Water-supply investigation of Whitehorse Lake area, McKinley County, New Mexico

By

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INTRODUCTION

During the summer of 1948 the supply of water for the Whitehorse Lake day school was found to be insufficient to allow further operation of the school on a semiboarding basis. Inasmuch as the Geological Survey has been studying the ground-water problems of the Navajo Indian Reservation since January 1948, officials of the Navajo Service requested that the program also include ground-water problems of Indian schools, such as Whitehorse Lake, that are not on the reservation but are, nevertheless, the responsibility of their office.

Location

The Whitehorse Lake day school is located in the NW¼ sec. 12, T. 18 N., R. 9 W., McKinley County, New Mexico, on 40 acres of land allotted to the Navajo Service by the Federal Government. A graded road connects Whitehorse Lake with Crown Point, about 30 miles to the east, and continues southward to Thoreau on U. S. Highway 66.

Topography and drainage

The Whitehorse Lake area lies in the southeastern part of the Colorado Plateau province, at an altitude of about 6,300 feet. The region displays the cuesta and mesa topography characteristic of the high plateau country. In the vicinity of the school the nearly flat lying sedimentary strata have been subjected to extensive erosive action by north-flowing intermittent streams, which has produced a rough terrain of relatively low relief.

Problem

Water for the Whitehorse Lake day school is obtained from a shallow well, dug in the alluvial fill of an arroyo a short distance east of the school (well 1, table 1). In 1946, a flood washed out an earth stock-tank dam upstream from the well. Since that time the stream has cut a deeper channel

and the water level in the well has declined about 7½ feet. This reduced the supply which could be produced from the well, so that in the summer of 1948 only about 1,800 gallons per day could be pumped. Present requirements at the school are about 4,000 gallons of water per day.

A second factor to be considered is that the existing well is not located on the school property. The wash crosses only the northeast corner of the allotment, where the alluvial fill is extremely thin; therefore an adequate water supply could not be developed from the fill on the school land.

Field work

Field work was done August 19 and 20, 1948, by H. A. Whitcomb, geologist, and G. A. Lerua, engineer, under the direct supervision of L. C. Halpenny, engineer in charge of Navajo work. A general geologic and hydrologic reconnaissance was made.

All producing wells in the area were sampled, and water levels were measured where possible. It was impossible to measure the depths to water in the deep wells, and all figures given are from records furnished by the Navajo Service. Records and logs of the wells are given in tables 1 and 2, and water analyses are given in table 3.

Acknowledgments

C. V. Theis, district geologist for ground-water investigations in New Mexico, was consulted during the work and reviewed the report. C. B. Read, Geologic Division, reviewed the geologic section. J. D. Hem, Quality of Water Branch, reviewed the section on quality of water.

GEOLOGY

The sedimentary rocks exposed in the vicinity of Whitehorse Lake are Upper Cretaceous in age. Dane[1/] has assigned the strata to the Allison member,

1/ Dane, C. H., Geology and fuel resources of the southern part of the San Juan Basin, N. Mex.: Part 3, The La Ventana-Chacra Mesa coal field: U. S. Geol. Survey Bull. 860-C, pp. 95-96, 1936.

in the upper part of the Mesaverde formation. Descriptions of unexposed rocks in the area were obtained from geologic reports by workers in adjacent areas.[2/3/]

Stratigraphy

The stratigraphic relationships of formations and members described in this report are as follows:

Age	Formation	Member
Quaternary	Alluvium	
Cretaceous (Upper)	Mesaverde formation	(Chacra sandstone member (Allison member (Gibson coal member (Hosta sandstone member

The Hosta sandstone member, the basal member of the Mesaverde formation, is essentially a buff marine sandstone, soft, thin bedded to massive, and containing occasional thin beds of gray shale and black carbonaceous material. The Hosta sandstone member is thought to be relatively thin in the Whitehorse Lake area, where the thickness probably does not exceed 75 feet. Below the Hosta sandstone member lies the Mancos shale, also of Upper Cretaceous age.

