STATE OF ILLINOIS

ADLAI E. STEVENSON, *Governor*

THE SILTING OF LAKE SPRINGFIELD

SPRINGFIELD, ILLINOIS

J. B. Stall, L. C. Goffschalk, and H. M. Smith

A Co-operative Study by the
Illinois State Water Survey Division and the United States
Department of Agriculture, Soil Conservation Service
with local aid from the City of Springfield
Water, Light and Power Department

DEPARTMENT OF REGISTRATION AND EDUCATION

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SUMMARY

1. Lake Springfield, the municipal water supply reservoir at Springfield, Illinois was completed in 1934 at a cost of about $2,500,000. The lake has a surface area of 4234 acres.

2. A sedimentation survey of this reservoir in 1948 shows that in its life of 14.6 years, the original storage capacity has been reduced from 20.0 billion gallons to 19.1 billion gallons. This amounts to 4.36 percent total loss or 0.30 percent loss per year.

3. At the present rate of sedimentation the ultimate life of the reservoir will be approximately 300 years.

4. The sediment accumulation in the reservoir represents an average rate of sediment production from the watershed amounting to 48.0 cubic feet or 1.03 tons per acre per year.

5. The water demand on Lake Springfield is increasing while the storage capacity is being depleted by sediment. At some future time the remaining storage capacity will become inadequate to furnish the entire needs of the water consumers during a severe drought. At the present rate of sedimentation such a water shortage could occur within a century.

6. The 870,000 gallons of storage space lost to sediment every year in Lake Springfield, would cost $17,018 to replace at 1952 price levels.

7. Lake Springfield has a total drainage basin of 265 square miles. Dark-colored soils, nearly level to gently sloping, and having a high capability, extend over 76.8 percent of the drainage area. Light-colored, gently sloping to steep soils cover 19.7 percent of the drainage area.

8. Erosion is progressing rapidly in many parts of the Lake Springfield watershed due primarily to the high percentage of land which is plowed each year for crops. About 85 percent of the total watershed area is used for cropland, including 55 percent for row crops, principally corn, 23 percent for small grains and 8 percent for hay.

9. Analysis of soil, land use, and slope data on sample areas of the watershed indicates that sheet and gully erosion is progressing fastest on the 'Group 4' or lighter-colored sloping soils, adjacent to the major drainage ways.

10. Of the total estimated tonnage of sheet erosion in the watershed, 62 percent occurs on "Group 4" soils although these soils occupy only 19.7 percent of the drainage area. An additional 33 percent of the sheet erosion occurs on the darker, more level, "Group 2" soils which occupy 54.8 percent of the watershed.

11. The total gross erosion on the watershed is estimated at 600,000 tons per year. Nearly 3/4 of this is deposited throughout the stream system. The remaining 1/4, primarily the finer-sized fractions, is carried into Lake Springfield.

12. A complete water shed treatment program including conversion in land use, proper rotations and contour farming would reduce sheet erosion and reservoir sedimentation by an estimated 78 percent. Similar reductions in erosion have been achieved at several locations in the nation.

13. A reduction of 78 percent in sedimentation in Lake Springfield by a watershed treatment program would extend the useful life of the reservoir 34 years.

14. The adoption of soil conservation practices as recommended in the watershed treatment program means increased net income to the farmer. Illinois studies in areas comparable to the Lake Springfield watershed show that the costs of applying such conservation measures were repaid within ten years by increased income.

15. Assuming that a land treatment program were initiated on the Lake Springfield watershed by 1955 and completed by 1965, the increased farm income would repay the treatment by 1975.

16. Soil conservation measures, as recommended for the watershed treatment program, improve the physical condition of the soil, generally increasing infiltration. Runoff is slower and stream flow is stabilized, thus more flow is available during dry periods.

17. The watershed measures needed to accomplish the sediment reduction shown in Table 5 are based on the productive use of the farm land in accordance with its capabilities.

18. Physical factors have no regard for civil boundaries or fence lines and a drainage area plan would be necessary for most effective and efficient control of erosion on a watershed basis.

19. In orienting watershed treatment work at Lake Springfield, the "Group 4" soils, the heaviest contributor of sediment, should be given highest priority.

20. Many local, state, and federal agencies offer substantial aid and technical assistance in planning and applying the conservation measures needed on this watershed. In most of the state, county- wide soil conservation districts have been organized by local farmers to supervise soil conservation work in the county. Sangamon County has not organized such a district.

21. Several Illinois cities, faced with similar reservoir sedimentation problems have successfully undertaken watershed land treatment programs by means of financial aid to the local soil conservation district.

22. Several water utilities in the nation have successfully controlled erosion by systematic purchase of critical watershed erosion areas. In most cases the income from such properties have made the projects self-sustaining.

RECOMMENDATIONS

23. It is recommended that a watershed treatment program be initiated on the Lake Springfield watershed to reduce soil losses from the farmland and to reduce sedimentation in the reservoir. The governing objective of such a program should be the most profitable agricultural use of each acre of land consistent with its physical capabilities.

24. It is recommended that the City of Springfield sponsor the application of the watershed treatment program in cooperation with the Sangamon County agricultural interests. Such a joint program is justified for the city by the reduction of sedimentation in Lake Springfield, and for the agricultural interests, by the increased farm income.

25. It is recommended that the watershed treatment program be carried out by (a) financial assistance from the city to agricultural interests for the purpose of intensifying conservation efforts on the watershed, or (b) purchase of the critical erosion areas by the city for application of the needed conservation measures.

THE SILTING OF LAKE SPRINGFIELD SPRINGFIELD, ILLINOIS

by

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INTRODUCTION

All impounding reservoirs which receive their water in whole or part from surface runoff are subject to loss of capacity by sedimentation. The rate of sediment deposition depends on how fast erosion is taking place in the watershed and how much runoff is available to carry eroded materials to the reservoir. In the Midwest agricultural area, particularly in the "Cornbelt," soil erosion is progressing at an alarming rate and sufficient runoff occurs to carry a large part of the eroded material to a downstream reservoir. Many reservoirs in this area are silting rapidly.

Owners of water supply reservoirs in Illinois have reason to be concerned. Recent studies indicate that the rates of silting of reservoirs in this state are as high as in any reservoirs of comparable size in the Midwest. Many reservoirs built in Illinois 20 or 30 years ago have by now lost over half of their original storage capacity. No storage allowance to offset the effect of sedimentation was included in the design of these structures. Consequently, reservoirs originally designed to meet the water needs of a growing community for a century or more are now, in 20 or 30 years, inadequate to meet present-day needs in the event of a prolonged dry period.

The day-by-day filter plant records of water delivery and consumption keep reservoir owners informed of periodic requirements and needs. The rate of depletion of storage facilities is not so readily apparent. Unless measurements are made of the sediment accumulation in a reservoir, owners do not actually know how much stored water is available to meet their needs. As a result, they may be "caught short*' and a water famine may develop.

In order to help reservoir owners to determine the extent and seriousness of their sedimentation problems and to develop design data for use in future reservoir construction, the Illinois State Water Survey Division has initiated a state-wide program to determine the causes, effects and control of reservoir sedimentation. Since the sedimentation problem and its control in Illinois is so intimately related to accelerated soil erosion and to agricultural practices on watershed lands, the Water Survey Division enlisted the cooperation of the Soil Conservation Service, U. S. Department of Agriculture, and the Illinois Agricultural Experiment Station, University of Illinois, in carrying out these studies. Cooperative sedimentation and watershed studies are underway, or have been completed, on 15 reservoirs in Illinois to date. The sedimentation survey of Lake Springfield with accompanying watershed studies described on the following pages of this report was made as a part of this program.

SCOPE OF INVESTIGATIONS

A detailed sedimentation survey of Lake Springfield was made in July-August. 1948. In this survey the original and the 1948 shoreline were determined from the enlarged aerial photographs used as base maps for the survey. A series of 38 cross-sections of water and sediment were taken on the lake. By this means the original and the 1948 capacity of the reservoir were determined, as well as the volume of sediment deposited within the lake since its construction.

Some information was available on soils, slopes and erosion in this drainage area from sample detailed conservation surveys made in 1948 by the Soil Conservation Service in connection with the U. S. Department of Agriculture flood-control studies of the Sangamon River Basin. To supplement this information additional conservation survey mapping was done in May 1951 for the purpose of this investigation. A total of 15,459 acres was mapped of representative parts of the watershed from which the values used in this report were derived.

During the course of the 1948 lake survey, ten samples of the lake sediment were obtained.

The sampler used consisted of a two-inch diameter pipe with a check-valve arrangement to retain the sediment in the sampler. The sediment samples were dried and weighed to determine specific weight.

ACKNOWLEDGMENT

The agencies conducting this survey wish to acknowledge the generous cooperation of the municipal authorities of Springfield, particularly the Water, Light and Power Department, in authorizing and expediting the survey. The city made available four men for the period of the survey to assist in the conduct of the work and paid field expenses of the two State Water Survey men on the job. The city also furnished boats for the work and made available space for a field office and for storage of field equipment in the filter plant at the lake. Mr. John H. Hunter, Commissioner of Public Property, Mr. S. T. Anderson, General Superintendent, Water, Light and Power Department, and Mr. M. M. Grady, Superintendent, Source of Supply, were most helpful at all times.

Mr. L. C. Gottschalk, Head, Sedimentation Section, Office of Research, Soil Conservation Service, helped to carry out preliminary spudding of the reservoir in order to determine the feasibility of this survey, and spent two weeks assisting the field party at the beginning of the survey. The Soil Conservation Service also furnished the specialized survey equipment and the aerial photographs used for the survey.

The lake survey was carried out by J. B. Stall, Assistant Engineer and T. E. Young, Engineering Assistant of the State Water Survey Division and the four helpers furnished by the city. The reservoir survey and the engineering phases of the present report were carried out under the guidance of H. E. Hudson, Jr., Head, Engineering Sub-Division, State Water Survey Division.

The watershed conservation surveys, both detailed and reconnaissance, were made by Harold M. Smith, Survey Supervisor, Soil Conservation Service, Urbana, Illinois.

FIG. 1. LAKE SPRINGFIELD

RESERVOIR

GENERAL INFORMATION

Lake Springfield, completed in 1935, is located about four miles south of the city of Springfield. Spaulding Dam (See Figure 1) which creates the reservoir is located in the southeast quarter of Section 12, Township 15 North, Range 5 West, Sangamon County. The reservoir is about twelve miles in length extending south and thence west from the dam. The Y-shaped reservoir is impounded on Sugar and Lick Creeks which form the arms of the Y in the upstream portion of the lake.

Spaulding Dam, 1900 feet in length, extends in a northeast-southwest direction across the valley of Sugar Creek. Spillway elevation is 560 feet above mean sea level. The water near the dam is approximately 25 feet deep over the valley floor which is relatively flat and approximately one-half mile wide. The stream' channel of the pre-reservoir Sugar Creek is entrenched to a depth of approximately 10 feet below the level of the valley floor, making the water 35 feet deep in this channel.

The reservoir is utilized as the source of the city water supply and for boiler and cooling water for the city power plant. The municipal water treatment plant and the power plant are located at the lake side just west of the dam. The intake tower is located near the west end of the dam.

