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MEMORANDUM IN REGARD TO THE POSSIBILITY OF LEAKAGE OF THE RESERVOIR BASIN OF THE PROPOSED SEDGWICK COUNTY LAKE, IN SOUTH-CENTRAL KANSAS

by

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Prepared by the United States Geological Survey and the Kansas State Geological Survey, with the cooperation of the Division of Sanitation of the Kansas State Board of Health and the Division of Water Resources of the Kansas State Board of Agriculture

July 1940

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INTRODUCTION

In response to a request to the Kansas Geological Survey from Mr. Robert Smrha, engineer of the Division of Water Resources, State Board of Agriculture, under date of June 26, 1940, I was assigned to make an investigation to determine whether or not the reservoir basin of the proposed Sedgwick County Lake would leak upon completion of the dam. R. C. Moore, State geologist, and Mr. Smrha visited the site July 2, but at that time adverse weather conditions prevented them from making a complete investigation. At the request of Mr. Moore data on core drilling were organized and transmitted by H. W. McMillen, resident engineer of the Sedgwick County Dam project. July 15 and part of July 16 were spent by me in an investigation at the dam and lake site.

The Sedgwick County Dam and Lake site is located about four miles south and three miles west of Goddard, Kansas, in the valley of Clear Creek, a tributary of the Minnescah River, in Sedgwick County, Kansas.

This memorandum has been reviewed by Mr. Moore and by S. W. Lohman, Federal geologist in charge of ground-water investigations in Kansas. Owing to the urgency of the request, however, it was transmitted in advance of approval by the Director of the Federal Geological Survey.

Geologic conditions

The bedrock lies at or near the surface in the vicinity of the dam site and consists of Permian shale belonging to the uppermost part of the Wellington formation. The regional dip of the shale is toward the west side of the reservoir basin, approximately parallel with the major axis of the dam and not at right angles to it. No local structure in the shale was noted.

During the course of the investigation I examined all of the shale exposures at the reservoir and dam sites, and I studied in detail the cores from 13 test holes drilled on or near the center line of the dam (see appendix of logs). The shale is mostly gray and blue, partly soft and partly hard. In general the shale is non-calcareous, but thin beds of gypsum are found in several places. Most of the beds of gypsum are only about 1/16- to 1/8-inch thick, but a few are 1/4-inch thick and a few are as much as 2 inches thick. A 3-inch bed of limestone was found at the top of the shale section in the test hole at Station 11+00, and a 2- to 3-inch bed of anhydrite was found about 45 feet below the surface (about 34 feet below the top of the shale) in the test hole at Station 8+00.

Water was reported to flow from the test hole at Station 12+00. According to Mr. McMillen the water entered the test hole at about 117 feet above an arbitrary datum and rose to an elevation of 157 feet. The flow from this hole was reported to be very irregular, ranging from 500 to 1,500 gallons an hour. At the time of my visit this well was plugged and I was not able personally to observe the water conditions in it.

A pit at Station 9+00 on the center line of the dam was dug to a depth of about 15 feet below the top of the shale. The shale in the pit is mostly medium hard and compact. A small seep of water was observed entering the pit from the south (downstream) side along a bedding plane at a point about

seven feet below the top. A little seepage was also noted in the bottom of the core trench that was dug several feet into the shale along the center line of the dam.

The illustrations on the following page illustrate by arrows the possible movements of ground water at the dam and lake sites.

Figure 1. East-west profile through the reservoir basin showing possible east-west movement of ground water along bedding planes and fractures.

Figure 2. North-south profile through the dam, showing probable effective blocking of ground-water movement by the dam.

Figure 3. North-south profile along a line west of the dam showing the possible movement of ground water around the dam.