The Gibson coal member of the Mesaverde formation overlies the Hosta sandstone member. The Gibson is not exposed in the Whitehorse Lake area but is known to underlie the Allison member. It is difficult to distinguish between the Gibson and Allison members, as both contain coal and the distinction is based solely upon the greater abundance of coal beds in the Gibson coal member. As described by Dane,[4/] the Gibson coal member is a coal-bearing sandstone and shale unit 250 to 300 feet thick.

2/ Renick, B. C., Geology and ground-water resources of western Sandoval County, N. Mex.: U. S. Geol. Survey Water-Supply Paper 620, 1931.

3/ Dane, C. H., op. cit., pp. 94-107.

4/ Dane, C. H., op. cit., p. 96.

The Allison is the only member of the Mesaverde formation exposed in the Whitehorse Lake area.[5] A comparison with the part of the Mesaverde formation displayed prominently in the steep southern face of Chacra Mesa, 5 miles to the north, leads to the conclusion that the irregularly bedded sandstone, gray shale, and clay cropping out in the vicinity of Whitehorse Lake day school constitute the upper part of the Allison member. The member consists of about 800 feet of gray structureless clay containing occasional thin beds of white to gray cross-bedded sandstone. Brown to black carbonaceous shales occur frequently, and thin coal beds of limited extent are found in places.

The Chacra sandstone member overlies the Allison member and forms the top of Chacra Mesa to the north. The sandstone is not recognized in the vicinity of Whitehorse Lake day school. This topmost member of the Mesaverde formation is a marine sandstone, ranging in color from white to gray and buff. It is fine-grained, massive, and thick-bedded. The sandstone is interbedded with gray shale and shaly sandstone units. The section described and measured by Dane[6] in the southern face of Chacra Mesa was 340 feet thick.

Recent alluvium, consisting of fine sand and silt, occurs along the wash east of the school. Above the dam, the upper 20 feet is comprised of silt deposited in the reservoir. Below the dam the stream has cut a deep channel and removed a large part of the alluvium.

Structure

The strike of the beds underlying the Whitehorse Lake area is approximately east and the dip is 2° to 3° to the north. No evidence of local folding or faulting was observed.

5/ Dane, C. H., op. cit., p. 96.

6/ Dane, C. H., op. cit., p. 102.

GROUND-WATER RESOURCES

Occurrence of ground water

The depths of the drilled wells in the area range from 430 to 650 feet (see table 1). This suggests that they obtain at least some water from the Allison member of the Mesaverde formation, although some of the wells may penetrate the underlying Gibson coal member, or even the deeper-lying Hosta sandstone member. However, it does not seem likely that the Hosta sandstone member was encountered in any of these wells. The complete absence of information on the thickness of the various members of the Mesaverde in the area does not permit a more definite statement.

Regardless of which member of the Mesaverde formation is producing most of the water, the quantity available is small and the water is almost everywhere unsatisfactory for domestic use. However, the water is soft (see table 3). The wells are used almost exclusively for stock water.

Wells in the Hospah oil field, about 8 miles to the south, have been drilled to 1,500 feet without encountering water suitable for domestic use. An oil test well was drilled by Mr. Floyd Burnham to a depth of more than 3,000 feet, 5 miles southeast of the Whitehorse Lake school. A considerable quantity of good water was reported, but the water level was far below the surface and made use of the well impracticable. Mr. Burnham also drilled a well in 1946 to a depth of 642 feet, 4 miles south of the school. The water was reported to be good but no samples could be obtained.

The water from the alluvial fill is clear, cool, and palatable but is hard. In spite of the hardness of the water, many Indian families journey to the school to launder and bathe rather than use deep-well water. The improved facilities available at the school apparently outweigh the disadvantages of using hard water.