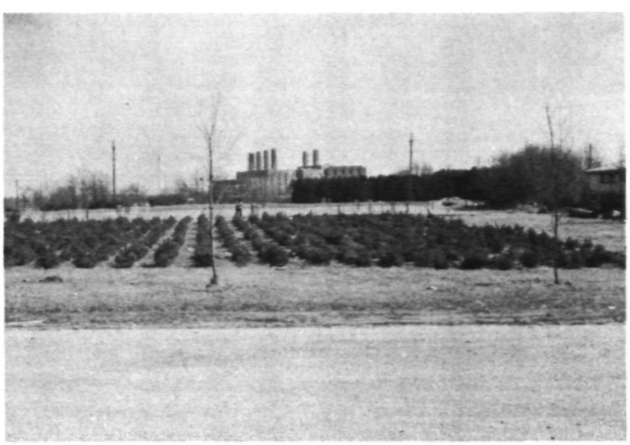


FIG. 2. VIEW OF A PORTION OF THE MUNICIPAL NURSERY AT SPRINGFIELD, ILLINOIS.

At the time the lake was constructed, much of the marginal land was cultivated. After purchase by the city, these areas were planted in grass and a sod covering was developed. Native hardwoods and conifers were planted on many areas surrounding the lake.[1] The city's own nursery was set up and by 1938 a half-million trees had passed through the nursery and had been set out in the field. The nursery has been continued in operation and at present furnishes planting stock for city-owned and privately-owned properties in the lake area. A portion of the nursery beds are shown in Figure 2. Early plantings have been effective in control of erosion in the areas they cover. Most of this planting has been done, however, in the immediate lake area. In a later section of this report "Land Treatment Measures" is shown the need for erosion control work on critical erosion areas covering much of the entire drainage area.

During the construction of the lake all highway and railroad fills were riprapped to protect them against erosion by wave action. Most of the reservoir shoreline has been riprapped also, and bank erosion is not believed to contribute important quantities of sediment to the lake at present.

METHODS OF SURVEY

The original and present water and sedimentvolumes of the reservoir were determined by the "range method" of survey developed by the Soil Conservation Service and described in their Bulletin No. 524, "Silting of Reservoirs."[2]

Aerial photographs enlarged to a scale of 1 inch equal to 500 feet were used as a base for the survey. Using the aerial photographs to determine the spillway crest contour, a system of 38 silt ranges was established on the reservoir. This survey network is shown in Figure 3. All survey stations were located on the aerial photographs by field inspection with reference to topographic and cultural features and by chaining from recognizable objects on the shore. The locations of all stations were checked by triangulation with the plane table and telescopic alidade during the course of the sounding work.

On each of the ten aerial photographs utilized for the survey, one or two baselines were laid out approximately one mile in length between recognizable points on the aerial photographs and the distance checked by chaining to verify the scale of the aerial photographs. All checks showed that the scales of the aerial photographs were only slightly in error. Errors ranged from 0.55 to 2.39 percent with an average error of 0.99 percent. Computed distances and areas on each photograph were adjusted to the scale determined by the base line.

[1] Anderson, S. T. and Spaulding, C. H., Moving the Springfield Waterworks. Journal of American Water Works Association, Volume 30, No. 4, April 1938.

[2] Eakin, H. M., Silting of Reservoirs. U. S. Department of Agriculture Technical Bulletin No. 524, Revised by C. B. Brown, 168 pp. illustrated. Washington, U. S. Government Printing Office, 1939. Appendix.

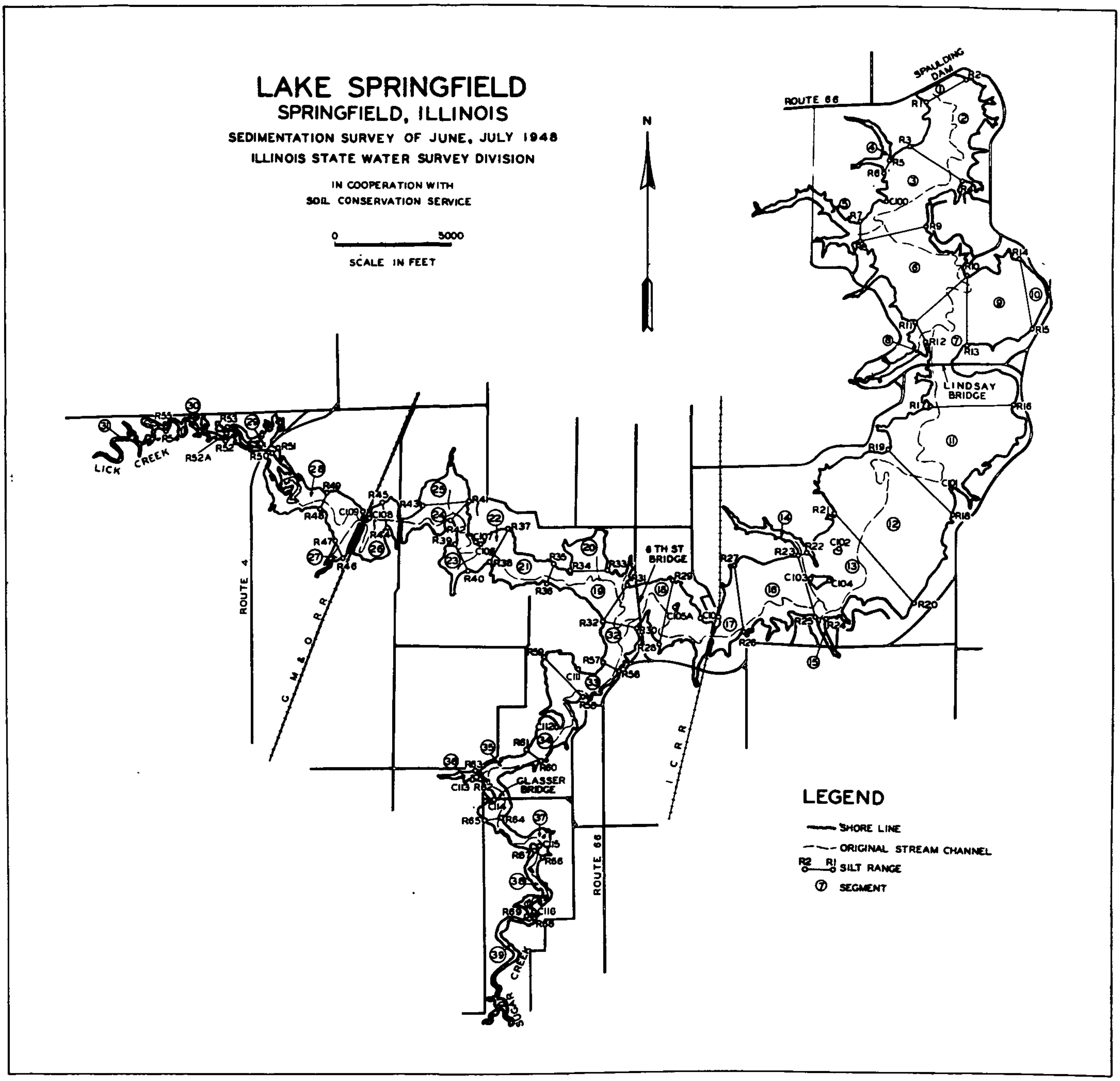


FIG. 3. BASE MAP OF LAKE SPRINGFIELD SEDIMENTATION SURVEY.

On each of the silt ranges shown in Figure 3 a cross-section was made of water depth and silt thickness. Soundings of water depth were made along each silt range, at approximate intervals of 50 feet to locate the elevation of the present top of the sediment. The locations of soundings along the range line were determined by single-angle triangulation with the telescopic alidade. Soundings were made with a bell-shaped 5-pound aluminum sounding weight with base diameter of 5 inches and a height of 6 inches. At intervals of every 100 feet, or with alternate soundings, the thickness of the sediment was measured with a "spud." This is a specially designed instrument developed for this work by the Soil Conservation Service. (See Figure 4). The spud consists of a 1 inch diameter, case-hardened steel rod in which cup-shaped grooves have been machined every one-tenth of a foot. The spud is thrown downward with enough force to pass completely through the sediment and penetrate the original bottom soil or pre-reservoir deposit. The total depth of penetration is determined by means of a calibrated line attached to the spud. After the spud is retrieved, the actual thickness of the sediment is measured by inspecting the small soil or sediment samples retained in the cups. For the visual differences between sediment and soil, see Figure 6 of this report.

FIG. 4. USE OF THE SPUD IN MEASURING SEDIMENT THICKNESS.

On a considerable number of the ranges it was possible to simplify and therefore expedite the survey work with no loss of accuracy by utilizing a sounding pole. This method was used where the original depth was less than 18 feet. The sounding pole consisted of a 22 foot length of light-weight 1-1/2-inch diameter wooden pole graduated in feet and tenths. On the range line this pole was lowered carefully into the water to rest lightly on the surface of the sediment; and the present water depth measured. The pole was then thrust on through the soft, loosely compacted sediment deposit until it struck the firm, hard original soil. (See Figure 5).

FIG. 5. USE OF THE SOUNDING POLE IN MEASURING SEDIMENT THICKNESS.

This method of measuring the sediment was possible only where the original reservoir bottom was firm and where the sediment deposit was relatively thin and soft and had not been exposed to air and consequent drying out and hardening. Fortunately, this was true of a considerable part of Lake Springfield. In each portion of the reservoir where the sounding pole was utilized, its accuracy was checked first by measurements with the spud. The use of the sounding pole greatly speeded the "survey.

FIG. 6A. SEDIMENT AS IT APPEARS IN LAKE SPRINGFIELD.

On Range R52 - R53 near the head of backwater of Lick Creek, the present water is very shallow and the sediment deposits support dense vegetation. This made it impossible to measure the sediment from a boat. On this range, the top of sediment was determined at 50 foot intervals by engineer's level and sediment thicknesses were measured with a 1 1/2 inch soil auger.

The calibrated bronze-core sounding lines used on the spud and sounding weight were checked for shrinkage every half day while they were in use. In no case was the observed error due to shrinkage more than 0.05 of a foot in the 50 foot lines. This is considered to be within the desired accuracy for the use of the lines in spudding and sounding.

FIG. 6B. SOIL - FROM THE ORIGINAL RESERVOIR BOTTOM.

All range ends and survey stations were marked permanently with concrete posts 4 1/2 inches square and 4 1/2 feet long. As shown in Figure 7 these posts were set into the ground with about one foot exposed. Identification numbers were stamped on a brass plate on top of each post. These permanent markers will make it possible to return to Lake Springfield in a number of years and relocate the 1948 cross-sections for a survey.