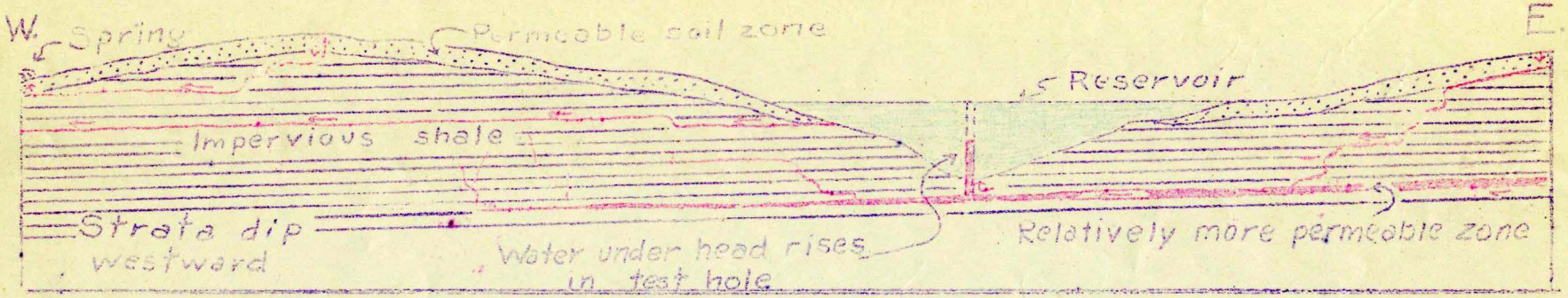

Figure 1

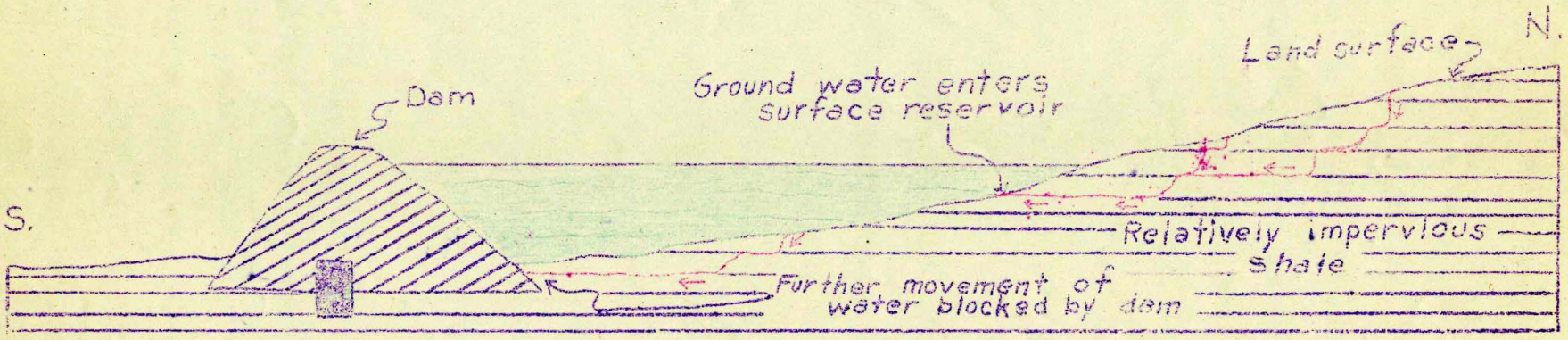

Figure 2

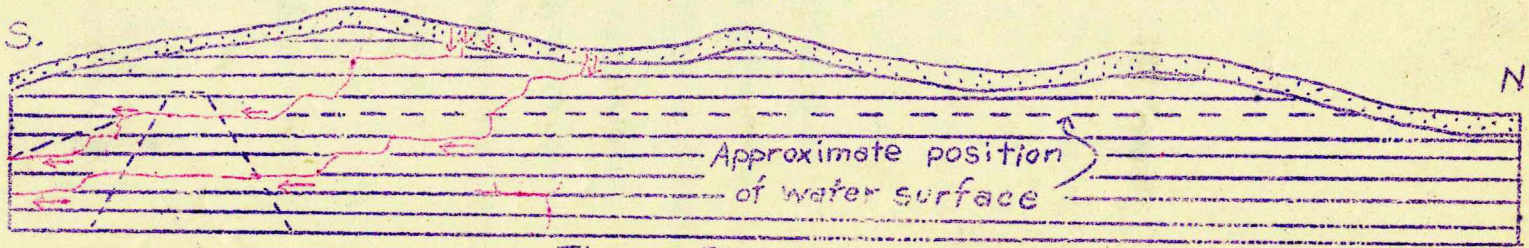

Figure 3

Conclusions

The evidence found by this investigation indicates that the shale forming the floor of the reservoir basin is so impervious that there is little likelihood of leakage or seepage hazardous to the dam or reservoir. The fact that the water found in the test hole at Station 12+00 was under pressure supports this conclusion for the following reasons. The material overlying the porous zone from which the ground water entered the hole must necessarily be relatively impervious to permit the pervious zone to hold water under pressure. The relatively high head of the ground water in this test hole indicates that any porous material near the surface is probably already saturated and hence would not absorb much additional water from the surface reservoir. Under the conditions of hydrostatic head in a deeper zone the tendency should be for all available small passageways to be filled with water moving upward from below. Any such movement of escape would seem to be insignificant, however. Owing to the regional dip of the bedrock and to the surface topography, there is no chance for the movement of water out of the reservoir basin to the north or east. Leakage to the west down the dip of the bedrock and leakage to the south around the dam may occur, but the amount in either direction probably would be insignificant and not hazardous.

