr nite
111	112	Fractured granite
112	400	Granite

TOTAL DEPTH OF BORING 400 (Feet)
TOTAL DEPTH OF COMPLETED WELL 400 (Feet)

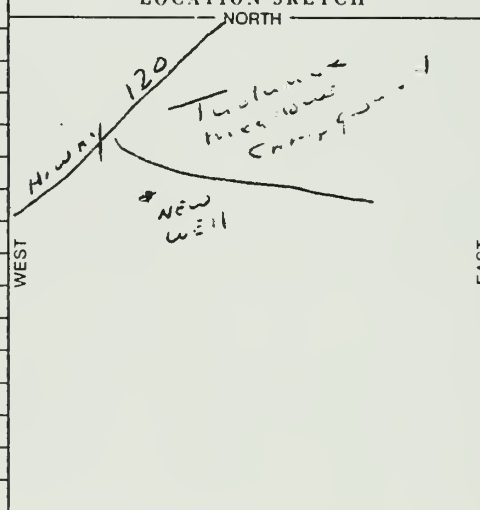
WELL OWNER

Name National Park Service
Mailing Address Yosemite National Park
CITY STATE ZIP

WELL LOCATION

Address Tuolumne Meadows Campground
City
County
APN Book ___ Page ___ Parcel ___
or
Township ___ Range ___ Section ___
or
Latitude ___ DEG. MIN. SEC. NORTH Longitude ___ DEG. MIN. SEC. WEST

LOCATION SKETCH



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

ACTIVITY (✓)

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

PLANNED USE(S) (✓)

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

DRILLING METHOD air rotary FLUID water

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL ___ (Ft.) & DATE MEASURED ___
ESTIMATED YIELD* 0 (GPM) & TEST TYPE ___
TEST LENGTH ___ (Hrs.) TOTAL DRAWDOWN ___ (Ft.)
* *May not be representative of a well's long-term yield.*

CASING(S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CONDUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	28	14	x				Grade B	16	.188	
0	55	14	x				Grade B	8	.188	
55	400	8								

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	10		x		
10	55	x			

ATTACHMENTS (✓)

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

ATTACH ADDITIONAL INFORMATION IF IT EXISTS

CERTIFICATION STATEMENT

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

NAME YOSEMITE FALLS WELL DRILLING
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

P.O. Box 1808 Mariposa CA 95338
ADDRESS CITY STATE ZIP

Signed [signature] 11/10/93 649378
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 7-90 IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

RIPLICATE
wner's Copy
ge 1 of 1
wner's Well No.
te Work Began 11/1/93, Ended 11/4/93
Local Permit Agency Tuolumne County Health Department
Permit No. 930-45 Permit Date 10/13/93

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 570245

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

RIENTATION (✓) x VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0	9	Soil
9	10	Water
10	18	Granite
18	19	Fractured granite
19	40	Granite
40	43	Fractured granite
43	47	Granite
47	48	Fractured granite
48	58	Granite
58	60	Fractured granite
60	100	Granite
00	101	Fractured Granite
01	104	Granite
04	105 v	Fractured granite
05	278	Granite
78	279	Fractured granite
79	400	Granite

OTAL DEPTH OF BORING 400 (Feet)
OTAL DEPTH OF COMPLETED WELL 400 (Feet)

WELL OWNER

Name National Park Service
Mailing Address Yosemite National Park
CITY STATE ZIP

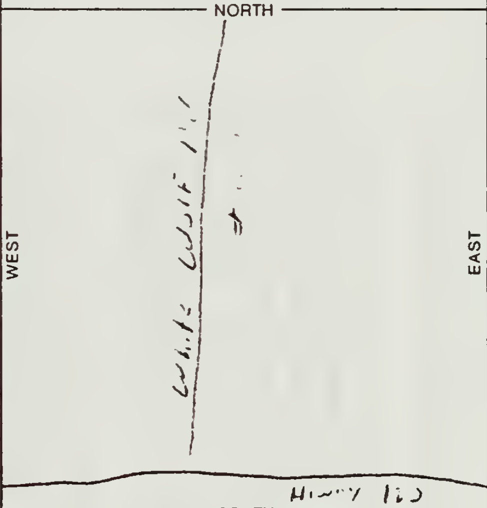
WELL LOCATION

Address White Wolf Rd.
City
County
APN Book ___ Page ___ Parcel ___
or
Township ___ Range ___ Section ___
or
Latitude ___ NORTH Longitude ___ WEST
DEG. MIN. SEC. DEG. MIN. SEC.