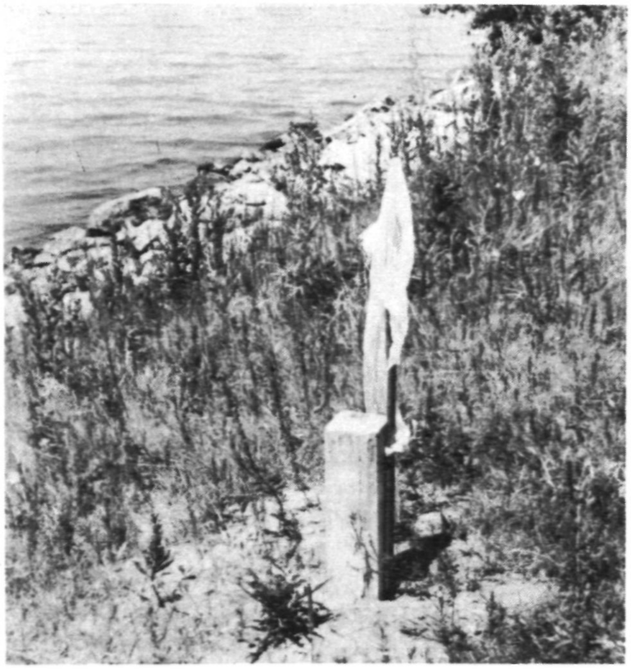


FIG. 7. CONCRETE POST USED TO MARK SURVEY STATIONS.

SEDIMENTATION IN THE RESERVOIR

Summary of Data. Table 1 is a summary of the sedimentation data obtained from this survey of Lake Springfield together with data derived therefrom which are pertinent to the sedimentation problem in this lake. Several of the significant findings shown in this summary are:

1. The storage capacity of the reservoir was reduced from 19,959 million gallons to 19,089 million gallons or 4.36 percent in 14.6 years.

2. The sediment accumulation in the lake represents an average annual soil loss of 48.0 cubic feet or 1.03 tons of soil per acre from the watershed.

3. At the present rate of sedimentation the expected ultimate life of the reservoir is approximately 300 years.

The thickest sediment deposits in the reservoir were found in the upper reaches of Sugar and Lick Creek arms of the reservoir. It is here that the greatest reduction of velocity occurs as the sediment-laden waters of the streams empty into the body of the lake. This reduction of velocity permits the heavier particles of sediment to settle out immediately; the finer and lighter fractions of the sediment are believed to be carried on and settle out uniformly in all parts of the lake.

Typical Cross-Sections. Figures 8 to 12 illustrate typical water and sediment cross-sections in various parts of Lake Springfield. The location of these cross-sections can be seen on the base map of the reservoir, Figure 3.

Figure 8 is a cross-section at Range R4 - R3 (looking upstream) located in the lower part of the main lake basin. This range is near the dam and filter plant as shown in Figure 3. Along this 3000-foot range a great part of the water is from 23 to 25 feet deep and sediment thicknesses vary from zero to 0.8 foot. In the pre-reservoir creek channel where water was originally 34.5 feet deep, the 2.5 foot sediment deposit has reduced the depth to 32 feet.

In Figure 9 is shown the cross-section of Range R 16 - R 17 which extends across the main body of the reservoir just above Lindsey Bridge. Here, in water depths varying from 18 to 20 feet (excluding the channel) sediment thicknesses vary from 0.5 to 1.0 foot.

Figure 10 shows the cross-section of Range R 32 -R 31, 2000 feet in length, which is located on the Lick Creek arm of the reservoir just west of the Highway No. 66 bridge. The original depth of water over the valley bottom was about 24 feet but this has been reduced by a sediment blanket averaging about 2 feet in thickness. The old Lick Creek channel had an original depth of about 25 feet. A 9-foot deposit has accumulated in this channel.

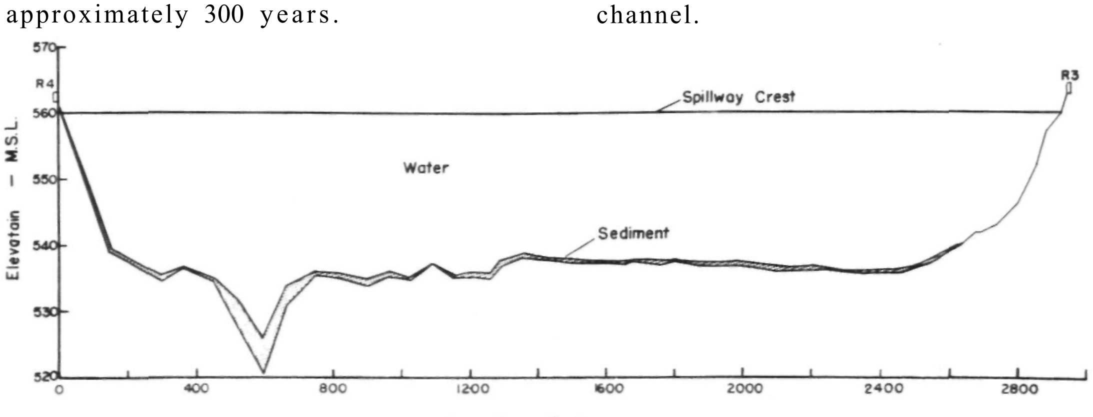


FIG. 8. CROSS-SECTION OF RANGE R4-R3.

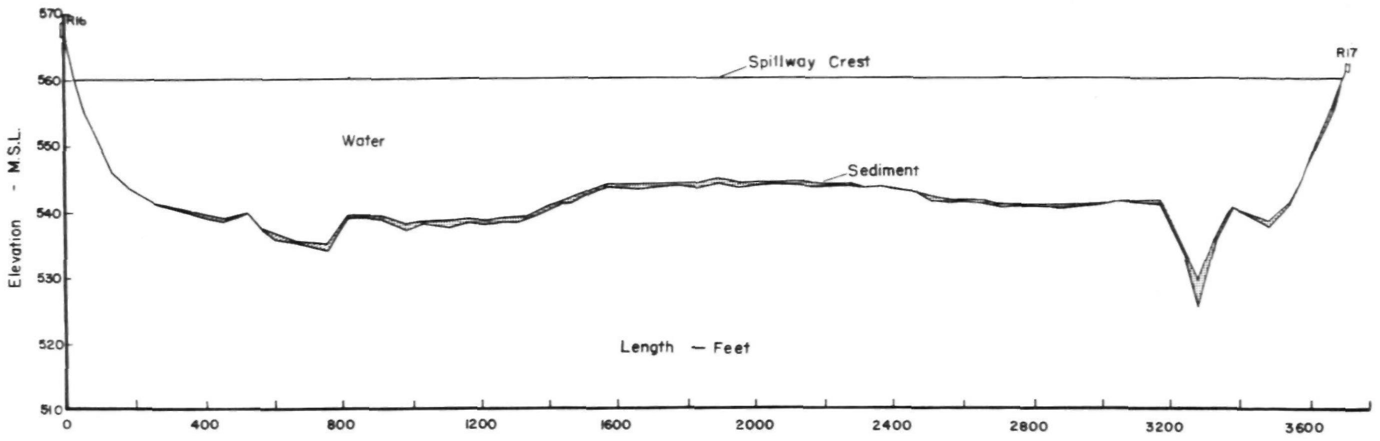


FIG. 9. CROSS-SECTION OF RANGE R16-R17.

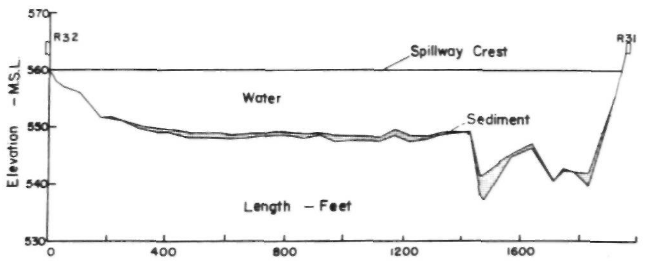


FIG. 10. CROSS-SECTION OF RANGE R32-R31.

In Figure 11 is shown the cross-section of Range R 48 - R 49, 700 feet in length, located near the head of the Lick Creek arm of the reservoir. Maximum sediment deposit here is 7 feet thick.

Figure 12 shows the cross-section of Range R 64 - R 65, 800 feet in length, located on the Sugar Creek arm of the reservoir near Glasser Bridge. Here, water formerly 6 or 7 feet in depth on the valley flats is now only 3 to 4 feet deep. Maximum sediment thickness on the old Sugar Creek channel is about 7 feet.

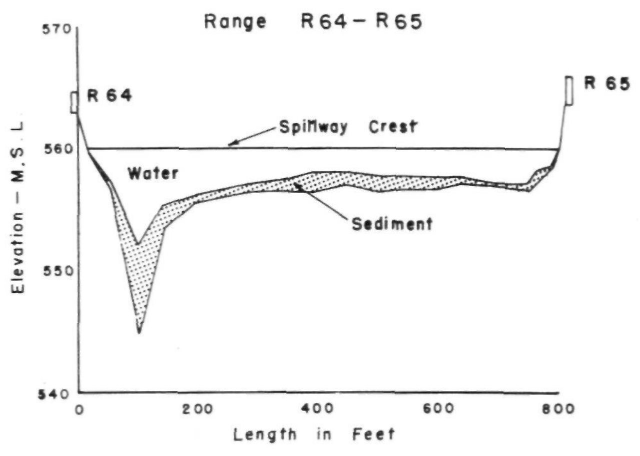


FIG. 12. CROSS-SECTION OF RANGE R64-R65.

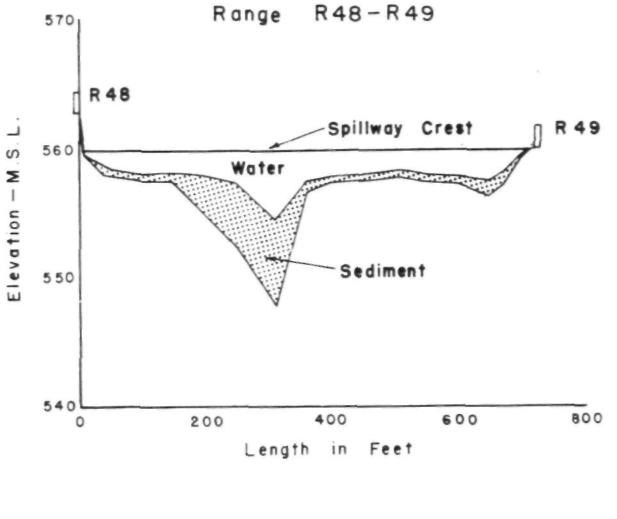


FIG. 11. CROSS-SECTION OF RANGE R48-R49.

FIG. 13. WATER LILIES GROWING ON SEDIMENT DEPOSIT IN SUGAR CREEK ARM OF THE RESERVOIR.

In Figure 13 is seen a heavy growth of water lilies in segment 36 of the reservoir near

Glasser Bridge. The water in the foreground, formerly 7 feet deep, has been reduced to about 3 1/2 feet by sediment deposits. It is in areas such as this that the sediment deposits become most noticeable. Objectional growths of vegetation spring up which detract from the esthetic beauty of the lake in addition to reducing water storage capacity. Views such as the one seen in Figure 13 are visible signs of similar sediment deposits which exist in many other parts of the reservoir, but which are submerged under deeper water and are not noticeable.

Comparison to Other Illinois Reservoirs. Table 2 presents several of the pertinent facts concerning Lake Springfield sedimentation as compared to similar data on three other reservoirs in Central Illinois. It is noted from Table 2 that the rate of capacity loss is largest where the original capacity-watershed ratio was low. It is understandable that the percent of storage lost per year would be much smaller for a large reservoir than it would be for a small reservoir on a watershed of equal size and rate of sediment production.