Gypsum, limestone, and anhydrite are slightly soluble in water and therefore can be dissolved along fractured zones, affording passageways for the movement of water. They generally are not dissolved, however, where fracturing and weathering are absent. Such beds of soluble material are indicated in the logs of the test holes. The soluble beds of sufficient thickness to be considered hazardous are as a rule relatively far below the base of the dam and lie deeper yet below the bottom of the reservoir, as

the reservoir lies in a direction parallel to the strike of the beds. The core trench was excavated below the 3-inch bed of limestone found in the test hole at Station 11+00, so that any water in this bed should be stopped effectively by the core of the dam.

The data indicate that although soluble beds are present, they are thin and so situated structurally as to permit very little if any leakage from the reservoir basin.

Appendix

Logs of core holes drilled on or near center line of dam. The locations of the stations are shown on the map in the pocket. The elevation in feet above an arbitrary datum is given for the top of the shale at each core hole.

Station 0+00
Elevation 180.4 feet

	Feet
Clay-shale, light gray, very soft	18 - 29
Clay-shale and shale, light gray to dark blue; in part calcareous, medium soft	29 - 32
Shale, gray, medium hard	32 - 34
Do., and in part calcareous	34 - 36
Do.	36 - 40
Shale, soft, crumbly, calcareous	40 - 42
Shale, hard, gray, non-calcareous	42 - 48
Do., with seams of gypsum (1/2")	48 - 50
Shale, brown, gypsum seams	50 - 52

Station 8+00
Elevation 151.9 feet

Shale, hard, calcareous (Poor recovery)	11 - 21
Top: Clay-shale, red, soft; bottom: Shale, hard, gray, in part calcareous	21 - 26
Shale, soft, crumbly, in part calcareous	26 - 28
Do., harder	28 - 30
Shale, hard, gray	30 - 32
Do., with rock gypsum, thin	32 - 34
Shale, hard, gray	34 - 36
Do	36 - 39
Shale, medium soft, thinly laminated, weakly calcareous	39 - 41
Upper part - do; lower part: Shale, hard, compact, with thin gypsum beds (1-1/2")	41 - 43
Shale, hard, compact, weakly calcareous, 2-3-inch piece of hard anhydrite	43 - 47
Shale, soft, with thin gypsum beds	47 - 49
Shale, hard, massive	49 - 53
Shale, hard, with little gypsum	53 - 62
Do	62 - 65

Station 10+00 (16 feet south of center line)
Elevation, 128.5 feet

Clay and shale, soft, gray	35 - 42.2
Shale, hard, massive	42.2 - 45.8
Do., with 2-inch bed of gypsum at about 47 feet	45.8 - 50.4
Shale, hard, massive. (Lower 1 foot, soft, crumbly)	50.4 - 55.7
Shale, hard, blue	55.7 - 63.3
Shale, hard, gray to blue, gypsiferous	63.3 - 72.7
Shale, hard, gray to blue, slightly calcareous	72.7 - 75.9
Shale, hard, light to dark gray and red, with few very thin beds of gypsum	75.9 - 83.8
Shale, hard, massive, gray, few thin seams of gypsum	83.8 - 93.5
Shale, medium hard, dark gray, with little gypsum; lower 1 foot - fractured vertically	93.5 - 98.5
Shale, very hard, white, calcareous	98.5 - 99.5
Shale, light to dark gray, hard, slightly calcareous	99.5 - 104.4
Shale, easily fractured, medium hard, and gypsiferous	104.4 - 108
Shale, red, easily fractured	108 - 110
Shale, hard, blue	110 - 113.3
Shale, hard, blue; fractures fairly easily	113.3 - 120.6
Shale, soft, crumbly	120.6 - 123.6
Shale, hard, blue	123.6 - 128.6
Shale, blue, fractures easily	128.6 - 130.6
Shale, hard	130.6 - 133.6
Do., lower 6 inches crumbly	133.6 - 135.6
Shale, hard, blue	135.6 - 146.5
Do.	146.5 - 155.6
Shale, gray, easily fractured	155.6 - 166.2
Do.	166.2 - 167.7

