Reconnaissance of ground-water conditions in vicinity of Philmont Scout Ranch, Colfax Co. N.M.

By

C. F. Berkstresser, Jr.

OFR: 56-7

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Albuquerque, N. Mex.

RECONNAISSANCE OF GROUND-WATER CONDITIONS IN VICINITY OF PHILMONT BOY SCOUT RANCH, COLFAX COUNTY, NEW MEXICO

By C. F. Berkstresser, Jr.

This memorandum gives the results of a brief reconnaissance of the ground-water conditions in the vicinity of the Philmont Boy Scout Ranch, Colfax County, N. Mex., made during April, 1956 as a part of the Statewide investigation of ground-water resources in cooperation with the New Mexico Bureau of Mines and Mineral Resources and the State Engineer of New Mexico.

General Geology

Structurally, the Cimarron Range is a broad northward-plunging anticline. The east flank of the structure, on which the Philmont Boy Scout Ranch lies, has been extensively dissected by streams, exposing Upper Cretaceous and Tertiary sedimentary rocks. Igneous rocks of the Tertiary system have been extensively intruded into the older rocks as dikes and sills.

The Pierre shale, of Late Cretaceous age, is the oldest formation exposed and identified in the areas where the reconnaissance was made. It is characteristically an impermeable gray to black fissile shale which locally contains concretions of calcium carbonate and thin beds of limestone and sandstone. It is reported to be about 3,000 feet thick, although this thickness probably included the Benton and Niobrara formations which underlie the Pierre shale. Overlying the Pierre shale is the Trinidad sandstone of Late Cretaceous age, which is a well-cemented coarse drab to

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dark-brown sandstone; it is about 100 feet thick in the northern part of the ranch area but is missing in the southern part. Overlying the Trinidad sandstone are sandstone, coal, and shale of the Raton formation of the Eocene series of the Tertiary system. After deposition of the Raton formation, numerous dikes and sills of porphyritic monzonite were intruded into the Raton and all older formations. Any Tertiary formations younger than the Raton that were deposited in this area were removed subsequently by erosion. Much of the erosion that has given the land surface its present shape has taken place since the early Pleistocene; contemporaniously, pediment gravels and alluvium derived from the older formations have been deposited.

Further information concerning the geology of the area is given in the following publications: Griggs, R. L., 1946, Geology and ground-water resources of the eastern part of Colfax County, N. Mex. New Mexico Bur. Mines and Mineral Resources Ground-Water Report 1; and, particularly for the Philmont area, Smith, J. F., and Ray, L. L., 1943, Geology of the Cimarron Range, New Mexico. Geol. Soc. America Bull., 54, no. 7, p. 891-924.

General Hydrology of the Rock Formations

According to Griggs, the Pierre shale generally yields little or no water to wells. The few wells that have been developed in the shale yield water of poor quality that is generally unfit for human consumption. An analysis of water from a Philmont Ranch well drilled in the Pierre shale about 3 miles south-southwest of the ranch headquarters is given at the end of the report. Consideration has been given to drilling through the Pierre shale to the Dakota sandstone to obtain water; however, in the vicinity of the Philmont Ranch the depth to the Dakota sandstone is between 1,000 and 2,000 feet, and the chemical quality of the water in this area is not known. To the east, water yielded to wells from the Dakota sandstone is of poor to fair quality.

The Trinidad sandstone, if saturated, probably would be an excellent aquifer. However, in most of the areas where water is needed, the formation is dissected and drained naturally, and has such a thin zone of saturation that yields would be inadequate. Where the sandstone is rather deeply buried, below the Raton formation, adequate yields for stock and domestic use possibly could be obtained. The Raton formation yields a moderate amount of water, as demonstrated by the Ponil Camp well, but the coal beds which are part of the formation contribute water of poor quality. The Tertiary intrusives as a general rule are sufficiently dense that the yield of water would be negligible.

The remaining possibility for the development of ground-water supplies is the Quaternary alluvium. The alluvium is a poorly to moderately sorted mixture of clay, sand, and gravel, which yields water of fair quality in small to moderate quantities. The analysis of water from a well dug in the alluvium about 1 mile west of the ranch headquarters is given at the end of the report. The thickness of the alluvium differs greatly from place to place, as does the thickness of the saturated zone. In general, the section would be thickest near the middle of the valley. At most of the camp sites and both ranch sites that were visited, the alluvium rests on the impermeable Pierre shale. At Ponil and North Ponil camps the alluvium lies on the Raton formation. The nature of the bedrock at Miner's Park is not known at present.

For obtaining water from a single aquifer the spacing between wells is important; it should be determined on the basis of the amount of water pumped from each well and the permeability (in turn determined by the size-grade and sorting) of the water-bearing material. Owing to insufficient data, the minimum desirable spacing between wells in feet cannot be calculated accurately. However, as a general rule, it seems that wells should be at least 200 feet apart. In the Ponil Camp area, spacing would be independent of the existing deep well, as it does not produce water from the alluvium.