TABLE I

Summary of Sedimentation Data
Lake Springfield, Springfield, Illinois

	Quantity	Units
Age[1]	14.58	Years
Watershed		
Total Area	265	Square Miles
Total Area (Excluding lake area)	258.4	Square Miles
Reservoir		
Area at spillway crest[2]	4,234.4	Acres
Storage capacity		
Original	61,039	Acre-Feet
	(19,959	Million Gallons)
Present	58,380	Acre-Feet
	(19,089	Million Gallons)
Storage per square mile of drainage area		
Original	230	Acre-Feet
Present	220	Acre-Feet
Sedimentation		
Total sediment volume	2,659	Acre-Feet
	(870	Million Gallons)
Average annual sediment accumulation		
From entire watershed	182	Acre-Feet
Per 100 square miles[3]	70.6	Acre-Feet
Per acre[3]	48.0	Cubic Feet
Tons per acre[4]	1.03	Tons
Depletion of Storage		
Loss of original capacity to date	4.36	Percent
Loss of original capacity per year	0.30	Percent

[1]Storage began January, 1934; date of this survey, August, 1948.
[2]Spillway crest elevation = 560.00 M.S.L.
[3]Excluding lake area.
[4]Based on a specific weight of 42.6 lbs. per cubic foot as determined from 10 sediment samples.

Table 2 shows that although the rate of sediment production from Spring Lake (Macomb) and Lake Springfield watersheds is 48 cubic feet of soil per acre per year, this is equivalent to only 0.30 percent of Lake Springfield's capacity as compared with 2.32 percent of Spring Lake's original capacity.

The original capacity-water shed ratio (C/W ratio) at Lake Decatur (21.8 acre-feet/square mile of drainage) has meant premature loss of utility of the reservoir. The survey of this reservoir[3,4] shows it to be inadequate to furnish a completely reliable supply for the City of Decatur after 1956. This is only 34 years after the lake was constructed. The Lake Springfield capacity-water shed ratio of 230 acre-feet/square mile has resulted in a silting rate of 0.30 percent per year.

[3]Brown, C. B., Stall, J. B., DeTurk, E. E., Causes and Effects of Sedimentation in Lake Decatur, Illinois State Water Survey Division, Bulletin No. 37, 62 pp., illus. March, 1947.
[4]Report on Lake Decatur Development and Water Supply Improvements, Warren and Van Praag, Inc., Consulting Engineers, 131 pp., Decatur, Illinois, October, 1948.

Precipitation. Official U. S. Weather Bureau records of precipitation are available from the Springfield station since the year 1879. The mean annual precipitation for the period 1879-1949 has been 36.45 inches. Investigation of these records shows that during the years 1934 to 1948, the period during which Lake Springfield has been collecting sediment, the mean annual precipitation is 33.84 inches or 7.2 percent below normal. Other things being equal, such a deficiency in rainfall will lead to a lower-than-normal rate of sediment production on the watershed. Consequently, the measured rate of sedimentation in the reservoir may be slightly lower than the long time norm.

REMAINING USEFUL LIFE OF THE RESERVOIR

Hydrologic Design. In 1928, when Lake Springfield was in the planning stage, Burns and McDonnell Engineering Co. of Kansas City, Missouri prepared a "Report on Water Supply and Lake Project" for the City of Springfield. About 14 possible reservoir projects were analyzed and compared; one project included was

TABLE 2

Sedimentation of Lake Springfield as Compared to Other Illinois Reservoirs

	Lake Springfield	Lake Decatur	Spring Lake Macomb, Ill.	Lake Bracken Galesburg, Ill.
Original Capacity				
Acre-feet	61,039	19,738	607	2,881
Million gallons	19,959	6,454	198	942
Watershed Area				
Square miles	265	906	20.2	8.9
Original Capacity-Watershed Ratio				
Acre-feet/sq. mile	230	21.8	30.0	323
Total Loss of Capacity Since Built				
Percent	4.36	26.2	43.3	7.7
Annual Loss of Capacity				
Acre-feet	182	236	14.2	17.4
Million gallons	59.5	77.2	4.6	5.7
Percent	0.30	1.20	2.32	0.60
Annual Rate of Sediment Production				
Cubic feet/acre	48.0	17.8	48.2	133
Tons/acre	1.03	0.46	1.44	6.65

the present Lake Springfield site on Sugar Creek. In this report the average daily water demand was estimated to reach 31.35 million gallons per day by 1980. This estimate was based on a population forecast and a per capita use figure of 110 gallons per day. All the reservoir projects were considered on the basis of their adequacy to serve this demand. The present Lake Springfield (Sugar Creek Project 5c) was estimated to serve the entire needs of the city during a nine-month period of drought. This would draw the reservoir water level down nine feet below the spillway crest.

Reservoir Operation and Need. Lake Springfield is losing capacity due to sedimentation; at the same time the pumpage from the lake is increasing. At some future time the remaining storage capacity in the reservoir will be just adequate to furnish the entire needs of the water consumers. It is desired to determine at what future time such a condition will occur and thus determine the "useful life" of the reservoir. After this date, the reservoir cannot be considered adequate to furnish the entire city supply and additional storage will be needed.

The purpose of a water supply impounding reservoir is to store the waters of the stream during the periods of high flow for use during periods of low flow when the volume of stream flow itself would be inadequate to serve the needs. The impounding reservoir is a "bank" in which the water is "deposited" during high flows for "withdrawal" when needed during low flow periods. In analyzing the adequacy of Lake Springfield to serve in such a capacity it is necessary to determine (1) the flow characteristics of the tributary streams and (2) the present and future demand on the lake, including consumption plus evaporation losses.

Analysis of Future Water Supply Needs. To determine the flow characteristics of Sugar and Lick Creeks furnishing the inflow to Lake Springfield, use was made of flow records on the South Fork of the Sangamon River. The gaging station was first located at Taylorville and later moved to Kincaid.

Future water consumption needs of the city were taken in part from a "Report on Water System for City of Springfield, Illinois." This report was prepared for the City in 1948 by the Burns and McDonnell Co. In this report the future demand on the water system to the year 1975 was estimated on the basis of a population forecast plus an increasing per capita consumption. Per capita figures used ranged from 115 gallons per day in 1950 to 140 gallons per day in 1975.

In making the analysis of the future water demand on Lake Springfield the population forecast from the 1948 Burns and McDonnell report was used. Since a much longer period was involved than the 1950-1975 period, a single value of 125 gallons per capita per day was used for the entire future period.

Analysis of various low-flow periods in light of expected water demands showed that the critical usage period was 18 months in length. It is during a low-flow period of 18 months duration that a water shortage might occur.

Figure 14 shows graphically the expected future life of Lake Springfield. The descending line shows the decreasing storage capacity of the lake in future years if sedimentation continues at the present rate. The rising line shows the increasing demand on the lake in future years. This demand is based on an inflow of 12.19 billion gallons during an 18-month period. This low inflow is expected to have a recurrence frequency of once in 50 years.

Date Water Shortage May Occur. Figure. 14 indicates that under the prevailing rate of sedimentation, in the year 2049 A.D. the decreased capacity of the reservoir will be just adequate to furnish the water demand of the city. In subsequent years a water shortage could be expected in the event of a severe drought. Thus Lake Springfield, completed in 1934, will be adequate to serve the city for a total of 115 years. The ultimate expected life of the reservoir, as stated earlier, is about 300 years.

At the present time, 1952, the reservoir owners have nearly 100 years remaining before a water shortage is expected. Obviously, immediate remedial measures are not imperative from a water supply standpoint. However, the knowledge of the sedimentation problem at this early stage in the life of the reservoir will enable owners to take preliminary steps to preserve the lake long before a water shortage is imminent. In a later section of this report, "The Control of Sediment" it is shown that a watershed treatment program consisting of soil conservation measures might reduce the rate of sedimentation by 78 percent. The dashed line in Figure 14 shows that if such a reduction were accomplished the useful life of the lake would be extended 34 years (about one-third) or till the year 2083 A.D.

By the year 2083 A.D. the reduction in sedimentation accomplished by the watershed treatment program would save about 5.6 billion gallons of storage space. At present prices it would cost about $1,300,000 to provide additional storage space of 5.6 billion gallons by constructing another reservoir.

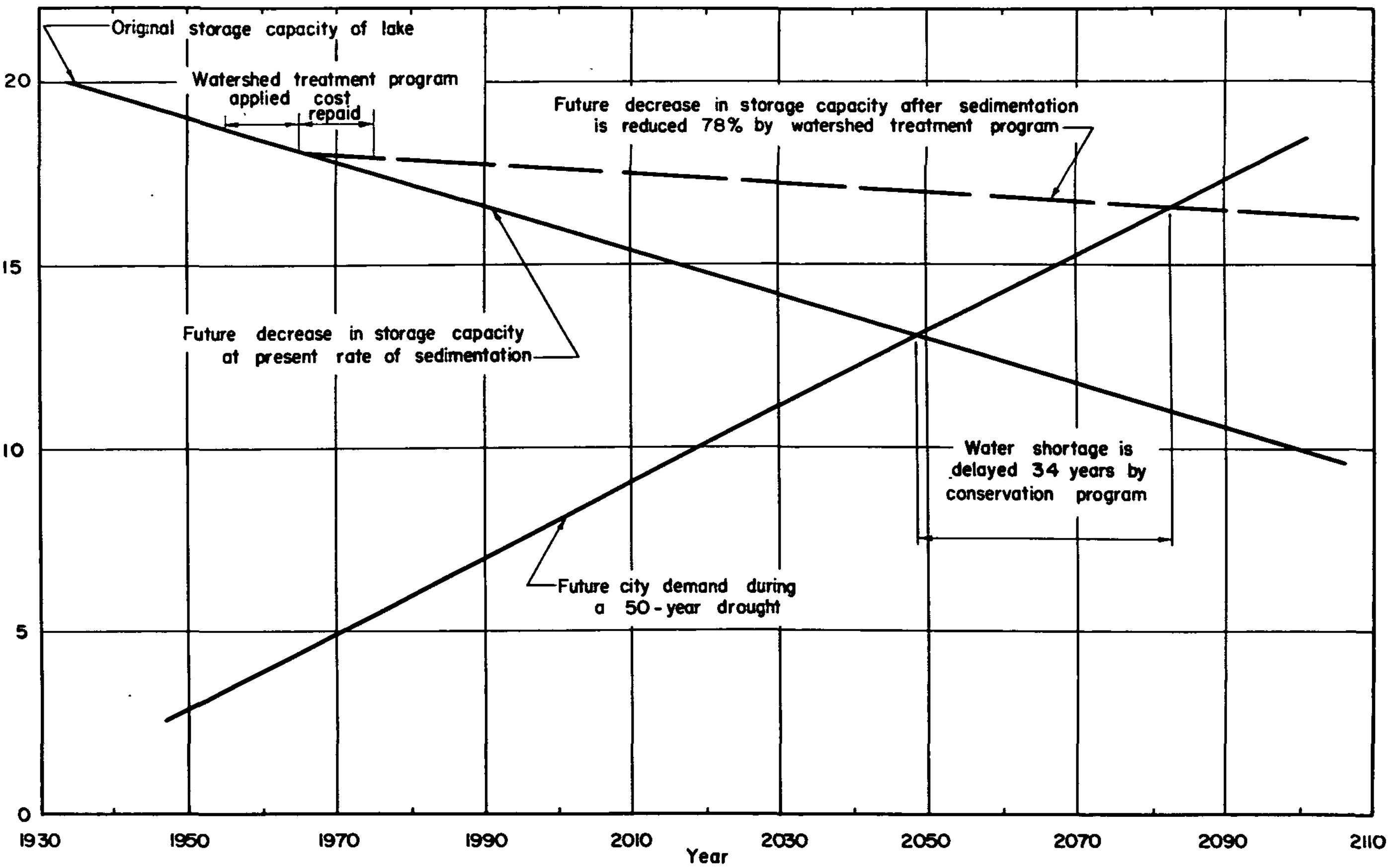


FIG. 14. WATER DEMAND AND SEDIMENTATION IN LAKE SPRINGFIELD.

