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H. H. BENNETT, CHIEF

ADVANCE REPORT

on the

SEDIMENTATION SURVEY OF LAKE BOONEVILLE

BOONEVILLE, ARKANSAS

November 22 - December 4, 1935

by

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SEDIMENTATION IN LAKE BOONEVILLE

BOONEVILLE, ARKANSAS

GENERAL INFORMATION

Location: State: Arkansas

County: Logan. Sec. 19, T. 6 N., R. 12 W.

Distance and direction from nearest city: 2 miles north of Booneville, Arkansas.

Drainage and backwater: Minor tributary of Petit Jean Creek.

Ownership: Arkansas Public Service Company.

Purpose served: Municipal water supply for Booneville, Arkansas.

Description of dam: The dam is an arch type, concrete structure, located on an outcrop of sandstone between the narrow V-shaped walls of a small gorge. The spillway, located on the west side of the dam, is 46 feet long, and has an axis trending approximately at right angles to the east-west direction of the dam. The overflowing water drops for a distance of about one foot to a sandstone ledge and then falls abruptly to the creek channel at a point about 100 feet below the dam. The height of the dam above the original stream channel is 47 feet; the spillway is 5 feet lower, or 42 feet above stream channel, and has an elevation of 628.24 feet above mean sea level. The upstream face of the dam is vertical. The downstream face has a small slope beginning at a point about 15 feet below the top of the dam and extending to the base which has a thickness of approximately 10 feet compared to the top thickness of 3.5 feet. The overall length of the dam is 223 feet.

Date of completion: February, 1929. Construction of the dam was begun in December 1928, and completed in February 1929. Water storage began in March 1929.

Length of lake:	Northeast Arm	West Arm
Original	1,590 feet	1,480 feet
Present	1,530 feet	1,460 feet
Shortening	60 feet	20 feet

Area of lake:

Original	18.31 acres	
Present	17.92 acres	
Reduction	0.39 acres	= 2.13 percent

Storage capacity at crest level:

	Acre feet	Gallons
Original	289.45	94,331,750[1]/
Present	281.57	91,763,663
Loss due to silting	7.88	2,568,087

General character of reservoir basin: The reservoir is advantageously situated at the confluence of two deep, narrow, youthful valleys. The shore line, consequently, has assumed a rude V-shape resembling the outline of a long-winged bird in flight. A rugged spur separates the two arms, and all shore lines are precipitous except at the mouths of the contributing streams. Both arms have an extreme length of approximately 1500 feet measured along their axes upstream from the dam. The largest arm, extending north and east from the dam, has an extreme width of about 600 feet. The precipitous submerged slope of the west shore 200 feet above the dam has a declivity of 30 feet in a distance of 31 feet, virtually a 1 to 1 slope. Ratios of 3 to 1 and 4 to 1 characterize most of the submerged slopes along the north and west shore lines above the dam. The extremely high gradient of the original stream channel and the 40-foot waterfall at the dam further illustrate the youthful character of the valley.

Average draft: The average daily draft during August is 72,000 gallons and during January is 36,000 gallons, according to Mr. Samuel Campbell, Superintendent of Water Works. These figures are based upon the water consumption records of 1934, and are considered representative of an average year. Accordingly, the year-round average daily consumption is approximately 55,000 gallons. For the population of 2100 this figure represents the low per capita daily consumption of 26.1 gallons.
No large industrial plants use municipal water, and many residences are not provided with connections to the mains. The small average draft on the reservoir has little effect on the storage capacity, and the water level remains almost continuously at crest.

1/ This figure is at variance with the 120,000,000 gallon capacity calculated by engineers engaged to construct the dam.

Area of watershed: 2.6 square miles, or 1665 acres. This figure was obtained by planimeter measurement of the drainage area as mapped on the Magazine Mountain Sheet[2], and is considered accurate within a limit of error of 5 percent.

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[2] Magazine Mountain Sheet, Arkansas, U. S. Geol. Survey, surveyed in 1887, reprinted in 1932. Scale 1/125,000, contour interval 50 feet.

General character of watershed: The watershed of Lake Booneville lies within the folded and faulted Ouachita Mountain province, and is characterized by its topographic maturity. Flat areas are practically absent, divides have been deeply dissected, and valley flats have not yet developed. Maximum relief within the watershed approaches 300 feet; and the highest points, nearly 850 feet above sea level, are located on Six Mile Creek Mountain on the north boundary of the area.

Three principal forks, all flowing directly into the reservoir, comprise the local drainage. The longest of the branches rise near the northwest corner of the drainage basin, and flows about 1½ miles east and south before entering the reservoir. All three creeks have gradients of about 100 feet per mile, and all are intermittent streams. Rugged topography, steep slopes, and high relief characterize the watershed. From the dam the overflow water follows the main creek valley southeast to the major eastward trending valley of Petit Jean Creek, which flows ultimately into Arkansas River. All drainage lines of the region have the typical lattice pattern of folded mountain areas.