The supply of water in the fill is failing rapidly since the storage capacity of the dam was reduced. Subsequent floods have cut into the fill, lowering the water table 7½ feet in the past 2 years. It is doubtful if the existing well can be restored to its former productivity without repairing the breach in the dam and removing the accumulation of silt from behind it. This would be expensive and would be only a temporary measure at best, as the reservoir would surely refill with silt within a short time. It is apparent that the dam, when acting as a storage reservoir for surface water, was a major factor in maintaining the productivity of the well.

Quality of water

Water samples collected during the investigation were analyzed in the Geological Survey laboratory in Albuquerque. The analyses show that water from the alluvial fill is hard and that waters from the deep drilled wells are very soft. The high concentration of bicarbonate, sulfate, and fluoride in the waters from the deeper wells outweighs the advantage of their softness and makes them undesirable for domestic use. Water from the school well, though hard, is considered satisfactory for domestic use.

Possibilities for obtaining additional water

Field investigation indicated that the bottom of the alluvial fill in the vicinity of the school well is below the bottom of the well. Therefore, if the well were deepened, the discharge probably would be increased. Unless down-cutting of the stream is stopped or greatly retarded, however, such a measure would not insure a permanent water supply.

It is not considered advisable to construct a well in the alluvial fill on the school land, as the fill is thin and it is believed that the underlying shale is at or not far below the water table.

The quality and quantity of water obtainable from the Hosta sandstone member of the Mesaverde formation is not known. The depth to which a well would have to be drilled to encounter the member also is not known but probably would not exceed 1,000 feet.

CONCLUSIONS AND RECOMMENDATIONS

The studies of the ground-water problem at the Whitehorse Lake day school indicate that:

1. The existing supply is inadequate for operating the school on a semiboarding basis.

2. Water from the alluvial fill is better suited to domestic use than water from the Allison member and the Gibson coal member of the Mesaverde formation. The quantity and quality of water obtainable from deeper beds are not known.

3. It is recommended that the existing school well be deepened to the bottom of the fill. Gravel packing probably will be needed if the well is deepened by drilling.

4. Remedial measures should be adopted to stop or retard down-cutting of the stream in the vicinity of the well.

ADDENDUM

The foregoing conclusions and recommendations were given orally to the officials of the Navajo Service at the conclusion of field work, because the problem had to be attacked immediately.

The well was deepened in September 1948. Seven-inch casing was set at 37 feet, perforated at the bottom of the dug portion of the well and from 26 to 31 feet. The well was gravel packed below the bottom of the dug portion. After deepening the yield increased from the original 2½ gallons per minute to 5 gallons per minute. The log is as follows:

	Thickness (feet)	Depth (feet)
Caisson	23	23
Fine sand	5	28
Coarse sand	2	30
Gumbo and fine sand	7	37
Shale		37
TOTAL DEPTH		37

Table 1. - Records of wells in Whitehorse Lake area, McKinley County, New Mexico.
(All wells are drilled unless otherwise noted in "Remarks" column)

Office number	Location	Owner	Driller	Date completed	Depth of well (feet)	Diameter of well (in.)
	T. 18 N., R. 9 W.					
c/ 1	NW¼NW¼ sec. 12	Navajo Service	Holly Miller	1936 (?)	23	96
c/ 2	sec. 26	do.	C. M. Carroll	1935	638	6 5/8
	T. 19 N., R. 8 W.					
c/ 3	sec. 33	do.	Burt Cravath	1943	650	6 5/8
	T. 19 N., R. 9 W.					
c/ 4	SE¼ sec. 11	do.	C. M. Carroll	1936	430	6 5/8
	T. 18 N., R. 9 W.					
5	sec. 36 (?)	Floyd Burnham	- Fountain	1946	642	-

a/ C, cylinder; G, gasoline; W, windmill.
b/ D, domestic; S, stock; N, none.
c/ See table 3 for analysis of water from this well.
d/ Water level reported.

Records obtained by H. A. Whitcomb and C. A. Lerua.