FINANCIAL ASPECTS

The reported cost of the Lake Springfield development was $2,500,000. Since the original capacity of the reservoir was 61,039 acre-feet, this means each acre-foot of original capacity-cost $40.95. At this rate, the 183 acre-feet of sediment which deposits in Lake Springfield each year destroys $7,453 of the original investment. However, since 1938 when the lake was completed, construction costs have increased. The Engineering News-Record construction cost index[5] has increased from about 240 in 1938 to 548 in January 1952. This index is compiled considering the current prices of cement, structural steel, labor, etc. and indicates the general cost of construction work. On the basis of present costs, the replacement of the storage volume lost to sediment every year in Lake Springfield would cost $17,018.

WATERSHED

PHYSIOGRAPHY

The watershed above Lake Springfield extends over an area of 165,366 acres, excluding the Lake area. It is bell-shaped (see Figure 2) lying primarily in Sangamon County with a small portion of the southern part extending into Macoupin County and a small portion of the western part extending into Morgan County. The watershed is drained by Sugar Creek and its principal tributary, Lick Creek, both of which flow generally northeast and join within the reservoir basin. Sugar Creek is a tributary of the Sangamon River, entering it 2 miles south of Riverton, 6 miles below Spaulding Dam.

The watershed is located in the north central portion of the Springfield Plain[6] a minor division of the Central Lowland Province. The watershed area is primarily a level to gently sloping plain which is deeply incised in the lower part by the valleys of Lick and Sugar Creeks. In the upper parts of the watershed, the valleys of the main streams and tributaries are shallow and less pronounced, often consisting of gently sloping waterways. Elevations in the watershed vary from about 700 feet at Waverly, Illinois, to 560 feet above mean sea level at spillway elevation at the dam. About 72 percent of the watershed is level to nearly level, 19 percent is gently sloping, 4 percent is moderately sloping, 3 per-

[5]Engineering News-Record, January 10, 1952, New York, New York.

[6]Leighton, M. M., Ekblaw, George E., and Horberg, Leland, Physiographic Divisions of Illinois, Geological Survey, Report of Investigations No. 129, 33 pp., illustrated. Urbana, Illinois. 1948.

cent is strongly sloping and 2 percent is steep. The watershed consists of Illinoian drift till plain overlain by a mantle of wind-deposited loess. Average thickness of uneroded loess varies from 6 feet in the southern part of the watershed to 8 feet in the northern part. Development of the watershed is in the late youthful stage. The channel density, as determined from USGS topographic maps, amounts to 8 feet per acre.

SOILS, LAND USE AND SLOPES

For purposes of simplification, the soils in Lake Springfield watershed may be classed into five principal groups according to similarity in color, texture and permeability. Estimated acreages of each group is shown in Table 3. The approximate areal distribution in the watershed is shown in Figure 15.

Group 1 includes upland prairie soils which are very dark colored, medium to heavy textured and moderately permeable. They occupy 12.3 percent of the watershed area and are located on level or nearly level upland on the fringes of the watershed and on the tops of the higher ridges separating stream valleys. (See Figure 16).

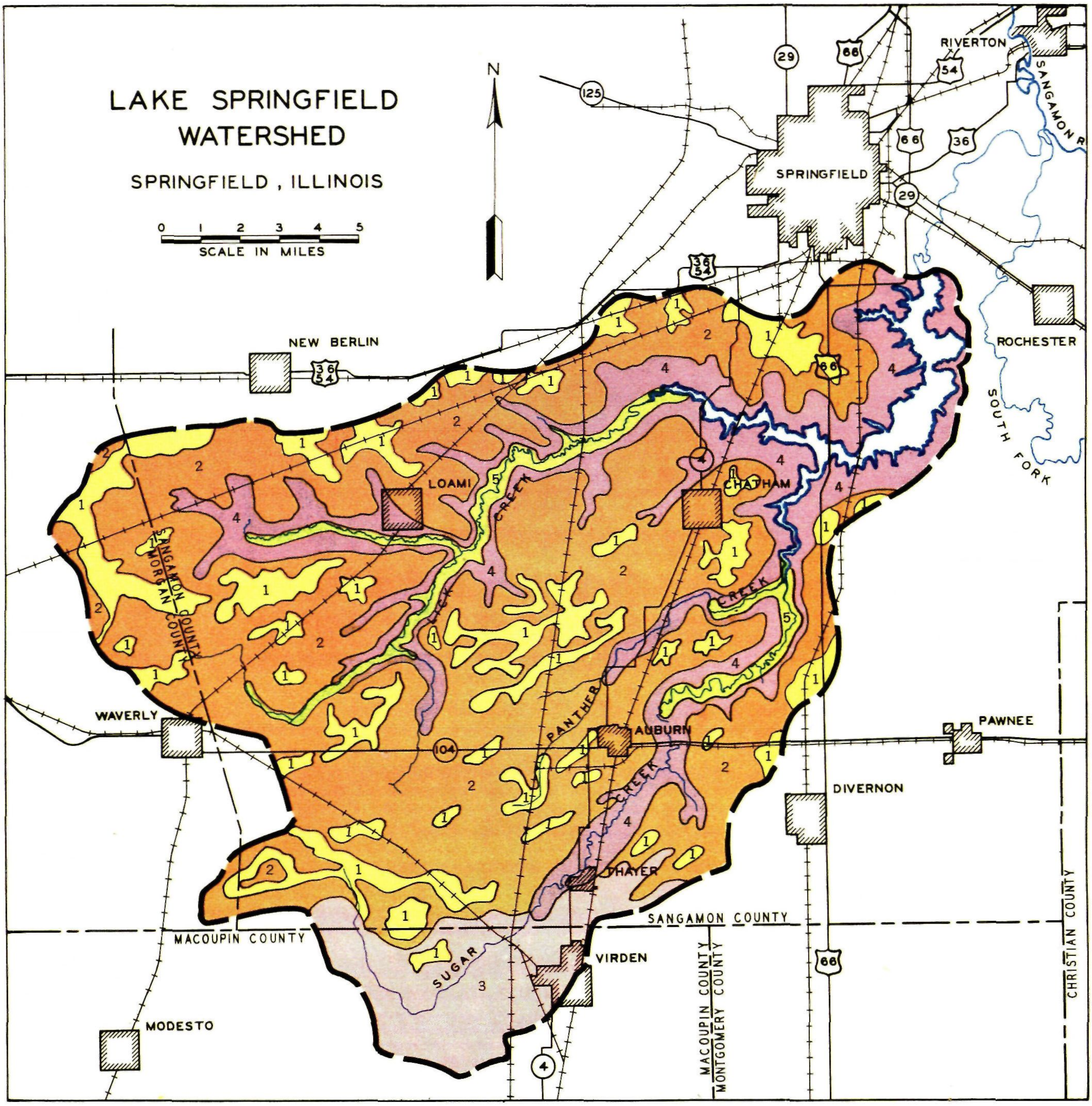
FIG. 16. VIEW OF FARMLAND ON GROUP 1 SOILS.

Practically all of the soils in this group are suitable for cultivation with good soil management and require no special erosion-control practices to maintain the soil for general agricultural purposes (See Table 4). They are highly productive soils with 96 percent used for cropland, including 67 percent for row crops, principally corn, 19 percent for small grains, and 10 percent for grassland. About 3 percent of the soils in the group are used for permanent pasture and 1 percent for farmyards and miscellaneous use. Over half of the soils in this group require artificial drainage for best crop production.

The soils in Group 2 are dark colored, medium textured and moderately permeable upland prairie soils. They occupy 54.8 percent of the Lake Springfield watershed. Group 2 soils are highly productive. Approximately 89 percent of the land is used for cropland of which 53 percent is used for row crops, 28 percent small grains, and 8 percent grassland. About 8 percent is used for permanent pasture and 3 percent miscellaneous including farmsteads. In general, these soils occur on level upland areas and on gently sloping land between the upland and the steep valley walls of the watershed. Of Group 2 soils 70 percent are located on level or nearly level land and 26 percent on gently sloping land. About 4 percent of these soils, near the valley walls, are on moderately sloping land. About 68 percent of the soils in Group 2 are suitable for cultivation with good soil management and require no special erosion-control practice s to maintain the soil for general agricultural purposes, while 30 percent require easily applied practices such as contour farming and longer rotations and 2 percent require intensive treatments such as terracing, strip cropping and long rotations to reduce erosion.

Group 3 soils are dark colored, medium to heavy textured and moderately slow to slowly permeable upland prairie soils. They occupy 9.7 percent of the total drainage area. Group 3 soils are highly productive with .94 percent being used for cropland including 60 percent in row crops, 27 percent in small grains and 7 percent in grassland. About 5 percent is used for permanent pasture and 1 percent for miscellaneous purposes including farmsteads and woodland. Group 3 soils are found mainly in the southern part of the watershed with scattered small outliers in other parts of the watershed. They occur generally on level to nearly level land with the largest percentage requiring artificial drainage. Of the Group 3 soils, 85 percent are located on level to nearly level land, 14 percent on gently sloping land and 1 percent on moderately sloping land. About 85 percent are suitable for continuous

FIG. 17. VIEW OF FARMLAND ON GROUP 4 SOILS.



1	Very dark colored, medium to heavy textured, moderately permeable, nearly level soils of high capability (Illiopolis and Ipava)
2	Dark colored, medium textured, moderately permeable, nearly level to undulating soils of high capability (Bolivia and Tovey)
3	Dark colored, medium to heavy textured, moderately slow to slowly permeable, level to gently sloping soils of high capability (Herrick, Shiloh, Harrison and Dunkle)
4	Light colored, medium textured, moderately to slowly permeable, gently sloping to steep soils of medium to high capability (Clary, Alma, Bagota, Whitson and Hickory)
5	First bottom and small stream terrace soils (Huntsville, Sawmill and Arensville)

FIGURE 15 - GENERAL RECONNAISSANCE MAP SHOWING DOMINANT SOIL AREAS

AGR-SCS-BELTSVILLE. MD. 1984 NOVEMBER 1950

TABLE 3

Estimated Acreages of Various Soils in Lake Springfield Watershed

	Acres	Percent
1. Very dark colored, medium to heavy textured, moderately permeable, nearly level soil of high capability, Illiopolis and Ipava soil group	20,461	12.3
2. Dark colored, medium textured, moderately permeable, nearly level to undulating soils of high capability, Bolivia, and Tovey soil group	90,505	54.8
3. Dark colored, medium to heavy textured, moderately slow to slowly permeable, level to gently sloping soils of high capability, Herrick, Shiloh and Harrison, soil group	16,097	9.7
4. Light colored, medium textured, moderately to slowly permeable, gently sloping to steep soils of low to high capability. Clary, Alma, Bogota, Whitson and Hickory soil group	32,679	19.7
5. First bottom and small stream terrace soils. Huntsville, Sawmill and Arensville soil group	5,624	3.5
TOTAL	165,366	100.0

cultivation with good soil management and require no special erosion-control practices to maintain the soil for general agricultural purposes while 15 percent require easily applied practices such as longer rotations and contour cultivation to reduce erosion and maintain productivity.

