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Standard Guide for Measurement of Morphologic Characteristics of Surface Water Bodies [1]

This standard is issued under the fixed designation D 4581; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε[1] NOTE—Keywords were added editorially in May 1996.

1. Scope

1.1 This guide describes the methods used for defining the morphologic characteristics of surface water bodies. This guide references manuals that provide various rationale and procedures necessary to conduct a morphologic survey.

1.2 The references were written for specific agency use and may not be applicable in all cases **(1–6)**.[2]

1.3 The values stated in inch-pound units are to be regarded as the standard. The SI units in parentheses are provided for information only.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 1129 Terminology Relating to Water[3]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this guide, refer to Terminology D 1129.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *large water bodies*—water areas large enough to require use of electronic horizontal positioning devices.

3.2.2 *morphologic surveys*—surveys made to determine shape, depth, and volume of water bodies; also density, distribution, and volume of sediment and characteristics of watersheds contributing to the water body.

3.2.3 *small water bodies*—water areas that can be surveyed using stretched cables or visual triangulation for horizontal positioning.

4. Summary of Guide

4.1 This standard provides guidance for conducting measurements and assembly of data into a standard format that facilitates comparative analysis of water body morphology on a national basis.

5. Significance and Use

5.1 No other standards presently exist for the survey of water body morphologic characteristics. The techniques described in the references represent the present state-of-art and contain sufficient information to inform geologists and engineers of the kinds of information to be gathered and the techniques to be used.

5.2 The major categories of methodologies described in the references are: sounding, positioning, land surveys, sediment properties, sediment sampling techniques, photogrammetric methods, calculating volume and area, morphologic base data, weighted sediment dry weight, reservoir operations, equipment, and reporting results.

5.3 The references are intended as operational manuals and do not describe experimental design.

6. Procedure

6.1 The references provide detailed information and procedures as follows:

6.1.1 *Field Investigations*—Section 3, Chapter 7 of the *SCS National Engineering Handbook* describes field investigations and survey techniques **((1))**. Pages 1 to 31 specifically describe equipment, methods, notekeeping, computations, and reports for small water bodies.

6.1.2 *Sedimentation Surveys*—Specifications were prepared by the Soil Conservation Service to allow contracting for services to perform reservoir sedimentation surveys on small water bodies **(2)**. These specifications are intended to meet SCS needs and should be used by others only as a guide in preparing their own material.

6.1.3 *Methods for Water-Data Acquisition*—Descriptions of various techniques for measuring sediment are contained in Ref **(3)**. The section on reservoir surveys provides guidance about the kinds of work to be done and features to be considered. However, it is not intended as a detailed operational manual. The scope of small and large reservoirs is covered.

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[1] This guide is under the jurisdiction of ASTM Committee D-19 on Water and is the direct responsibility of Subcommittee D19.07 on Sediments, Geomorphology, and Open-Channel Flow.

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[2] The boldface numbers in parentheses refer to the list of references at the end of this guide.

[3] *Annual Book of ASTM Standards*, Vol 11.01.

6.1.4 *Monitoring Reservoir Sedimentation*—Detailed descriptions of most aspects of performing reservoir sedimentation surveys that are applicable to small and large reservoirs are found in Ref **(4)**. Main topics include base reservoir data, selection of surveying method, and hydrographic surveys.

6.1.5 *Hydrographic Parameters in Large Sand-Bed Streams*—Many techniques are described in varying detail **((5))**. The techniques are suitable for reservoirs, lakes and streams. The main topics are hydrographic investigation programs, horizontal positioning equipment and techniques, soundings, velocity measurements and suspended-sediment, bedload and bed-material sampling.

6.1.6 *Hydrographic Manual*—Detailed description of procedures applicable to large water bodies is provided **(6)**. Many described techniques, such as echo sounding, are applicable to small water bodies. The manual is divided into three major elements: hydrographic field operations, final data processing, and appendices. Detailed information is provided on equipment, instruments, and special survey techniques.

7. Report

7.1 All morphologic surveys should report their results in a format sufficient to include the necessary elements to describe where and when the survey was performed, what methods were used and how precisely they were applied, and what were the measured results. Appendix X1 contains a data summary form currently used by several U.S. See Figs. X1.1-X1.6 government and state agencies. Appendix X2 is a list of additional factors to be considered when reporting results.