The entire watershed lies within the outcrop area of the Atoka Formation, a thick series of Pennsylvanian sandstones and shales[3]. Axes of the major structures trend approximately northeastward.

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[3] Geologic Map of Ark; Ark. Geological Survey, Little Rock, 1929.

Major valleys have developed on the anticlines and mountains in the synclines due to differential erosion which accompanied and followed deformation. The Booneville region is dominated by a large syncline on which Magazine Mountain, 15 miles east of Booneville, is conspicuous. The Lake Booneville drainage area includes minor structures within the major syncline.

At the lake a conspicuous outcrop of predominantly massive sandstone provides good anchorage for the dam. The constricted channel and waterfall have originated by resistance of the sandstone to erosion where the channel

crosses its outcrop. Both to the northwest and northeast of the dam, the sandstone crowns the rugged bluff some 200 feet above the water level. Structurally the outcrop represents the south limb of a relatively small anticline, and the dip is approximately uniform all around the lake. At the dam, the strike is N. 75°E. and the dip 15°S. The sandstone formation along the southern shores of the lake is from 45 to 55 feet thick. It consists chiefly of well-cemented, uniformly fine grained, argillaceous sandstone. The surface exposures are case-hardened by a siliceous cement to a depth of one-half inch. The larger particles, medium-sized sand grains, are fairly well rounded, and muscovite is conspicuous along some bedding planes. Medium gray is the typical color, although on weathered surfaces oxidation of iron-bearing minerals has changed the color to brown or reddish shades. Bedding is fairly regular near the top and bottom of the sandstone where the individual strata range from one-quarter inch to 1 foot in thickness. An intractely cross-bedded zone occupies the center of the formation.

Beneath the sandstone, as a part of the same sedimentary series, is a body of very arenaceous, regularly, bedded shale, characterized in many places by strata of hard sandstone from one-quarter inch to 2 inches thick. Highly carbonaceous zones occur in at least three places within the 150 feet or more of shale exposed around the lake.

The minerals of the country rock undergo only slight alterations during weathering. The more massive sandstone is broken into blocks or smaller fragments. The shales enter into the process of soil formation with little change except for the red or tan coloration produced by oxidation of ferric minerals. Thus, the soil which accumulates on the flatter areas is a very sandy, red to bluff loam with low humus content. Except in a few small areas, its thickness seldom exceeds 3 or 4 inches. On many of the steeper slopes denudation keeps pace with weathering so that nearly all weathered material is removed.

Accurate figures on land use in the watershed are not available. From observation during the survey, it is estimated that not over 11 percent of the area is under cultivation, 75 percent occupied by more or less heavily wooded slopes, and 14 percent in open pasture. Some of the wooded portions serve also as pasture land. Oaks accompanied by other hardwood trees and pines predominate on the slopes, and a growth of willows occupies small areas at the heads of the lake. Scanty grass, thick moss, and tree roots on the steeper slopes are responsible for materially retarding the run-off and slope-wash into the valleys.

Mean annual rainfall and run-off: According to Mr. M. Z. Baer, Arkansas Sanitary Engineer of Little Rock, the average annual precipitation is 32 inches and the run-off is 16 inches.

HISTORY OF SURVEY

The survey of Lake Booneville was made during the period, November 22 to December 4, 1935 by the Mid-western Sedimentation Party, under the direction of Louis M. Glymph, Jr., Chief of Party. The remaining personnel of the party consisted of Victor H. Jones, Assistant Chief, Elliott M. Flaxman, William G. Shannon, Harry L. Fischer, and Oscar D. Price, Engineering Field Aides.

Because of distinct differences between pre-lake and lake sediments and the well defined shore lines, the quantitative determinations of this survey have a relatively high order of accuracy. Field work included mapping the crest level shore line on a scale of 100 feet to the inch by plane-table and telescopic alidade. The comparatively small surface area made it unnecessary to establish a triangulation system. Stations used in primary control were first established by stadia readings and then orientation at each new set-up was checked by back sight on as many previously located points as possible. All survey points were marked in the field with iron pipe and numbered to conform with the system used on the plane-table sheet. During the period of mapping, the water level was generally at crest elevation which facilitated the accuracy, ease, and speed with which the survey was made. On the completed map two contour lines are shown, the crest level line and a contour two feet higher than crest.

Around the entrances of tributary streams into the reservoir, the position of the shore line has changed due to the accumulation of sediment at and above the original crest level elevation. In these areas, the original shore line was mapped by interpolation between numerous well distributed auger borings in which the elevation of old soil was definitely established. The original shore line, traced in this manner, is shown on the accompanying map by a distinctive line.