Group 4 soils are light colored, medium textured, and moderately to slowly permeable. They are principally timber soils. Group 4 soils occupy 19.7 percent of the total drainage area. They are located generally on the valley walls of the stream system primarily in the lower and central reaches of the main streams and tributaries. (See Figure 17) Of the soils in Group 4, 9 percent are level to nearly level, 28 are gently sloping, 23 percent are moderately sloping, 28 percent are strongly sloping, 12 percent are steep. Productivity of these soils varies according to the nature of the soils and the degree of erosion. Generally they are of medium to high productivity. The sample survey indicated that about 37 percent of these soils are used for cropland, including 25 percent for row crops, 1 percent for small grains, and 11 percent grassland. About 40 percent are used for permanent pasture, 10 percent for woodland, 6 for miscellaneous, including farmsteads, and 7 percent is idle land. Of the Group 4 soils, only 5 percent is suitable for cultivation with no erosion-control practices. About 30 percent require easily applied practices such as longer rotations and contour farming, and 26 percent require intensive treatments including longer rotations, terracing and strip cropping. About 24 percent is best suited for hay or pasture but can be cultivated occasionally, usually not more than 1 year in 6. The balance of this land (about 15 percent) is unsuitable for cultivation and should be used only for permanent pasture or woodland.

Group 5 soils are bottomland soils located mainly on the flood plains of the main streams. They comprise only 3.5 percent of the total area of Lake Springfield watershed. Three-fourths of this group of soils can be cultivated with good soil management and require no special erosional-control practices to maintain the soil for general agricultural purposes. About 25 percent of the soils in this group are wet, often flooded or cut up by flood plain scour or bank erosion and are suitable only for pasture or woodland. About 44 percent of bottomland soils is used for cropland, including 40 percent for row crops, 4 percent for small grains. About 44 percent is used for pasture, and 11 percent for woodland.

TABLE 4

Acreages and Percentages of the Various Soil Groups in Each Land Use Capability Class, Lake Springfield Watershed

Land Capability Class	Group 1		Group 2		Group 3		Group 4		Group 5		Total	
	Acres	Per-cent	Acres	Per-cent	Acres	Per-cent	Acres	Per-cent	Acres	Per-cent	Acres	Per-cent
Class I Land Suitable for cultivation, requiring no erosion control practices to maintain soil for general agricultural practices	20,429	99.8	61,156	67.5	13,641	84.7	1,727	5.2	4,180	74.3	101,133	61.1
Class II Land Good land that can be cultivated safely with easily applied practices	32	0.2	27,174	30.0	2,339	14.5	9,880	30.3	-----	----	39,425	23.8
Class III Land Moderately good land that can be cultivated safely with such intensive treatments as terracing and strip-cropping	------	----	2,130	2.4	117	0.8	8,386	25.6	372	6.6	11,005	6.7
Class IV Land Best suited to hay or pasture, but can be cultivated occasionally, usually not more than 1 year in 6	------	----	45	0.1	------	----	7,907	24.2	-----	----	7,952	4.8
Class V Land Bottomland not suited for cultivation because it is very wet, often flooded or cut up by winding streams	------	----	------	----	------	----	-----	----	1,072	19.1	1,072	0.7
Class VI Land Not recommended for cultivation. Best suited for permanent pasture	------	----	------	----	------	----	4,242	13.0	-----	----	4,242	2.5
Class VII Land Not recommended for cultivation. Suited for woodland or pasture with major restrictions in use	------	----	------	----	------	----	537	1.7	-----	----	537	0.4
TOTALS	20,461	100.0	90,505	100.0	16,097	100.0	32,679	100.0	5,624	100.0	165,366	100.0

EROSION

Erosion is progressing rapidly in many parts of Lake Springfield watershed due primarily to the high percentage of land which is plowed each year for crops. About 85 percent of the total watershed area is used for cropland, including 55 percent for row crops, principally corn, 23 percent for small grains and 8 percent for hay or plowable pasture. Plowing the land for crops leaves the soil bare, particularly during the months of May and June which are the months of highest rainfall in the watershed. The impact of rain drops falling on bare ground detaches soil particles and starts the erosion process. The harder it rains the more soil detached and the greater the surface runoff to carry it out of fields. Studies at Urbana, Illinois, over a 9 year period, 1941-1949, indicate that 89 percent of the total annual soil losses in this area occur during the months of May and June .

On many farms in the watershed corn is grown continuously, year after year, without even the simplest rotations designed to maintain productivity and yield. To maintain organic matter in the soil in this area a rotation of no more than 2 years of corn with 1 year of small grains and 1 year of hay should be used. The average present land use for this watershed is 7 acres of corn and 4 acres of small grains for every acre of hay or plowable pasture. On many farms, land that is too steep for cultivation is planted to up and down hill row crops while pastures and woodlots are poorly managed and overgrazed. As a result, abnormally high rates of erosion have developed in the watershed which are directly responsible for much of the sediment found in Lake Springfield.

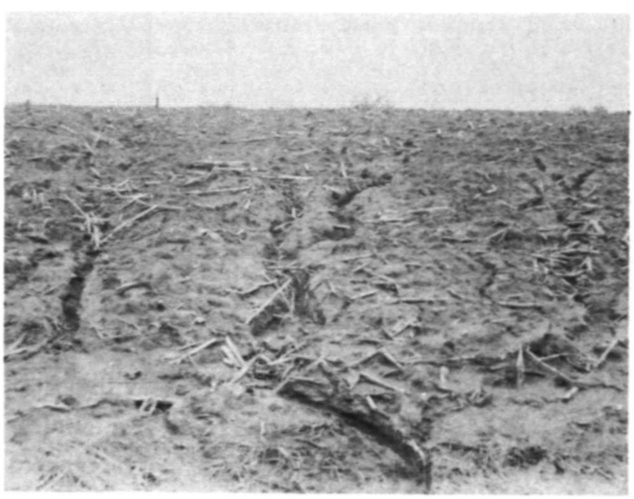


FIG. 18. SEVERE EROSION OF UNPROTECTED LAND ON GROUP 4 SOILS.

[7]Van Doren, C. E., Stauffer, R. S., and Kidder, E. E., Effect of Contour Farning on Soil Loss and Runoff. Proceedings of Soil Science Society of America, Volume 15, pp. 413-417, illus., 1951.

Analysis of soil, land use and slope data on sample areas of Lake Springfield watershed indicates that sheet and gully erosion is progressing fastest on the Group 4 soils. (See Figure 18) Erosion is very severe on 1 percent of these soils, severe on 8 percent, moderately severe on 24 percent and slight to moderate on 58 percent. Only 9 percent of the soils in this group show no apparent erosion. The sample survey showed some fields were losing soil at rates exceeding 100 tons per acre annually. One field sampled, 3 miles east and 2 miles south of Chatham-, showed that 15 inches of surface soil had been removed from a steeply cultivated field as compared to an adjacent field in bluegrass pasture. It has been the tendency in the past to crop many of the steep slopes in the Group 4 soils area until the top soil is entirely gone. When the land no longer gives a profitable return as cropland, it is converted to pasture but with lack of pasture improvement and proper pasture management, good cover is not established and these lands continue to erode. Much of the woodland as well as the pasture on Group 4 soils is overgrazed. Hogs, which are turned loose in woodland and pasture areas, tear up what little sod remains to hasten the erosion process.

It is estimated from sample survey data thatthe average rate of erosion of Group 4 soils amounts to 10.19 tons per acre per year. Of the total estimated tonnage of sheet erosion in the Lake Springfield watershed 62 percent is derived from Group 4 soils although these soils occupy only 19.7 percent of the drainage area. Channel, gully and roadside erosion also occurs in this soil group area and becomes progressively greater toward the lower part of the watershed where slopes are steeper and longer. Since these soils are located in the valley walls of the stream system, much of the eroded material finds its way into the stream system and is carried to Lake Springfield.

Next in importance, from the standpoint of erosion, are the Group 2 soils. A small portion of these soils are on strongly sloping land near the stream system, particularly in the lower part of the basin and erosion is progressing rapidly on these areas. About one-fourth of this group of soils is located on gently sloping land with relatively long slopes which are conducive to rapid erosion. These soils lack proper rotations and the conservation measures needed to reduce the effective length of slopes and thereby reduce erosion. From the sample data it is estimated that the average rate of erosion of these soils is 2.0 tons per acre per year. Of the estimated gross tonnage of sheet erosion in the watershed 33 percent comes from Group 2 soils. These soils occupy 54.8 percent of the watershed area.

Erosion is progressing more slowly on Group 1 and Group 3 soils mainly because these soils occur generally on level to nearly level land. Slight to moderate erosion was found on 5 percent of Group 1 soils and 15 percent of the Group 3 soils. No erosion is apparent on 95 percent of Group 1 soils and 84 percent of Group 3 soils. Moderately severe erosion was found on 1 percent of the Group 3 soils on the more strongly sloping portions of this soil group located near valley slopes. The average annual rate of sheet erosion from Group 1 soils under present land use and management is estimated to be 0.13 tons per acre while that of Group 3 soils is 1.40 tons per acre. Of the total estimated tonnage of sheet erosion in the watershed 1 percent is derived from Group 1 soils and 4 percent is derived from Group 3 soils. Group 1 soils occupy 12.3 percent of the total watershed area and Group 3 soils occupy 9.7 percent.

Group 5 soils are generally level and are not subject to sheet erosion. Localized flood plain scour and stream bank erosion is occurring in this area but the amount of sediment derived from these sources is small in comparison with that derived from upland areas.

SOURCES OF SEDIMENT

The sedimentation survey of Lake Springfield indicates an average annual accumulation of more than 170,000 tons of sediment per year. Since the lake shore is well protected in the lower part and only minor bank erosion is occurring in the upper part, the sediment in Lake Springfield is derived mainly from sheet and channel erosion in the watershed. An analysis of soil, slope, and land use data obtained by a sample conservation survey of the watershed indicates that sheet erosion is occurring at an estimated rate of slightly more than 539,000 tons per year in the watershed. Channel and gully erosion were not mapped but inspection of the watershed indicates that eroded material from these sources probably would not exceed 10 percent of the gross erosion in the watershed. The gross erosion, therefore, might be expected to amount to about 600,000 tons per year. Of this, nearly 3/4 is left stranded in the watershed as colluvial and alluvial deposits and the balance, primarily fine silt and clay, is carried to Lake Springfield.