Well Sites

Ponil Camp.--The Ponil camp is in Middle Ponil Canyon about 0.2 mile southeast of the confluence of South and Middle Ponil Creek and about 11 miles northwest of Cimarron. The width of the valley floor ranges from about 200 to 500 feet. The camp is served at present by a drilled well, reportedly 205 feet deep, which penetrates the Raton formation. The yield of the well averages about 20 gpm (gallons per minute) for extended periods of pumping, but for shorter periods of intermittent pumping the well yields about 40 gpm. The water is of poor quality and contains large amounts of a flammable gas, presumably methane, derived from the coal beds.

According to the log of the present well the alluvium is 18.5 feet thick at that location, but probably varies considerably in thickness in different parts of the valley. The alluvium probably receives adequate recharge from Ponil Creek to meet necessary requirements of the immediate future, inasmuch as Ponil Creek flows most of each year.

Suggested locations for wells to be drilled are as follows: in the area near the present well, either to the southwest between the present deep well and the creek, or southward toward the grove of trees, or along the edge of the field about 300 feet south of the present well and about midway between the valley walls. The land surface in the field is somewhat higher than in the valley near the present well, and damage by flooding would be minimized. Further development, if desired, could take place in the upper part of the camp area along Middle Ponil Creek.

North Ponil Camp.--The North Ponil camp area, known also as Old Camp, is in North Ponil Canyon about 0.2 mile southeast of the confluence of Metcalf and North Ponil Canyons and about 12.5 miles north-northwest of Cimarron. The camp is supplied by one drilled well about 36 feet deep, the yield of which is unknown.

The alluvium in the valley floor is about 300 to 500 feet wide in the camp area, and it is reported in the log of the well as being 24 feet thick. North Ponil Creek flows most of each year, providing recharge to the alluvium. The alluvium should yield enough water to wells to meet future demands.

Cimarroncito Camp.--The Cimarroncito camp is about 8.5 miles west-southwest of Cimarron, about 6 miles west-northwest of camp headquarters, and about 2 miles east of Cimarroncito Peak. The camp lies in a valley tributary to Cimarroncito Creek, extending from Cimarroncito Creek northward about 1 mile across a low divide or saddle. The entire camp is supplied by a drilled well which is about 1.4 miles north-northwest of Cimarroncito Reservoir, about 0.25 mile south of the saddle at the head of the canyon, and about midway between the dry creek and the road. The well is 76 feet deep and, as reported, yields about 12 gpm.

The valley floor is about 100 feet wide near the well, somewhat narrower than to the north in the saddle or south toward the hunting lodge where the valley is about 500 and 700 feet wide, respectively. The altitude ranges from approximately 7,800 feet near the Hunting Lodge to nearly 8,200 feet in the saddle. The altitude of the well is about 8,000 feet.

The thickness of the alluvium in the Cimarroncito area is not definitely known, as a log is not available for the Cimarroncito well. However, from the appearance of the well cuttings remaining on the ground near the well, it seems possible that the well is bottomed in shale. The thickness of the alluvium probably differs greatly from place to place in this area. The alluvium receives recharge from the runoff of infrequent precipitation.

There appear to be several fairly good possible locations for future well sites in the Cimarroncito area. On the north side of the divide, at least two possibilities can be considered: one is about 300 to 400 feet southward from the new shower house, west of the main vehicle trail, and about 80 feet south of a clump of trees; another is northeast of the new shower house toward the gorge and the convergence of the two dry creek beds. The area lying several hundred feet west or west-northwest of the new shower house also holds possibilities for future development. The meadow lying between the rifle range and the Hunting Lodge will probably yield water to wells. A well in this location would reduce the demand on the existing well.

Miner's Park.--The Miner's Park camp site is in a small park or natural clearing north of and topographically above the South Fork of Urraca Creek, about 5 miles west-southwest of camp headquarters and somewhat southwest of a divide between North and South Forks of the creek. The park, which is approximately triangular, is about 600 feet across. A small lake, which is usually dry, occupies the middle of the park. The proposed camp area will be along the southern edge of the clearing along the shore of the lake. The campsite is supplied with water from a well near a dry creek at the southern end of the park. About 150 feet southwest of the well and along the creek is an old dug well, and about 400 feet farther southwest is a small concrete diversion structure, both of which contained water at the time of the visit.

The present well, which is about 23 feet deep, obtains water from alluvium. According to the log of the well, a hard, sharp gray sand was encountered at the bottom of the well; whether this is bedrock or a sandstone boulder is not known. The well furnished at least 20 gpm for short periods, and pumping for 4 hours and 15 minutes at 20 gpm reportedly lowered the water level 47 inches.

Future development in the area should be northward from the present well, preferably along the western edge of the clearing. It would appear that the lake, which serves as a collection area for runoff, should afford excellent recharge after periods of precipitation.

Clark's Fork Camp.--The Clark's Fork area is at the mouth of Clark's Fork Canyon, a tributary of Cimarroncito Creek, about 5 miles west of camp headquarters and about 7 miles west-southwest of Cimarron.