LOCATION SKETCH

NORTH

WEST



EAST

SOUTH

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

ACTIVITY (✓)

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

PLANNED USE(S) (✓)

___ MONITORING
WATER SUPPLY
___ Domestic
___ Public
___ Irrigation
___ Industrial
x "TEST WELL"
___ CATHODIC PROTECTION
___ OTHER (Specify)

DRILLING METHOD air rotary FLUID water

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL 2 (Ft.) & DATE MEASURED
ESTIMATED YIELD* 1.5 (GPM) & TEST TYPE blow test
TEST LENGTH .75 (Hrs.) TOTAL DRAWDOWN ___ (Ft.)
** May not be representative of a well's long-term yield.*

CASING(S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CONDUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	9	14	x				Grade B	16	.188	
0	50	14	x				Grade B	8	.188	
50	400	8								

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	10		x		
10	50	x			

ATTACHMENTS (✓)

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

CERTIFICATION STATEMENT

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

NAME YOSEMITE FALLS WELL DRILLING
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

P.O.Box 1808 Mariposa CA 95338
ADDRESS CITY STATE ZIP

Signed ___ 11/10/93 649378
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

DENVER SERVICE CENTER
REVIEW COMMENTS

PARK AND PKG. NO: YOSE 383 PT 06
PROJECT: Well Reports
REVIEWER: Mark Johnston, Civil Engineer, A/E Manager

NO. REVIEW COMMENTS	ACTION TAKEN ON COMMENTS
Thank you for your hard work on this project. The reports seems well done.	
Note that comments made by other reviewers refer to the report entitled "Tests of Existing Wells, and Test-Well Site Selection", unless otherwise indicated.	
Following are my comments. Comments #1-#3 relate to "Tests of Existing Wells, and Test-Well Site Selection".	
1. Grouting of wells:	
a. Pages 15, 30. During our visits to the site, Yosemite National Park staff were concerned that one of the two Hodgdon Meadows wells was not grouted to 50 feet, and that the White Wolf well no. 1 was not grouted at all. Is this not true? (Ed Walls planned to make a physical check of the White Wolf well.)	ADDED EXPLANATION.
b. Pages 15, 16, 32. Arber's discussions with the State of California apparently indicate that under some conditions it is possible to get a variance to allow less than the 50 feet of grout, and (this I heard secondhand) that wells which were installed before the 50 foot requirement became effective do not have to be corrected so long as testing indicates they are O.K. It is unclear to me whether filtration is necessary for wells with less than 50 feet of grout. Let's discuss this with Arber.	ADDED EXPLANATION.
Arber speculated on the amount of water available near surface. Can this be done in the report?	INCORPORATED IN RECOMMENDATIONS.
2. As discussed at the site there was recently a high radioactivity reading from one of the Hodgdon Meadows wells. Presumably this reading was anomalous and was the result of not pumping the water for a while at initial startup. Is this problem, such that it should be discussed in the report?	DISCUSSION INCORPORATED IN WATER-QUALITY NARRATIVE FOR HODGDON WELL NO. 2.
3. As the A/E Manager, it is my responsibility to resolve any questions regarding other peoples' commments. Following are	

DENVER SERVICE CENTER
REVIEW COMMENTS

PARK AND PKG. NO: YOSE 383 PT 06
PROJECT: Well Reports
REVIEWER: Mark Johnston, Civil Engineer, A/E Manager

NO.	REVIEW COMMENTS	ACTION TAKEN ON COMMENTS
	notes related to Mr. Pat Fleming's comments:	
	a. His comment #3: Please single-space report, and if possible copy back-to-back as Pat suggests. I would prefer to keep attached reports if they might otherwise be difficult for those reading the report to find.	INCORPORATED.
	b. His comment #7: No action required by the A/E.	
	The following comments #4-#5 relates to "Test-Well Drilling and Completion":	
4.	Please single-space, and if possible copy double-sided, for the final report.	INCORPORATED.
5.	Table 1, last sentence (in note): "don't know source": is the source of water unknown, or the source of muddiness?	ADDED CLARIFICATION.
	The following comments #6-#7 relate to both reports:	
6.	For clarity please combine the two reports. (Right now test-well site selection, and test well drilling, are in separate reports; and some of the points made in each report would be clearer if the reports were combined.) We suggest doing this in whatever manner is easiest and most convenient so long as the final product (particularly the table of contents) is clear. Please take care to prevent repetitions, to properly arrange information, etc.	INCORPORATED.
7.	We ordinarily expect to see "DRAFT" indicated on reports which are sent to us for review, and do not expect to see the draft reports stamped. (Only the final product needs to be stamped.) To avoid possible confusion as to which are the draft and which the final reports, I will write "DRAFT" across the copies of the reports which we received for review.	WILL STAMP FINALS.
8.	Please remember to include written responses to review comments with the final report.	WILL INCLUDE.