Of the total tonnage of sheet erosion in the watershed, 1 percent is derived from Group 1 soils, 33 percent from Group 2 soils, 4 percent from Group 3 soils, and 62 percent from Group 4 soils. Group 1 soils and most of Group 3 soils are remote from well-defined channels which serve as avenues of transportation of eroded material out of the watershed. For this reason nearly all of the material eroded from these two soil groups moves only short distances and remains in the watershed. This is true to a large extent of Group 2 soils with the exception of that portion of strongly sloping land located adjacent to the steep valleys in the lower part of the basin. A large amount of material eroded from Group 4 soils gets into the stream system and eventually finds its way into Lake Springfield. The principal channel erosion in the watershed also occurs in the area of Group 4 soils. Group 4 soils, therefore, represent the principal sediment source area above Lake Springfield with Group 2 soils next in importance. Group 1, Group 3 and Group 5 soils are only minor sources of the sediment in Lake Springfield.

REMEDIAL MEASURES

CONTROL OF SEDIMENT [8]

Land Treatment Measures. The character of sediment in Lake Springfield is primarily silt and clay indicating that it is derived chiefly from sheet erosion in the watershed. The remaining useful life of the reservoir has been shown to be about 100 years. Under these circumstances, the logical approach to reducing sedimentation in the reservoir is land treatment measures on the watershed. A sample study of land capability, land use and farming practices and the conservation needs in the watershed indicates that substantial reductions in sheet erosion and sedimentation can be achieved by a land treatment program. A complete program would include conversion in land use,,proper rotations, contour farming, strip cropping, terraces, crop residue management, winter cover crops, diversions, grass waterways, farm ponds, and gully, roadside, and stream bank control. Of these rotations and conversion of land use, particularly in the Group 2 and Group 4 soil areas, are the more important measures from the standpoint of sediment control in Lake Springfield watershed. (See Figure 19) In many cases such supporting measures as contour plowing, strip cropping, and terracing should be used. When these practices are used more intensive rotations may be used and still hold soil losses to a minimum. The effects of recommended rotations and conversion of land use on erosion without the supporting measures mentioned above may be seen in Table 5. Up to 80 percent reduction in sheet erosion could be achieved in Group 4 soils, the principal sediment-source area in the watershed, by proper rotations and land use. Installation of the other measures would have

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[8]For detailed information on methods of sediment control, see Brown, C. B., The Control of Reservoir Silting, U. S. Department of Agriculture, Misc. Pub. 521, 166 pp., illus., 1943.

TABLE 5

Estimated Sheet Erosion under Prevailing Conditions and Recommended Land Treatment Program, Lake Springfield Watershed

			Estimated erosion under prevailing practices	Estimated erosion with land treatment Program[1/]	
	Acres	Percent	Tons/Yr.	Tons/Yr.	Percent Reduction
1. Very dark colored, medium to heavy textured, moderately permeable, nearly level soils of high capability	20,461	12.3	2,700	1,600	40.7
2. Dark colored, medium textured, moderately permeable, nearly level to undulating soils of high capability	90,505	54.8	181,000	47,800	73.6
3. Dark colored, medium to heavy textured, moderately slow to slowly permeable, level to gently sloping soils of high capability	16,097	9.7	22,500	6,000	73.3
4. Light colored, medium textured, moderately to slowly permeable, gently sloping to steep soils of low to high capability	32,679	19.7	332,600	63,600	80.8
5. First bottom and small stream terrace soils	5,624	3.5	0	0	0
Totals	165,366	100.0	538,800	119,000	77.9

[1/]Based only on recommended rotations under different conditions of soils and slopes. Additional reductions can be achieved by use of supporting measures such as contour plowing, strip cropping and terracing.

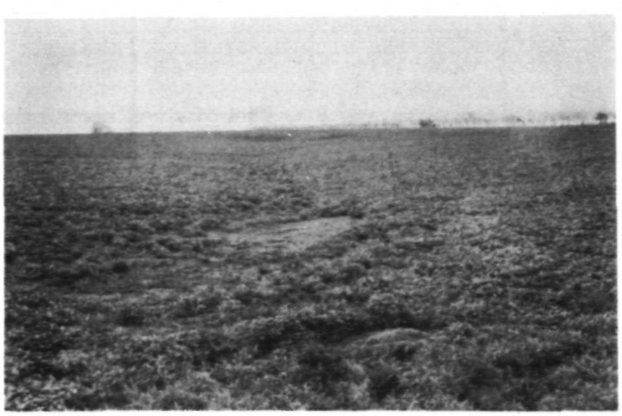

FIG. 19. VIEW OF RED CLOVER MEADOW. THIS CROP IS RECOMMENDED IN ROTATION WITH CORN AND SMALL GRAINS: IT NOT ONLY PROTECTS THE SOIL FROM EROSION BUT IMPROVES SOIL STRUCTURE AND INCREASES FERTILITY.

additional benefits in reducing erosion in the watershed and sedimentation in Lake Springfield. No other method of sediment control would be as effective over a long period of time nor as economical as land treatment measures. *As* shown earlier in Figure 14, 78 percent reduction in sedimentation in the reservoir will extend the useful life of the reservoir by 34 years.

It has been demonstrated in numerous instances in the United States that land treatment measures on a watershed will result in substantial reductions on rates of sedimentation of reservoirs below. A recent survey made under the direction of V. H. Jones[9], Soil Conservation Service, Ft. Worth, Texas, showed that land treatment measures installed on the 1660 square mile watershed above Lake Waco, Waco, Texas, has resulted in a reduction of 38.6 percent in

[9]Unpublished data, Soil Conservation Service.

the rate of sedimentation in the last 11 years. Land treatment measures in the watershed above Lake Issaqueena, Pickens County, South Carolina, resulted in a 58 percent reduction in the rate of sedimentation during the past 8 years[10].

Desilting Basins. Desilting basins have been suggested as a possible means of sediment control for Lake Springfield. Such basins, if built solely for sediment control purposes, would be costly. The sediment transported to Lake Springfield is primarily silt and clay. To retain this material in a desilting basin would require that the basin have a capacity-water shed retio of at least 100 acre-feet per square mile of drainage in order to provide sufficient detention storage time to cause complete deposition of the silt and partial deposition of clay particles. With this storage ratio they would correspond to farm ponds.

Several hundred sites are available for farm ponds in the Group 4 soils area. However, to reduce soil loss from this area by 50 percent, an aggregate storage of about 2500 acre-feet would be required. The cost of developing this volume of storage with farm ponds of 2 or 3 acre-feet capacity would be over $2,000,000. This represents expensive sediment storage. Nearly twice as much sediment storage could be provided by raising the spillway of Lake Springfield 1 foot;

Farm ponds may be justified if included in a watershed treatment program. Over 1800 farm ponds have been built by landowners to date in Illinois under the Soil Conservation District program. In general, landowners are interested in these ponds. They serve for recreational purposes, stock water supplyand fire protection. Experience shows that when a landowner builds such a pond there is added incentive to improve the watershed above in order to preserve it. Such ponds ordinarily are effective for a period of 15 to 20 years under prevailing land use and farming practices, but if conservation practices are installed on the watersheds they last from 2 to 4 times as long. In this way they serve in helping tp get conservation on the land and are built by the landowners themselves at no cost to reservoir owners and operators.

Costs and Benefits of Conservation. The land treatment measures needed to reduce soil loss from the drainage area are soil conservation measures based on the productive use of the soil in accordance with its physical capabilities. The use of such conservation measures are normally profitable to the landowners. In addition to reducing sediment production, such measures provide increased farm income. Studies by E. L. Sauer,[11] Soil Conservation Service and Illinois Agricultural Experiment Station, on 400 farms in 15 counties in Illinois showed that net farm income averaged from $3.46 to $7.39 an acre higher on farms following a recommended conservation program as compared to physically similar farms without a program. Corn yields on farms having good rotations were from 5 to 16 bushels higher than on those following the usual system of farming. On some grain farms with low fertility, corn yields were doubled by leaving 1/4 to 1/3 of the cropland in legumes and plowing them in to improve fertility. Similar benefits could be realized in Lake Springfield watershed by proper conservation farming.

The long-time benefits of conservation are certain. However, considerable effort and money must usually be expended before positive results are achieved. Studies in McLean County for the period 1936-1945 showed that the costs of applying conservation measures to the farmland were repaid by increased farm income in a period of only 10 years. In this case, the average cost of applying the program was approximately $35 per acre. It seems reasonable to assume that similar increases in farm production csn be realized in the Lake Springfield watershed. Although costs are higher now, benefits would also be higher.

In Figure 14 is shown the effect of the watershed treatment program in reducing sedimentation. Assuming the program were begun by 1955 and completed by 1965, the increased farm income would repay the cost of the conservation program before 1975. Such a program is thus amortized long before a possible water shortage.

DEVELOPMENT OF A WATERSHED TREATMENT PLAN

Need. Above-normal sheet erosionis occurring in Lake Springfield watershed. Control of this erosion by land use readjustments and supporting measures such as contouring, strip cropping and terracing would result in a 78 percent reduction in sheet erosion as well as considerable benefits to land owners through increases in per-acre yields and greater farm income. There would be commensurate benefits to owners of

[10] Noll, John J., Roehl, John W. and Bennett, Jackson, Effects of Soil Conservation on Sedimentation in Lake Issaqueena. Pickens County. South Carolina. U. S. Soil Conservation Service SCS-TP-95, 20 pp., illus., processed, Spartanburg, S.C., June 1950.

[11] News release, August 16, 1950, Extension Service in Agriculture and Home Economics, College of Agriculture, University of Illinois.

Lake Springfield through reduction in the rate of sedimentation. This form of sediment control is recommended as the most economical which could be developed for Lake Springfield as well as the most effective and durable.

Communities and industries in Illinois spend millions of dollars for a sustained yield of water by constructing dams to catch the waters of spring rains to make them available during autumn droughts. The chief function of any water supply reservoir is this storage feature.

To some degree this same storage function is performed by the soil on the watershed of a reservoir. The soil itself absorbs and retains a portion of the moisture it receives during rains. The better the physical condition of the soil, the greater is its water-holding capacity. When water enters the soil a portion of it percolates into the underlying strata and replenishes the groundwater supply. This is likely to emerge into the streams of the area much later contributing to the normal base-flow of the local streams.

Every falling raindrop that strikes the bare ground acts as a little bomb and splashes the exposed particles of soil into the air. If the rain water is allowed to flow away it will carry the soil particles with it.

Gully erosion occurs when the flow of water running off of the land becomes concentrated. The cutting of a gully into the field is quickly noticeable; this type of soil loss is spectacular and immediately draws attention. Sheet erosion, on the other hand, removes an imperceptibly thin layer of soil every time rainfall occurs. It is effective over much larger areas than gullying and in humid agricultural areas like Illinois, is a much more important soil thief than gully erosion. The magnitude of this type of erosion is not readily apparent. Sheet erosion may remove large quantities of soil.

<u>Elements and Orientation.</u> The prevention of soil and water loss from Lake Springfield watershed means preventing rapid runoff by proper land use and management and the promotion of infiltration by keeping the soil in good physical condition by soil treatment. Soil loss can also be reduced by covering the soil with grasses which break the force of the falling raindrop by intercepting much of the rainfall, and by slowing down runoff. Measures to control sheet erosion are needed.

The drainage-area program for erosion control and reservoir protection must be comprehensive; must take into consideration the entire area, and must include all the things to be done, each in its proper relation to the others, as required by the problem. The main objective of the watershed-treatment plan is the reduction of sediment deposition in Lake Springfield. The measures necessary to bring this about, however, carry many additional benefits; increased productivity of the farm land, stabilization of the agriculture of the area by control of soil losses and the stabilization of the stream flow.