Two reportedly dry holes were drilled in the area: one, thought to be that referred to in camp records as the no. 1 test, was drilled about 100 feet south of the shower house; the other, the no. 2 test, was drilled about 20 feet southeast of the shower house. The southernmost test hole, no. 1, was filled and abandoned, but casing was left in the so-called no. 2 hole. Its measured depth, which was reported as 24 feet in the log, is about 49 feet, and the depth to water is 9.7 feet. If it is assumed that the log of the well is essentially correct, and that the depth to bedrock is 24 feet, then there is nearly 14 feet of saturated thickness which perhaps could yield a few gallons per minute if the well were rehabilitated. It is suggested that the casing be pulled and measured and the number and size of the perforations be determined. If the length of perforated casing is less than 14 feet, more perforations should be made. The casing should then be replaced in the hole to a depth of 24 to 26 feet and supported from the top by a casing clamp. Perforation and development procedures as described later should be used.

Rayado Pasture.--The Rayado Pasture well is about 4.5 miles southward from camp headquarters. The "new" well is about 0.3 mile north of the Rayado Pasture well, and both are 1 mile west of New Mexico State Highway 21. Each well is reported to yield a maximum of about 1 quart per minute after water in storage in the casing is removed.

It appears from the available data, including the driller's log, casing data, and the reported water-level data, that in the older Rayado well the water may be partially sealed off by the casing. As suggested in the case of the Clark's Fork no. 2 test, it might be worthwhile to pull the casing, measure the amount of perforation, and make more perforations if needed. Assuming from the log that the shale bedrock was encountered at a depth of about 90 feet, and that the depth to water from land surface is about 70 feet, perforation should be made in at least the lowest 20 feet of casing if 90 feet of casing is replaced. The water level should be measured after a period of no pumping to determine the true static water level. If the depth to water is less than the value previously stated, then more of the casing should be perforated. The well should be developed as outlined later.

In the case of the "new" well, further development may help to increase the yield. However, the well is located rather high along the flank of the valley, and the zone of saturation may not be sufficiently thick to yield adequate water. There appears little possibility of the water being cased off in this well, as it is reportedly cased with one length of pipe to a depth of about 20 feet. The static water level is 42.1 feet. If it is considered desirable to attempt further development of this well, it would be advisable to case it to a depth of about 60 feet to provide support to the bore wall; at least 20 feet of casing should be perforated if this procedure is followed.

Vega.--The vega is part of a pasture area along the east property line of the ranch, about 3 miles south of Cimarron, 2 miles northeast of camp headquarters, and about 1 mile east-northeast of the ranch headquarters. The vega has been irrigated with water obtained from a pit reportedly about 10 feet deep and about 40 feet square, which was excavated at the west end of a long, narrow marshy area. The pit reportedly provides about 150 gpm for 5 hours and requires about 3 days to recover. The static water level is near the land surface.

A pump capable of delivering the desired amount of water could be installed at the pit and placed in operation. When the water level has declined nearly to the bottom of the pit, the pit could be deepened to bedrock. When, and if, water flows in at a rate equal to or greater than the amount being pumped, the supply will be adequate. If the yield is not adequate after deepening the pit, then lengthening the pit southward may increase the volume. Heavy pumping in the vega area should not influence the wells to the west at the Lower Heck Place.

Suggestions and General Information

Records.--As a matter of good administration for possible future reference in questions concerning individual wells and as an aid in determining future actions for new wells, it is advisable to collect the following data at the time a well is being drilled:

A set of labeled, unwashed samples of rock encountered, collected at 2- to 5-foot intervals, is excellent. However, a written log, carefully recorded during the time a well is being drilled, can be of great value. The length and size of casing should be recorded, as well as the amount and type of perforation or screen. This information is particularly of value in the event that a promising uncased well becomes inadequate after it is cased and "finished." The depth to water from the land surface or the top of the casing, and date measured, should be recorded, along with the measured depth of the well.

Drilling.--Holes should be drilled in short runs of 2 to 5 feet and should be bailed clean at the end of each run. Each hole should be drilled a few feet into bedrock, for two reasons: to make certain that bedrock has been reached, and to provide a small bailing pit which is somewhat below the base of the aquifer in order to insure a clean hole upon completion of the well and to provide a small catchment for material which may enter the well later.

Perforations.--Casing is put in a well to support the wall of the drill hole and is perforated to permit the entry of water into the casing. The shape and amount of perforations used vary greatly with different drillers, and depend also on the type of casing and the nature of the aquifer. For the alluvium at Philmont Scout Ranch, it appears that slots cut into the casing about one-sixteenth to one-eighth inch wide, 12 inches long, and 2 to 4 inches apart would be adequate. The blank zone in each line of slots should be staggered in relation to the blanks of the adjacent lines of slots, which effectively increased the amount of perforation without jeopardizing the strength of the casing. For 6- to 8-inch casing, 8 lines of slots distributed around the circumference should be adequate.

The linear amount of casing to be perforated should be determined by the thickness of the saturated zone. This is determined by measuring the depth of the well and depth to the nonpumping, or static, water level; their difference being the thickness of the aquifer (assuming, as is likely, that water table rather than artesian conditions exist). The distance drilled into bedrock should be subtracted from this value, and that part of the casing which extends into non-water-bearing bedrock such as the Pierre shale need not be perforated.