The lake was readily adaptable to the regular range and segment method of sub-division. No difficulty was experienced in measuring silt thickness with the sampling spud. The regular range formula for capacity and silt volume was used in computations. On this lake, the vertical upstream side of the dam does not displace any of the volume of segment 1.

ACKNOWLEDGMENTS

Mr. Samuel Campbell, Superintendent of the Booneville Water Department, assisted materially in the survey by furnishing boats and equipment on the lake, and information concerning the structure and history of the dam.

Credit is due also to Mr. M. Z. Baer, Arkansas Sanitary Engineer, of Little Rock for data on average annual precipitation and run-off of the Lake Booneville drainage area.

CHARACTER, VOLUME AND DISTRIBUTION OF SEDIMENT

Taken as a whole, the sediments of Lake Booneville contain a relatively high proportion of fine sand. In the delta areas fine sand comprises the bulk of the deposit, with lesser proportions of silt. On ranges at increasing distances from the heads of the lake, increasingly

finer textures prevail until on range 01 and 02, just above the dam, the sediment is true lake silt with some clay-size material. On this range, the silt has a blue-black color due to reduction of the iron compounds. In contrast, the silt above crest level is brownish or reddish due to oxidation of the iron compounds. The textural distribution in the lake is of the normal type to be expected in a small body of water where the inflowing streams have high gradients and loads consisting chiefly of silt and fine sand.

Despite the steep slopes in the watershed, the quantity of sediment contributed by slope wash is relatively low because of the almost universal growth of small trees, moss, and grass on the slopes.

The original basin floor beneath recent reservoir sediment consists of reddish sand and gravel which represents bar and channel deposits of swift, high gradient streams in a valley that contains no true flats and no deep soil. Distinctions between these older deposits and the lake silts and sands are made with certainty. Old gravel bars from 1 to 3 feet thick are now covered by backwater a short distance above the main body of the lake in channels entering segments 8 and 9.

Following a heavy rain during the course of the survey, considerable silt and clay was carried through the lake and over the spillway. The quantity of this non-settling load has not yet been determined, but it may amount to an appreciable proportion of the silt and clay-size material carried out of the drainage basin. It is as yet an unknown factor that must be evaluated in considering the figure representing erosion in the watershed.

Certain facts on the distribution of sediment in Lake Booneville have special significance in relation to the life history of the reservoir. The results of this survey show that the deposition of sediment has reduced the effective capacity of the reservoir 2.72 percent in the six-year period since 1929. At the present rate of filling, the entire basin would be occupied by sediment in 247 years. The growth of willows and smaller vegetation on the delta areas may cause a reduction in the rate of deposition of foreset beds and an increase in the rate for the top-set beds, which would provide a retarding effect on total fill because more deposition would occur above crest level of the reservoir. This effect cannot be evaluated quantitatively at present. If the protective vegetation on the slopes is not destroyed the low slope-wash rate should remain unchanged for a long period.