The governing objective in the regulation and control plan should be the most profitable use and most practicable conservation of both water and soil.

The watershed measures needed to accomplish the sediment reduction shown in Table 5 are based on the use of the farmland in accordance with its capabilities. The sample survey of the watershed upon which this report was based, consisted of mapping the soil, slope and erosion of each particular field. It is only on the basis of this complete information that a plan of land use and agricultural practices can be determined for each field and for the entire area. The land can then be used in accordance with its capabilities, that is, in a manner which tends to restore the original natural relations among the physical factors involved and prevent the undue loss of soil and water.

One of the basic conditions of action in the control plan is the fact that physical factors have no regard for fence lines between farms or for civil boundaries. The physical factors are such that the beginning of soil and water conservation should be at the raindrop stage. The detailed efforts of the individual farmers should fit into the drainage-area plan. Only in this manner will greatest results be accomplished per unit cost. Erosion-control efforts should be given highest priority on the Group 4 soils which are the heaviest contributors of sediment. Of next importance are the Group 2 soils.

<u>Available Aids.</u> The erosion-control measures needed in this watershed to prevent sedimentation in Lake Springfield are measures which are being recommended and encouraged throughout the state and nation to prevent the waste of soil and water resources and the impoverishment of the agricultural system. Many state and federal agencies offer aid in planning and carrying out erosion-control measures. Information and advice may be obtained from such state agencies as the Department of Agriculture, Department of Conservation, Department of Public Works and Buildings, Division of Parks and Memorials, Department of Registration and Education, Water Survey, and Natural History Survey, and the University of Illinois, College of Agriculture and Agricultural Experiment Station.

Immediately at hand for consultation is the county farm adviser, acquainted with local conditions and the agricultural needs of the area. The farm adviser represents within the county, the federal extension service in agriculture and the University of Illinois extension service in agriculture. The advice and help of the extension specialists in agriculture of the University of Illinois can be obtained through the farm adviser. Specialists are available in all the fields necessary to the productive use of the soil and its conservation. Advice and recommendations are based on results obtained from the laboratories and experimental farms of the Illinois Agricultural Experiment Station and represent the most up-to-date information on the needs of Illinois soils.

The United States Department of Agriculture through its various agencies offers the farmer educational help and technical assistance based upon many years of experience in carrying on a Nation-wide program in the field of agriculture. The Soil Conservation Service was created as a permanent agency of this department in 1935 to furnish technical assistance to farmers or other groups undertaking soil and water conservation. Under prevailing policies this technical assistance is extended to landowners at their request, through locally organized soil conservation districts.

Sangamon County is one of the few remaining counties in Illinois in which no soil conservation district has been organized. Information regarding organization and the work of such a district can be obtained from the Division of Soil Conservation, Illinois Department of Agriculture, Springfield, Illinois.

Some erosion problems are so acute that they cannot wait. Work on these critical areas must be done now to prevent severe damages; not only to the land itself, but in this case, to Lake Springfield. Other problems can wait a few years without so much damage. An individual plan is needed for each farm, because each farm is operated as a separate unit; yet each farm plan must fit into the plans for neighboring farms to give full protection to all the land within the district. In the Lake Springfield watershed, a group plan would be necessary within the district so that a coordinated erosion control program could be accomplished without unbalancing the operation of any individual farm, and to make the program most effective.[12]

[12]Hudson. H. E., Brown, C. B., Shaw, H. B., and Longwell, J. S., Effect of Land Use on Reservoir Siltation, Journal American Water Works Association, Vol 21, No. 10, October, 1949.

The fundamental basis for the work plan for each farm is a conservation survey of the farm in which the soil, slope and erosion are mapped. The farm operation plan is then developed according to the capabilities of the land. Only by means of this detailed conservation field survey is it possible to determine the location, kind and amount of land use readjustments and conservation practices required on each farm, to reduce erosion and lake sedimentation. This field work, mapping the physical characteristics of the land, and the development of the farm plans are services carried out by soil surveyors, conservationists, engineers and other specialists furnished by the Soil Conservation Service to an organized soil conservation district to aid in the conduct of the district program.

METHODS OF APPLICATION

Cooperative Project. Since the watershed treatment program on the Lake Springfield drainage area coincides with the activities of the soil conservation districts program, it seems desirable that the watershed program be administered through such a district. In this manner the technical services of the Soil Conservation Service could be obtained. At Macomb, Illinois, the municipal water department has undertaken a watershed-control program on the watershed of the municipal reservoir, Spring Lake. Through financial assistance to the McDonough County Soil Conservation District, conservation efforts have been intensified on the lake watershed. The district supervisors have given the watershed a high priority within the district work plan and the erosion control measures are being installed in this manner.

At Virginia, Illinois, the City has requested the cooperation of the Cass County Soil Conservation District in applying a control program to the watershed of the city reservoir. At present, detailed conservation surveys and farm plans have been made and control measures are being administered on all the farms in this 530 acre drainage area.

The City of Decatur, Illinois, faced with a serious reservoir sedimentation problem, has maintained for many years a trained conservationist to work only on the reservoir watershed. This man, paid entirely from city funds, gives technical help to farmers in the area in a manner similar to that furnished all farmers by the soil conservation district and the Soil Conservation Service.

Regarding watershed erosion control work by a municipality, Carl Brown, Sedimentation Specialist of the U. S. Department of Agriculture has stated: "A little aid, strategically placed - a gift of seed, concrete for a check dam, loan of a bulldozer - will often enable a farmer to control erosion on critical silt-producing areas and to complete a conservation plan on his whole farm. The city can aid very effectively in control of major gullies and stream-bank erosion, which often requires resources beyond the farmer's means. Also, many cities may find it advantageous to buy and reforest certain severely eroding areas where conditions of land ownership or other factors make it impossible for the Soil Conservation District Supervisors to negotiate a conservation agreement."

"Scarcely any form of public works is more flexible, or better adapted to use temporarily idle construction equipment, road machinery or labor forces. Once plans are drawn, no public works can better stabilize month-to-month fluctuations in employment demand for unskilled and semiskilled labor."[13]

Purchase of Critical Erosion Areas. Many cities within the country have found it economical to purchase all or much of the reservoir watershed for control. In this manner the city water department can make certain that the control of soil loss is complete. This does not mean that the land is all taken out of cultivation or agricultural use. Such lands are frequently leased to private interests for farming in line with the capabilities of the land. The high cost and productive capacity of the farm land in the Lake Spring field watershed rules out the possibility of purchase of the entire drainage area by the city. It has been shown, however, that the areas contributing the most sediment are the sloping lands of Soil Group 4 (See Figure 15). Consideration should be given to the acquisition of such lands by the city. Parts of the areas could be reforested from the city nursery or converted to permanent grass or pasture; much of the area, suitable for cultivation could be leased for private farming. Additional city park or recreational areas might possibly be developed on such watershed lands.

The ownership and operation of such watershed lands by a city is considered a rightful field of activity. Such programs of watershed control have been found self-supporting and even profitable to the city in many cases. The City of Akron, Ohio has carried on such operations profitably.[14] Here much of the city-owned land is farmed but modern soil-saving farming methods are required. The Akron water supply reservoir is losing capacity at the rate of 0.20 percent of original capacity per year. This means an ultimate reservoir life of about 500 years.[15] The City of Akron now owns 8000 acres in various parts of the watershed; this amounts to about ten percent of the total watershed area. On these farms the City has cattle, sheep and hogs; 800,000 trees have been planted since 1922; 35,000 bushels of apples were harvested from city-owned orchards last year.

It need not be the purpose of a water department to retain property not necessary to the operation of the water system. At Springfield, where the purchase of critical erosion areas is necessary for proper erosion control, acquisition of the land is justified for reservoir protection for the maintenance of a permanent, potable water supply.

The development and maintenance of the water supply for the City of Springfield since 1839 has been a continuing story of (1) high interest on the part of citizens in water problems; (2) a conscientious acceptance of responsibility, unusual foresight, and great personal efforts on the part of public officials; (3) good technical personnel and advice from consultants; and (4) a sound development policy. In this manner the Water, Light and Power Department has become one of the most successful public utilities in the nation. It is believed by the authors of this report that action by the City in the establishment of effective measures to control sedimentation in Lake Springfield at this early stage in the life of the lake would be beneficial to all concerned in the long run and that such action would be in accordance with the City's past record of efficient development and maintenance.

RECOMMENDATIONS

1. It is recommended that a water shed treatment program be initiated on the Lake Springfield watershed to reduce soil losses from the farm land and to reduce sedimentation in the reservoir. The governing objective of such a program should be the most profitable agricultural use of each acre of land consistent with its physical capabilities.

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[13] Bown, Carl B. Protecting Municipal Watersheds in Southeastern States. Public Works, Vol. 76, No. 5, May 1945.

[14] La Due, Wendell R., Reservoir Lands Pay Their Way - Balanced Use of Reservoir Lands. Journal of American Water Works Association, Vol. 40, No. 8, August, 1948.

[15] La Due, Wendell R., Watershed Management and SiRation Experience of Akron, Ohio Water Department. Paper presented before Water Resources Building Conference, Urbana, Illinois, October 2, 1951.

[16] Your Municipal Light and Water, 1839-1939, 23 pp., illus. Water, Light and Power Department, Springfield, Illinois, 1939.

2. It is recommended that the City of Springfield sponsor the application of the watershed treatment program in cooperation with the Sangamon County agricultural interests. Such a joint program is justified for the City by the reduction of sedimentation in Lake Springfield and for the agricultural interests by the increased farm income.

3. It is recommended that the watershed treatment program be carried out by (a) financial assistance from the City to agricultural interests for the purpose of intensifying conservation efforts on the watershed, or (b) purchase of the critical erosion areas by the City for application of the needed conservation measures.

REPORTS OF INVESTIGATIONS

ISSUED BY THE STATE WATER SURVEY

No. 1. Temperature and Turbidity of Some River Waters in Illinois, 1948.

No. 2. Groundwater Resources in Winnebago County, with Specific Reference to Conditions at Rockford. 1948.

No. 3. Radar and Rainfall. 1949.

No. 4. The Silt Problem at Spring Lake, Macomb, Illinois. 1949.*

No. 5. Infiltration of Soils in the Peoria Area. 1949.

No. 6. Groundwater Resources in Champaign County. 1950.

No. 7. The Silting of Ridge Lake, Fox Ridge State Park, Charleston, Illinois. 1951.*

No. 8. The Silting of Lake Chautauqua, Havana, Illinois. 1951.

No. 9. The Silting of Carbondale Reservoir, Carbondale, Illinois. 1951.

No. 10. The Silting of Lake Bracken, Galesburg, Illinois. 1951.

No. 11. Irrigation in Illinois. 1951.

No. 12. The Silting of West Frankfort Reservoir, West Frankfort, Illinois. 1951.

No. 13. Studies of Thunderstorm Rainfall with Dense Raingage Networks and Radar. 1952.

No. 14. The Storm of July 8, 1951 in North Central Illinois. 1952.

No. 15. The Silting of Lake Calhoun, Galva, Illinois. 1952.

No. 16. The Silting of Lake Springfield, Springfield, Illinois. 1952.

*Out of print.