Development of wells.--Developing a well refers to the process of removing the fine material such as clay, silt, and fine sand from the rock or alluvium immediately outside the well casing, permitting water to enter the casing more readily. This can be done by surging and bailing. Surging is a process resulting in a vertical movement of water in the upper part of the casing, which in turn becomes an in-and-out movement in the slotted part of the casing. It helps to remove the finer materials from the rock or alluvium outside the casing, increases the porosity of the aquifer adjacent to the casing, and cleans the slots or screen. Surging should be followed by bailing, which is the removal of fine materials and water from within the casing. In the event that a driller does not have a surge block, a bailer slightly smaller than the casing diameter and filled with water can be used. The individual periods of surging may range from a few minutes at the start to perhaps 15 minutes later in the period of development, dependent on the amount of clay and fine sand that accumulated inside of the casing. The well should be bailed at frequent intervals, to remove the accumulated material. Surging and bailing should be continued at least until the amount of material that enters the casing during surging is slight.

In some cases, the addition of commerical well detergents may facilitate the removal of clay from the slots or bore wall. One such detergent is sodium hexametaphosphate. These chemicals are used in addition to surging and bailing. The recommended concentration is 15 to 30 pounds of chemical per hundred gallons of water in the well. The volume of water in storage in a well is determined by the formula: $\pi r^2 h$ divided by 7.5, where π is 3.14, r is the radius (not diameter) in feet, h is the height (in feet) of water in well, and the volume is in gallons. The chemical should remain in the well 24 to 48 hours and should be surged briefly 10 to 12 times during the period. Surging and bailing are then carried on until development is complete. The treatment should be repeated once, but if results warrant further repetition, there may be as many as 5 or 6 treatments. It should be understood that chemical treatment is not a cure-all for weak wells and should follow a preliminary period of development. Whether chemical treatment will improve yields of the wells drilled in the area is not known and if tried should be considered as an experiment.

Development with or without chemicals can be considered complete when the water bailed from the well is clear, little or no silt or sand is present, and the yield does not increase appreciably with continued development. In the event that the yield of a well is apparently inadequate, development should be continued at least 4 hours before abandoning the site.

Sanitation.--The top of the casing of each well should be sufficiently high above the land surface to prevent entry of floodwater. At ground level, an adequate concrete slab should be poured to prevent runoff water and small animals from entering the hole outside the casing. After finishing a well, but prior to installing a pump, some provision for inserting a tape to make water-level measurements should be made. One possibility is to drill and tap a half-inch hole in either the casing or the casing cover and seal the hole with a threaded plug. Another equally good method is to weld or thread a ½- to 1¼-inch diameter threaded and capped nipple into a hole in the casing or well cover. The top of the casing under the pump should be covered tightly.

Pumping tests.--A pumping test consists of two parts, drawdown and recovery. Such a test can provide data which will determine what the pumping level for a given yield will be, what the spacing between wells should be, and what the maximum yield of that well will be. A pumping test is a matter not only of determining the amount of drawdown after a specific period of pumping, but of determining the rate at which drawdown occurs and, upon cessation of pumping, the rate of recovery.

Pumping tests should be run for at least 8 hours, and preferably longer. The rate of pumping should be kept constant and should not be great enough to draw the water level down to the pump intake. As an example, if a test were to be made on the Cimarroncito well, which reportedly will produce 12 gpm but not 15, the pumping rate should probably be 8 or 10 gpm if the pump intake is close to the bottom of the well. Discharged water should be led away from the well so that local immediate recharge cannot occur. A practical schedule of measurements is as follows: Make several measurements over a period of several hours before the test starts, noting the time and making one last measurement immediately before starting the pump. For the first 10 minutes of the test, measurements should be made as frequently as possible, recording the measurements and the time, preferably in minutes from the start of the test. A suggested schedule of measurements to be used for both the pumping test and period of recovery follows:

Time in minutes from start	Frequency of measurements
0-10	As many as possible
10-30	Once per minute
30-60	Once every 2 minutes
60-90 (1-1½ hours)	Once every 3 minutes
90-120 (1½ - 2 hours)	Once every 5 minutes
120-180 (2 - 3 hours)	Every 10 minutes
180-240 (3 - 4 hours)	Every 20 minutes
240-300 (4 - 5 hours)	Every 30 minutes
300 - End of test	Every hour

Immediately before the pump is shut off, two or three measurements should be made. As soon as the pump is shut off, the recovering water level is measured on the same schedule as used during drawdown.

Analyses by Geological Survey, United States Department of the Interior
(parts per million)

36631

Maxwell Grant No. / Analysis No.	59 / 38	42 / 47				
Date of collection	5/31/46	5/31/46				
Silica (SiO_2)	-	-				
Iron (Fe), dissolved 1/	-	-				
Iron (Fe), total						
Manganese (Mn), dissolved 1/						
Manganese (Mn), total						
Calcium (Ca)	244	142				
Magnesium (Mg)	215	34				
Sodium (Na) / Potassium (K)	489	22				
Bicarbonate (HCO_3)	512	215				
Carbonate (CO_3)						
Sulfate (SO_4)	2,030	342				
Chloride (Cl)	16	7.5				
Fluoride (F)	.3	.0				
Nitrate (NO_3)	.2	0				
Borate (BO_3)	-	.2				
Dissolved solids Sum	3,250	653				
Residue on evaporation at 180°C						
Hardness as $CaCO_3$	1,490	949				
Non-carbonate	1,070	313				
Specific conductance (micromhos at 25°C)	385	90.2				
pH	-	-				
Color						
Percent sodium	42	9				

1/In solution at time of analysis.