DENVER SERVICE CENTER
REVIEW COMMENTS

PARK AND PKG. NO: YOSE 383 PT 06

PROJECT: Well Reports
REVIEWER: Mark Johnston, Civil Engineer, A/E Manager

NO.	REVIEW COMMENTS	ACTION TAKEN ON COMMENTS
	The following comments are from Cynthia Hunter's review of the "Test Well Drilling and Completion" report:	
9.	Page 1, end of 1st paragraph: when the reports are combined, please delete or revise the reference to the other report.	INCORPORATED.
10.	Page 3. Please indicate the advantages of this type of drilling procedure and reasons it was chosen. If another drilling method had been used, would there have been the same problem with collapse of the top of the hole?	ADDED EXPLANATION.
11.	Please discuss the presumed near-surface sources of water and possible volume.	INCORPORATED IN RECOMMENDATIONS.
12.	Page 16, 6th line from top: should "surface geophysical" be "subsurface geophysical"?	REWORDED TO CLARIFY.
13.	Table 3:	
	a. Under description, at ground depth 18 to 19: Please explain what "no returns" means.	REWORDED TO CLARIFY.
	b. Bottom of page: Should "Estimated" be inserted in front of "total flow rate"?	INCORPORATED.

21 January 1994
93030-01/02

to: Mark Johnston, NPS Denver
Steve Bainbridge, NPS Denver
Joe Chwirka, Arber Associates

from: Eric Harmon, HRS Water Consultants

subject: response to comments received following finalization of the Yosemite test well report.

This memo is an addendum to our report on the recent pump-testing and test-well drilling at Yosemite. Comments on the HRS draft report, received via fax from Mark Johnston on January 18, contained two substantive queries. One of these comments concerned derivation of the pump efficiency figures discussed in the report. The other concerned cost estimates for the geophysical methods discussed as possible alternatives for ground-water exploration at Tuolumne Meadows. This memo addresses these two points.

RECONNAISSANCE METHOD COST ALTERNATIVES

For geophysical exploration surveys at Tuolumne Meadows discussed in the report (Section 1.2.3; pp. 13-14) following are the estimated cost ranges:

Seismic-refraction survey:	$ 30,000 - 35,000
Two-loop EM conductivity survey:	$ 18,000 - 22,000
Magnetometer survey:	$ 12,000 - 14,000

These estimates include costs for personnel, instrument rental, per diem and travel costs, data interpretation, report, and contingencies.

WELL-PUMP EFFICIENCY

The following page is a typed transcription of my calculations of overall pumping system efficiency for each of the three wells tested: Hodgdon well no. 1, Hodgdon well no. 2, and White Wolf well no. 1.

PUMPING SYSTEM EFFICIENCY CALCULATIONS

A. Hodgdon Well No. 1 pump: Grundfos 5 hp

1. Electrical HP: 230V, 21.0A, 0.94 power factor
   HPe = (21.0*230*.94)/746
   = 6.09 hp

2. Hydraulic HP: 24 gpm, 105'water level, 180 psig, 5' line loss
   TDH = 105 + 5 + (180*2.31) = 526'
   HPh = (24 * 526)/3960
   = 3.19 hp

3. Overall Pumping System Efficiency:
   OPE = (3.19/6.09) * 100
   = 52.4 %

B. Hodgdon Well No. 2 pump: Grundfos 3 hp

1. Electrical HP: 230V, 12.0A, 0.78 power factor
   HPe = (12.0*230*.78)/746
   = 2.89 hp

2. Hydraulic HP: 14 gpm, 335'water level, 78 psig, 10' line loss
   TDH = 335 + 10 + (78*2.31) = 525'
   HPh = (14 * 525)/3960
   = 1.86 hp

3. Overall Pumping System Efficiency:
   OPE = (1.86/2.89) * 100
   = 64.4 %

C. White Wolf Well No. 1 pump: Grundfos 1.5 hp

1. Electrical HP: 230V, 8.4A, 0.66 power factor
   HPe = (8.4*230*.66)/746
   = 1.71 hp

2. Hydraulic HP: 7 gpm, 95'water level, 175 psig, 10' line loss
   TDH = 95 + 10 + (175*2.31) = 509'
   HPh = (7 * 509)/3960
   = 0.90 hp

3. Overall Pumping System Efficiency:
   OPE = (0.90/1.71) * 100
   = 52.6 %

Data Sources: I, V, water level, pressure: test measurements
power factors: Grundfos rep, Denver, CO, personal comm., 1993.
line losses: estimated from pipe size/length
equations and constants: *Submersible Pump Handbook*, 1978, Centrilift Inc., Tulsa, OK.