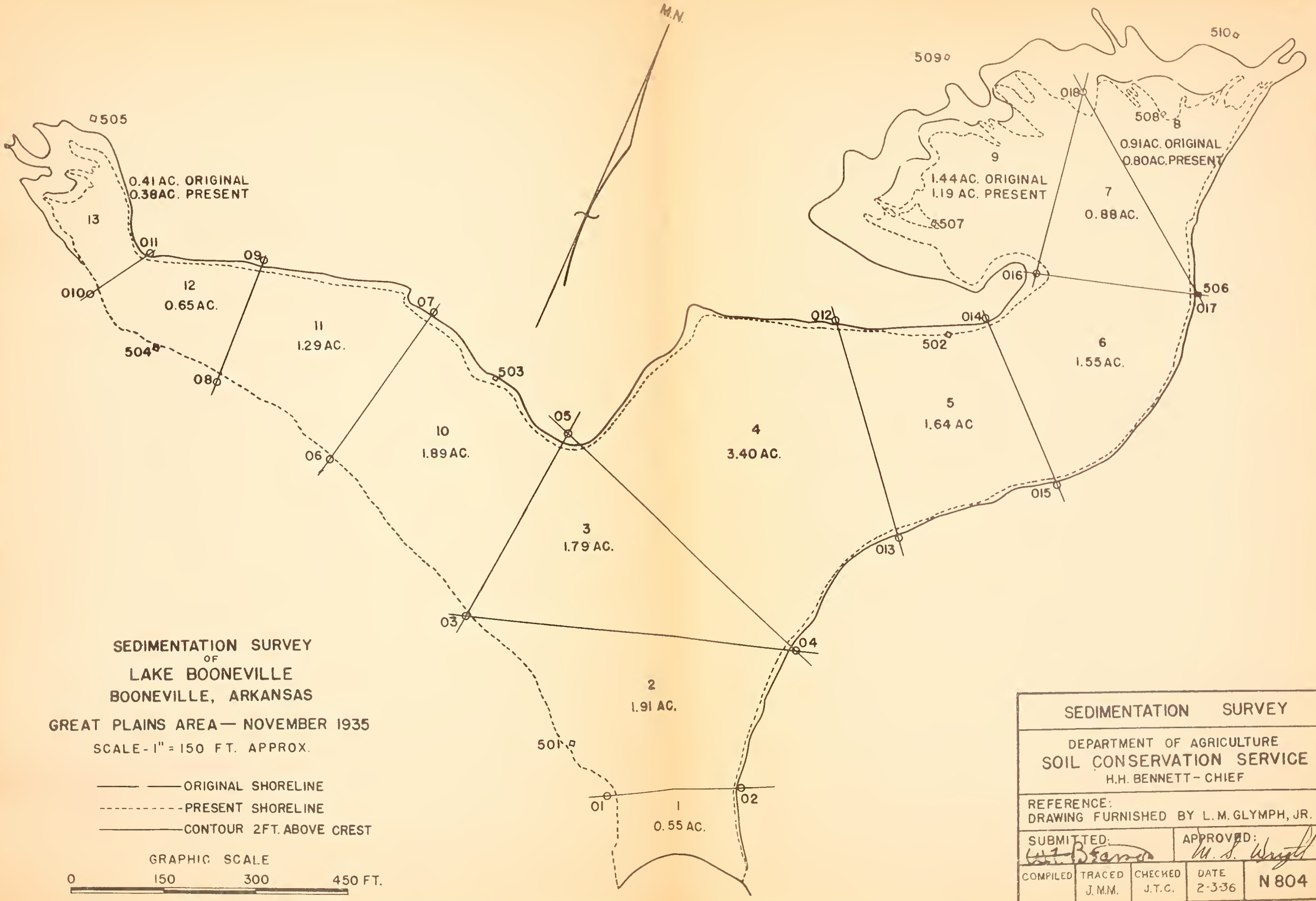
From a maximum thickness of 2.5 to 3.0 feet in the old channel near the dam, the bottomset beds decrease rather uniformly in thickness to a few tenths of a foot at the heads of the lake. The dam and adjacent deep channel thus constitute a silt trap. Little or no silt has been deposited along the steep lake margins.

This relatively heavy silt accumulation in the deep narrow channel just above the dam suggests the possibility that properly arranged gates might provide a means of removing some accumulated sediment in this type of reservoir.

Table 1.--Statistical summary of data relating to LAKE BOONEVILLE, BOONEVILLE, ARK.

	Quantity	Unit
Age: 1/	6.74	Years
Watershed:		
Total area	(2.6 (1,665	Square miles Acres
Reservoir:		
Original area at crest stage	18.31	Acres
Present area at crest stage	17.92	Acres
Original storage capacity	289.45	Acre feet
Present storage capacity	281.57	Acre feet
Original storage per square mile of drainage area	111.33	Acre feet
Present storage per square mile of drainage area	108.30	Acre feet
Sedimentation		
Delta deposits	2.22	Acre feet
Bottomset beds	5.66	Acre feet
Total sediment	7.88	Acre feet
Accumulation per year average	1.17	Acre feet
Accumulation per year per 100 square miles drainage area	45.00	Acre feet
Accumulation per year per acre of drainage area	30.61	Cubic feet
Or, assuming average weight of 1 cubic foot of silt is 100 pounds	1.53	Tons
Depletion of storage:		
Loss of original capacity per year	.40	Percent
Loss of original capacity to date of survey	2.72	Percent

1/ Storage began Feb. 1929. Date of this survey, Nov. 22 to Dec. 4, 1935.



SEDIMENTATION SURVEY
OF
LAKE BOONEVILLE
BOONEVILLE, ARKANSAS

GREAT PLAINS AREA— NOVEMBER 1935

SCALE- 1" = 150 FT. APPROX.

——— ———ORIGINAL SHORELINE

----------PRESENT SHORELINE

———————CONTOUR 2FT. ABOVE CREST

GRAPHIC SCALE

0 150 300 450 FT.

SEDIMENTATION SURVEY				
DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE H.H. BENNETT – CHIEF				
REFERENCE: DRAWING FURNISHED BY L.M. GLYMPH, JR.				
SUBMITTED: W.T. Beam		APPROVED: W. S. Wright		
COMPILED	TRACED J.M.M.	CHECKED J.T.C.	DATE 2-3-36	N 804