Station 11+00
(17.5 feet south of center line of dam)
Elevation, 132.1 feet

Shale, fractures easily, gray, with 3-inch bed of limestone at top	34.5 - 43.6
Shale, hard, gray, with very thin gypsum beds	43.6 - 45.6
Shale, soft, crumbly	45.6 - 47.6
Shale, hard, blue	47.6 - 52.2
Shale, hard; upper 1 foot soft and crumbly	52.2 - 55.6
Shale, fractures easily, non-calcareous, and in part crumbly	55.6 - 65.5

Station 12+00
Elevation, 148.2 feet

Clay, brown, silty, loose	16 -	17
Clay, red, light	17 -	21
Shale, gray, weakly calcareous, medium hard	21 -	25
Shale, gray, weakly calcareous, hard	25 -	28
Do., with thin seams of gypsum	28 -	37
Shale, hard, with few thin seams of gypsum	37 -	42.5
Do.	42.5 -	51.5
Shale, hard, with vertical fractures	51.5 -	53.5
Do.	53.5 -	57
Shale, hard; 3 seams of gypsum ¼-inch thick	57 -	60
Do., no gypsum	60 -	62

Station 15+00
Elevation, 160.9 feet

Shale, blue, soft, slightly calcareous; 2-inch bed of limestone near bottom	10.5 -	18.7
Clay-shale, soft, calcareous, blue and green	18.7 -	24
Clay-shale, soft, red and blue	24 -	28.3
Shale, hard, blue	28.3 -	38
Do., with little gypsum near bottom	38 -	45
Do.	45 -	48.5

Station 16+00
Elevation, 166.2 feet

Shale, hard, slightly calcareous, with red clay-shale at bottom	15.6 -	20.7
Clay-shale, soft, calcareous. (Poor recovery)	20.7 -	29
Clay-shale, soft, crumbly, blue-brown	29 -	35.3
Clay-shale, soft, red, slightly calcareous	35.3 -	38.2
Shale, hard, blue	38.2 -	47.2

Station 20+00
Elevation, 177.6 feet

Shale, medium hard, light gray	15 -	17
Clay-shale, soft, calcareous, gray	17 -	19
Do., with hard shale	19 -	21
Shale, hard, weakly calcareous	21 -	24
Shale, medium, hard, fractures easily	24 -	26
Shale, hard, with few thin soft layers (1/2")	26 -	35.5

Station 24+00
Elevation, 181.3 feet

Gray, medium hard, shale	12	- 14
Do.	14	- 16
Gray, soft, clay-shale	16	- 20
Gray, hard, non-calcareous shale	20	- 22
Gray, hard, calcareous shale	22	- 24
Hard, dark gray shale; in part, calcareous	24	- 26
Gray, hard, calcareous shale	26	- 28
Gray, hard shale	28	- 32
Hard, gray shale, slightly calcareous-	32	- 37

Station 28+00
Elevation, 174.0 feet

Gray, dark blue, yellow, hard shale (Poor recovery)	18	- 25
Gray, hard, calcareous shale	25	- 30
Gray to blue, hard, calcareous shale	30	- 40
Brown, medium hard, shale (Poor recovery)	40	- 42
Dark gray, hard shale	42	- 44
Gray to red, hard, shale (soft, at bottom), with thin seams of gypsum	44	- 46

Station 32+00
Elevation, 181.8 feet

Soft, calcareous clay-shale	12.5	- 22.5
Soft to hard clay-shale, and shale	22.5	- 25.5
Gray, hard, calcareous shale	25.5	- 27.5
Gray, hard, calcareous shale	27.5	- 33.5
Do.	33.5	- 39.5
Do.	39.5	- 42.5

Station 36+00
Elevation, 185.6 feet

Soft, crumbly clay, with minor amount of soft shale	10	- 15
Clay, soft, and soft shale	15	- 20
Clay-shale and shale, soft, fractures easily	20	- 25
Hard shale, calcareous (in lower part)	25	- 30
Hard shale, gray to blue, slightly calcareous	30	- 40
Do., with little gypsum	40	- 42
Blue and brown, hard shale	42	- 44
Brown, soft shale at top; bottom, blue hard shale	44	- 46
Top: dark-blue, hard shale; bottom: red, hard shale	46	- 48
Red, hard shale and blue shale, with large amount of gypsum	48	- 50
Hard, gray shale	50	- 52

Station 40+00

Yellow and gray clay-shale (Poor recovery)	24 - 26
Gray, soft clay-shale (Poor recovery)	26 - 28
Gray, soft to hard shale; slightly calcareous	28 - 32
Gray, hard, calcareous shale	32 - 34
Do.	34 - 36
Do.; lower part: soft, calcareous clay-shale	36 - 40
Gray, hard shale	40 - 42