Office number	Water level: Depth below measuring point (feet)	Water level: Date of measurement	Pump and power a/	Use of water b/	Temp. °F.	Remarks
1	17.91	Aug. 20, 1948	C,G	D	55	Navajo Service No. 16K-406. Measuring point was top of well curb. Dug well, in alluvium of wash east of school.
2	220	do.	C,W	S	64	Navajo Service No. 15S-30. Reported discharge, 10 gallons per minute. Water-level measurement approximate. See log.
3	330	d/	C,W	S	66	Navajo Service No. 15S-28. Reported discharge, 10 gallons per minute. Reported drawdown, 135 feet. See log.
4	294	d/	C,W	S	62	Navajo Service No. 15S-27. Reported discharge, 5 gallons per minute. See log.
5	-	-	None	N	-	Reported discharge, 5 gallons per minute. See log.

Table 2. - Driller's logs of wells in Whitehorse Lake area, McKinley County, New Mexico.

	Thickness (feet)	Depth (feet)
Driller's log of well 2.		
Navajo Service, owner.		
Surface soil	10	10
Sand rock	10	20
Gray shale	70	90
Sandy gray shale	61	151
Gray sand	9	160
Gray shale	4	164
Gray sand	20	184
Sandy gray shale	11	195
Brown shale	11	206
Gray sand	4	210
Brown shale	10	220
Blue shale	22	242
Gray sand	4	246
Gray shale	15	261
Sandy gray shale	54	315
Gray sand, water	25	340
Gray shale	18	358
Coal and shale	7	365
Gray shale	132	497
Black shale and coal	11	508
Blue shale	6	514
Sandy gray shale	5	519
Gray sand, water	17	536
Gray shale	6	542
Brown lime	3	545
Gray sand	8	553
Blue shale	5	558
Black shale	8	566
Gray sand	8	574
Lime shell	2	576
Gray sand	18	594
Gray shale	26	620
Gray sand	9	629
Gray shale	9	638
TOTAL DEPTH		638
Driller's log of well 3.		
Navajo Service, owner.		
Light-yellow clay	62	62
Hard rock	4	66
Gray shale	126	192
Driller's log of well 3-Cont.		
Gray sandstone	8	200
Gray shale	16	216
Gray sandstone	7	223
Gray shale	35	258
Gray sandstone	12	270
Gray shale	58	328
Gray sandstone, seep	9	337
Gray shale	37	374
Gray sandstone, water	21	395
Gray shale	128	523
Gray sandstone, water	17	540
Gray shale	38	578
Very dark-brown shale	6	584
Gray sandstone	12	596
Gray shale	24	620
Gray sandstone, water	14	634
Gray shale	16	650
TOTAL DEPTH		650
Driller's log of well 4.		
Navajo Service, owner.		
Brown sand	50	50
Blue shale	155	205
Gray sand	20	225
Sandy gray shale	15	240
Hard shale	10	250
Sandy blue shale	30	280
Water sand	14	294
Gray shale	68	362
Light-gray water sand	33	395
Light-gray shale	35	430
TOTAL DEPTH		430
Partial log of well 5.		
Floyd Burnham, owner.		
Water sand	2	87
do.	3	400
do.	5	485
do.	7	565
do.	13	615
TOTAL DEPTH		642

Table 3. - Analyses of water from wells in Whitehorse Lake area, McKinley County, New Mexico.
Analyzed in Southwestern Laboratory of Geological Survey, Albuquerque, New Mexico.
(Numbers correspond to numbers in tables 1 and 2.)
(Parts per million except specific conductance.)

Well No.	Date of collection 1948	Specific conductance, (micromhos @ 25°C.)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$
1	Aug. 20	916	80	19	107	425	118	18	0.3	14	566	278
2	Aug. 3	2,700	-	-	-	724	741	54	-	-	-	15
3	Aug. 20	1,720	5.5	2.2	413	686	270	49	2.6	1.3	1,080	22
4	do.	1,530	3.5	1.5	365	560	267	46	2.1	1.3	962	14