Well 59 Water-bearing formation: Pierre shale. Source of sample: Well of Philmont Scout Ranch, about 3 miles south-southwest of ranch headquarters and 6 miles southwest of Cimarron. Temp.=55°F. Total depth=119 feet. Water level=53.4 feet below top of casing. [51.9 feet below land surface], May 31, 1946.

Well 42 Water-bearing formation: Quaternary alluvium. Source of sample: Well of Philmont Scout Ranch, about 1 mile west of ranch headquarters and 3 miles southwest of Cimarron. Temp.=52°F. Total depth=15 feet. Water level=11.0 feet below land surface.

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COOPERATOR(S): N. Mex. Bur. Mines, N. Mex. State Engineer.

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NOTES ON RECONNAISSANCE OF GROUND-WATER CONDITIONS AT PHILMONT SCOUT RANCH, APRIL 1956

By C. F. Berkstresser, Jr.

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The Pierre shale, of late Cretaceous age, is the oldest formation exposed and identified in the areas where the reconnaissance was made. It is characteristically an impermeable gray to black fissile shale which locally contains lime concretions and thin beds of limestone and sandstone. It is reported to be about 3,000 feet thick, although this probably includes the Benton and Niobrara formations which underlie the Pierre shale. Overlying the Pierre shale is the Trinidad sandstone of late Cretaceous age which is a well-cemented, coarse, drab to dark-brown sandstone; it is about 100 feet thick in the northern part of the ranch, but is missing in the southern part. Overlying the Trinidad sandstone are sandstone, coal, and shale strata of the Raton formation of the Eocene series of the Tertiary system. After deposition of the Raton formation, numerous dikes and sills of porphyritic monzonite were intruded into the Raton and all older formations. Since the early Pleistocene, erosion has shaped the mountains and canyons, and contemporaneously, pediment gravels and alluvium derived from the older formations were deposited.

Further information concerning the geology of the area, is given in the following publications: Griggs, R. L., 1946, Geology and ground-water resources of the eastern part of Colfax County, New Mexico; New Mexico Bureau of Mines and Mineral Resources, Ground-Water Report Number 1; and particularly for the Philmont area; Smith, J. F., and Ray, L. L., 1943, Geology of the Cimarron Range, New Mexico; Geol. Soc. America Bull., vol. 54, no. 7, p. 891-924.

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The yield of the well averages about 20 gpm for extended periods of pumping, but for shorter periods of intermittent pumping the well yields about 40 gpm. The water is of poor quality and contains large amounts of a flammable gas, presumably methane, derived from the coal beds.

According to the log of the present well the alluvium is 18.5 feet thick at that location, but probably varies considerably in thickness in different parts of the valley. The alluvium probably receives adequate recharge from Ponil Creek to meet necessary requirements of the immediate future, inasmuch as Ponil Creek flows ~~the greater part~~ of each year.

Suggested locations for wells to be drilled are as follows: in the area near the present well, either to the southwest between the present deep well and the creek, or southward toward the grove of trees, ~~and~~ or along the edge of the field about 300 feet south of the present well and about midway between the valley walls. Land surface in the field is somewhat higher than in the valley near the present well, and damage by flooding would be minimized. Further development, if desired, could take place in the upper part of the camp area along Middle Ponil Creek.

North Ponil Camp.--The North Ponil camp area, also known as Old Camp, is in North Ponil Canyon about 0.2 mile southeast of the confluence of Metcalf and North Ponil Canyons and about 12.5 miles north-northwest of Cimarron. The camp is supplied by one drilled well about 36 feet deep, the yield of which is unknown.

The ~~width of the~~ alluvium in the valley floor is about 300 to 500 feet in the camp area, and is reported in the log of the well as being 24 feet thick. North Ponil Creek flows ~~the greater part~~ of each year, providing recharge to the alluvium. The alluvium should yield ~~adequate~~ water to wells to meet future demands.

Cimarroncito Camp.--The Cimarroncito camp is about 8.5 miles west-southwest of Cimarron, about 6 miles west-northwest of Camp Headquarters, and about 2 miles east of Cimarroncito Peak. The camp lies in a tributary valley of Cimarroncito Creek, extending from Cimarroncito Creek northward about 1 mile across a low divide or saddle. The entire camp is supplied by a drilled well which is about 1.4 miles north-northwest of Cimarroncito Reservoir, about 0.25 mile south of the saddle at the head of the canyon and about midway between the dry creek and the road. The well is 76 feet deep and, according to reported data, yields about 12 gpm.

The valley floor is about 100 feet wide near the well, somewhat narrower than to the north in the saddle or south toward the hunting lodge where the valley is about 500 and 700 feet wide respectively. The altitude ranges from approximately 7,800 feet near the Hunting Lodge to nearly 8,200 feet in the saddle. The altitude of the well is about 8,000 feet.

The thickness of the alluvium in the Cimarroncito area is not definitely known, since a log is not available for the Cimarroncito well. However, from the appearance of the well cuttings remaining on the ground near the well, it seems possible that the well is bottomed in shale. The thickness of the alluvium probably differs greatly from place to place in this area. The alluvium receives recharge from the runoff of infrequent precipitation.

There appear to be several fairly good possible locations for future well sites in the Cimarroncito area. On the north side of the divide, at least two possibilities can be considered: one is about 300 to 400 feet southward from the new shower house, west of the main vehicle trail, and about 80 feet south of a clump of trees; another is northeast of the new shower house toward the gorge and the convergence of the two dry creek beds. The area lying several hundred feet west or west-northwest of the new shower house also holds possibilities for future development. The meadow lying between the rifle range and the Hunting Lodge will probably yield water to wells. A well in this location would reduce the demand on the existing well which could then be used in supplying the camp area near the well.

Miner's Park.--The Miner's Park camp site is located at a small park or natural clearing north of and topographically above South Fork Urraca Creek, about 5 miles west-southwest of Camp Headquarters and somewhat southwest of a divide between North and South Fork Urraca Creeks. The park, which is somewhat triangular in shape, is about 600 feet on each side. A small lake which is usually dry occupies the middle of the park. The proposed camp area will be along the southern edge of the clearing along the shore of the usually dry lake. The campsite is supplied with water from a well near a dry creek at the southern end of the park. About 160 feet southwestward from the well and along the creek is an old dug well, and about 400 feet farther is a small concrete diversion structure, both of which contained water at the time of the visit.

The present well, which is about 28 feet deep, obtains water from alluvium. According to the log of the well, a hard sharp gray sand was encountered in the bottom of the well; whether this is bedrock or a sandstone boulder is not known. The well furnishes at least 20 gpm for short periods, and pumping for 4 hours and 15 minutes at 20 gpm reportedly lowered the water level 47 inches. Four hours' pumping at 20 gpm would supply water for 160 boys, allowing 30 gallons per boy per day.

Future development in the area should be northward from the present well, preferably along the western edge of the clearing. It would appear that the lake, which serves as a collection area for runoff, should afford excellent recharge after periods of precipitation.

Clark's Fork Camp.--The Clark's Fork area is at the mouth of Clark's Fork Canyon, a tributary of Cimarroncito Creek, about 5 miles west of Camp Headquarters and about 7 miles west-southwest of Cimarron.

Two reportedly dry holes were drilled in the area: one, thought to be the No. 1 test, was drilled about 100 feet south~~ward~~ from the shower house ~~and~~ the other, the No. 2 test, was drilled about 20 feet southeast of the shower house. The southernmost test hole No. 1, was filled and abandoned, but casing was left in the so-called No. 2 hole. Its measured depth, which was reported as 24 feet in the log, is about 49 feet, and the depth to water is 9.7 feet. If it is assumed that the log of the well is essentially correct, and that the depth to bedrock is 24 feet, then there is nearly 14 feet of saturated thickness which could perhaps yield a few gallons per minute ~~with~~ rehabilitati~~on of the well.~~ It is suggested that the casing be pulled, measured, and the ~~amount~~ and ~~nature~~ of the perforations be determined. If the length of perforated casing is less than 14 feet, more perforations should be made. The casing should then be replaced in the hole to a depth of 24 to 26 feet and supported from the top by a casing clamp. Perforation and development procedures as described later should be used.

Rayado Pasture.--The Rayado Pasture well is about 4.5 miles southward from Camp Headquarters. The "new" well is about 0.3 mile north of the Rayado Pasture well, and both are 1 mile west of New Mexico State Highway 21. Each well is reported to yield a maximum of about 1 quart per minute after storage in the casing is removed.

It appears from the available data, including the driller's log, casing data, and the reported water-level data, that in the older Rayado well the water may be partially sealed off by the casing. As suggested in the case of the

Clark's Fork No. 2 test, it might be profitable to pull the casing, measure the amount of perforation, and make more perforations if needed. Assuming from the log that the shale bedrock was encountered at a depth of about 90 feet, and the depth to water from land surface is about 70 feet, perforation should be made in at least the lowest 20 feet of casing before replacing 90 feet of casing. The water level should be measured after a period of no pumping to determine the true static water level. If the depth to water is less than the value previously stated, then more of the casing should be perforated. The well should be developed as outlined later.

In the case of the "new" well, further development may help to increase the yield. However, the well is located rather high along the flank of the valley, and the zone of saturation may not sufficiently thick to yield adequate water. There appears little possibility of the water being cased off in this well, as it is reportedly cased with one length of pipe to a depth of about 20 feet. The static water level is 42.1 feet. If it is considered desirable to attempt further development of this well, it would be advisable to case it to a depth of about 60 feet to provide support to the bore wall; and least 20 feet of casing should be perforated if this procedure is followed.

Vega.--The vega is part of a pasture area along the east property line of the ranch, about 3 miles south of Cimarron, 2 miles northeast of Camp Headquarters, and about 1 mile east-northeast of the ranch headquarters. The vega has been irrigated with water obtained from a pit that is about 10 feet deep and about 40 feet square, that was excavated at the west end of a long narrow marshy area. The present arrangement reportedly provides about 150 gpm for 5 hours and requires about 3 days to recover. The static water level is near land surface.

~~It is suggested that a~~ pump capable of delivering the desired amount of water be installed at the pit and placed in operation. When the water level has declined nearly to the bottom of the pit, ~~excavate~~ to bedrock. When, and if, water flows in at a rate equal to or greater than the amount being pumped, the supply will be adequate. If the yield is not adequate after deepening the pit, then lengthening the pit southward ~~should be of value~~. Heavy pumping in the vega area should not influence the wells to the west on the Lower Heck Place.

Suggestions and General Information

Records.--As a matter of good administration for possible future reference in questions concerning individual wells and as an aid in determining future actions for new wells, it is advisable to collect the following data at the time a well is being drilled.

A set of labeled, unwashed samples of rock encountered, collected at 2-to 5-foot intervals, is excellent. However, a written log, carefully recorded during the time a well is being drilled, can be of great value. The length and size of casing should be recorded as well as the amount and type of perforation, ~~slotting,~~ or screen. This information is particularly of value in the event that a promising uncased well becomes inadequate after it is cased and "finished." The depth to water from land surface or the top of the casing, and date, should be recorded, along with the measured depth of the well.

Drilling ~~recommendations~~.--~~It is strongly suggested that drillers be requested to make~~ short runs of 2 to 5 feet and ~~to~~ bail ~~the hole~~ clean at the end of each run. ~~The~~ hole should be drilled a few feet into bedrock for two reasons: to make certain that bedrock has been reached, and to provide a small bailing pit which is somewhat below the base of the aquifer in order to insure a clean hole upon completion of the well and to provide a small cachment for material which may enter the well ~~when used~~.

Suggestions ~~on the amount and spacing of~~ perforations.--Casing is put in a well to support the wall of the drilled hole, ~~or bore,~~ and is perforated to permit the entry of water into the casing. The shape and amount of perforations used vary greatly with different drillers, and also depend on the type of casing and the nature of the ~~material of the~~ aquifer. For the alluvium ~~encountered~~ at Philmont Scout Ranch, it appears that slots cut into the casing about one-sixteenth to one-eighth inch wide, 12 inches long, and 2 to 4 inches apart would be adequate. The blank zone ~~between~~ each line of slots should be staggered in ~~respect~~ to the blanks of the adjacent line of slots which effectively increases the amount of perforation without jeopardizing the strength of the casing. For 6- to 8-inch casing, 8 slots distributed around the circumference should be adequate.

The linear amount of casing to perforated should be determined by the thickness of the saturated zone. This is determined by measuring the depth of the well and depth to the nonpumping, or static, water level; their difference being the thickness of the aquifer ~~unless their is artesian pressure~~. The distance drilled into bedrock should be subtracted from this value, and that part of the casing which extends into bedrock need not be perforated ~~of non-water bearing~~ such as the Pierre shale.

Suggestions ~~for~~ development of wells.--Developing a well refers to the process of removing the fine material such as clay, silt, and fine sand from the rock or alluvium immediately outside ~~of~~ the well casing, ~~which in turn~~ permits water to enter the casing more readily. This can be done by surging and bailing. Surging is a process resulting in a vertical movement of water in the upper part of the casing, which in turn becomes an in-and-out movement in the slotted part of the casing. This helps to remove the finer materials from the rock or alluvium outside the casing, increases the porosity of the aquifer adjacent to the casing, and cleans the slots or screen. Surging should be followed by bailing, which is the removal of fine materials and water from within the casing. In the event that a driller does not have a surge block, a bailer filled with water can be used. The surging period may range from a few minutes at the start to probably not over 15 minutes later in the period of development, and is determined by the amount of clay and fine sand that accumulates inside of the casing. The well should be bailed when the slotted portion of the casing is half filled, and the hole should be bailed clean. Surging and bailing should be continued at least until the amount of material that enters the casing is a minor amount.

In some cases, the addition of certain chemicals such as Calgon and Weltone will facilitate the removal of clay from the slots or bore wall. Calgon is a commercial water softener, and Weltone is mainly Calgon with calcium hypochlorite added for algae control. These chemicals are used in addition to surging and bailing. The recommended concentration is 15 to 30 pounds of chemical per hundred gallons of water in the well. The volume of water, or storage, standing in a well is determined by the formula: $\pi r^2 h$ divided by 7.5, where π is 3.14, r is the radius (not diameter) in feet, h is the height (in feet) of water standing in well, and the volume is in gallons. The chemical should remain in the well 24 to 48 hours and should be surged briefly 10 to 12 times during the period. Surging and bailing are then carried on until development is complete.

The treatment should be repeated once, but if results warrant further repetition, there may be as many as 5 or 6 treatments. It should be understood that chemical treatment is not a cure-all for weak wells and should follow a preliminary period of development. Whether chemical treatment will improve yields of the wells drilled in the area is not known and if tried should be considered as an experiment.

Development with or without chemicals can be considered complete when the water bailed from the well is clear, little or no silt or sand is present, and the yield does not increase appreciably with continued development. In the event that the yield of a well is apparently inadequate, development should be continued at least 4 hours before abandoning the site.

Sanitation.--The top of the casing of each well should be sufficiently high above the land surface to prevent entry of flood water. At ground level, an adequate concrete slab should be poured to prevent runoff water and small animals from entering the hole outside ~~of~~ the casing ~~and polluting the well~~. After finishing a well, but prior to installing a pump, some provision for inserting a tape to make water-level measurements should be made. One possibility is to drill and tap a half-inch hole in either the casing or the casing cover and seal the hole with a threaded plug. Another equally good method is to weld or thread a $\frac{1}{2}$- to $1\frac{1}{4}$-inch diameter threaded and capped nipple into a hole in the casing or well cover. The top of the casing under the pump should be covered tightly ~~to keep out insects, rodents, and rocks which might be dropped in by curious boys~~.

Pumping tests ~~and procedure~~.--A pumping test consists of ~~actually occurs in~~ two parts; drawdown and recovery. Such a test can provide data which will determine what the pumping level for a given yield will be, what the spacing between wells should be, and what the maximum ~~specific capacity or total~~ yield of that well will be. ~~Also,~~ A pumping test is a matter not only of determining the amount of drawdown after a specific period of pumping, but of ~~it is also for~~ determining the rate at which drawdown occurs and, upon cessation of pumping, the rate of recovery.

Pumping tests should be run for at least 8 hours, and preferably longer. ~~if possible.~~ The rate of pumping ~~must~~ should be kept constant ~~at all times,~~ and should not be great enough to draw the water level down to the pump intake. As an example, if a test were to be made on the Cimarroncito well, which ~~will~~ reportedly will produce 12 gpm but not 15, the pumping rate should probably be 8 or 10 gpm ~~with~~ if the pump intake is close to the bottom of the well. Discharged water should be led away from the well so that local immediate recharge cannot occur. ~~The~~ A practical schedule of measurements is as follows: Make several measurements over a period of several hours before the test starts, noting the time and ~~getting~~ making one last measurement immediately ~~prior to~~ before starting the pump. For the first 10 minutes of the test, measurements should be made as ~~quickly and as often~~ frequently as possible, recording the measurements and the time, preferably in minutes from the start of the test. A suggested schedule of measurements to be used for both the pumping test and period of recovery follows:

Time in minutes from start	Frequency of measurements
0-10	As many as possible
10-30	Once per minute
30-60	Once every 2 minutes
60-90 (1-$1\frac{1}{2}$ hours)	Once every 3 minutes
90-120 ($1\frac{1}{2}$ - 2 hours)	Once every 5 minutes
120-180 (2 - 3 hours)	Every 10 minutes
180-240 (3 - 4 hours)	Every 20 minutes
240-300 (4 - 5 hours)	Every 30 minutes
300 - End of test	Every hour

Immediately before ~~cessation of pumping,~~ the pump is shut off, two or three ~~final~~ measurements should be made. As soon as the pump is shut off, ~~the~~ recovering water level is ~~measurement procedure is repeated~~ measured on the same schedule as used ~~before~~ during drawdown.

~~C. F. Berkstresser~~

36631

Analyses by Geological Survey, United States Department of the Interior
(parts per million)

Maxwell Grant No.	59	42
Analysis No.	38	47
Date of collection	5/31/46	5/31/46
Silica (SiO_2)	-	-
Iron (Fe), dissolved 1/	-	-
Iron (Fe), total		
Manganese (Mn), dissolved 1/		
Manganese (Mn), total		
Calcium (Ca)	244	142
Magnesium (Mg)	215	34
Sodium (Na) / Potassium (K)	489	22
Bicarbonate (HCO_3)	512	215
Carbonate (CO_3)		
Sulfate (SO_4)	2,030	342
Chloride (Cl)	16	7.5
Fluoride (F)	0.3	.0
Nitrate (NO_3)	0.2	0
Borate (BO_3)	-	.2
Dissolved solids		
Sum	3,250	653
Residue on evaporation at 180°C		
Hardness as $CaCO_3$	1,490	949
Non-carbonate	1,070	318
Specific conductance (micromhos at 25°C)	385	90.2
pH	-	-
Color		
Percent sodium	42	9

1/In solution at time of analysis.

Well 59 Water-bearing formation: Pierre shale. Source of sample: Well of Philmont Scout Ranch, about 3 miles south-southwest of ranch headquarters and 6 miles southwest of Cimarron. Temp.=55° F. T. D.=119 feet. W. L.=53.4 feet below top of casing. [51.9 feet below land surface], May 31, 1946.

Well 42 Water-bearing formation: Quaternary alluvium. Source of sample: Well of Philmont Scout Ranch, about 1 mile west of ranch headquarters and 3 miles southwest of Cimarron. Temp.=52° F. T. D.=15 feet. W. L.= 11.0 feet below land surface.

Total depth