8. Precision

8.1 The precision is a function of the conditions encountered and the measurement techniques used for each individual survey.

9. Keywords

9.1 bathymetric survey; reservoir sediment; reservoir survey; sedimentation

APPENDIXES

(Nonmandatory Information)

X1. SUBCOMMITTEE ON SEDIMENTATION (ICWR) INSTRUCTIONS FOR COMPILING THE RESERVOIR SEDIMENT DATA SUMMARY FORM [4]

X1.1 The following instructions were prepared by members of the Subcommittee as a guide for use in the completion of Reservoir Sediment Data Summary forms. The purpose of the summary form is to provide for the uniform compilation and dissemination of pertinent basic data obtained from reservoir sedimentation surveys. A summary is desired for each reservoir on which one or more sedimentation surveys have been made. New summaries should be prepared when additional sedimentation surveys are made and should carry forward the results of previous surveys, as indicated in the instructions. A typed copy of each new summary in condition suitable for offset printing should be furnished for publication. After a summary is prepared it will be reproduced by the Subcommittee in sufficient numbers to meet the needs of each agency represented on the Subcommittee. This will permit each agency to maintain a file of basic data prepared in a uniform manner suitable for analysis and interpretation. The Subcommittee recognizes that all items of data provided for on the summary will not be readily available for every reservoir. The early compilation and dissemination of available data is preferable to postponement until all items can be completed. However, it is important that every item be filled out for which data are obtainable. The following instructions are based on the instructions issued by the Subcommittee on Sedimentation in 1961 but are revised to apply to the new summary form.

X1.1.1 Figs. X1.1 and X1.2 provides a reservoir data summary form. Figs. X1.3 and X1.4 is a reservoir data summary form in SI units. Figs. X1.5 and X1.6 is an example of a completed reservoir data summary form. A complete description of each item on the form is given in X1.3.

X1.2 *General Notes*:

X1.2.1 In all cases where data are estimated or assumed, insert an asterisk, and show an asterisk with the word "assumed" at the bottom of the front page of the form.

X1.2.2 Where other information is presented that needs clarification, footnotes should be used and shown by numbers, as[5, 2], etc. All footnotes are to be explained in the space provided under Item 47.

X1.2.3 All data should be shown to at least three significant figures, if available, and if accuracy of the survey warrants. However, it is common practice and permissible to show all items of data to the nearest whole number, even though the accuracy of the survey may not give significance to the last one or two whole numbers. For example, for Item 14: 167 624, 16 762, 1676, 168, 16.8, 1.68.

X1.2.4 *Items 31, 32, 33, 37, 38, 40, 41*—Where the sedimentation survey of a multiple-purpose reservoir has covered only the pool level of levels used for storage most of the year (as irrigation, power, inactive) and has not covered the flood-control pool above such levels, the data should be shown for

[4] Prepared by the following agencies represented on the Subcommittee on Sedimentation Inter-Agency Committee on Water Resources: Department of Agriculture: Agricultural Research Service, Forest Service, Soil Conservation Service; Department of Commerce: Bureau of Public Roads, Environmental Science Services Administration; Department of Defense: Corps of Engineers, Naval Oceanographic Office; Department of Health, Education and Welfare: Water Pollution Control Administration; Department of the Interior: Bureau of Mines, Bureau of Reclamation, Geological Survey; Federal Power Commission; and Tennessee Valley Authority.

RESERVOIR SEDIMENT
DATA SUMMARY

NAME OF RESERVOIR

DATA SHEET NO.

DAM

1. OWNER	2. STREAM	3. STATE
4. SEC. TWP. RANGE	5. NEAREST P. O.	6. COUNTY
7. LAT. ° ′ ″ LONG. ° ′ ″	8. TOP OF DAM ELEVATION	9. SPILLWAY CREST ELEV.

RESERVOIR

10. STORAGE ALLOCATION	11. ELEVATION TOP OF POOL	12. ORIGINAL SURFACE AREA, ACRES	13. ORIGINAL CAPACITY, ACRE-FEET	14. GROSS STORAGE, ACRE-FEET	15. DATE STORAGE BEGAN
a. FLOOD CONTROL					
b. MULTIPLE USE					
c. POWER					
d. WATER SUPPLY					16. DATE NORMAL OPER BEGAN
e. IRRIGATION					
f. CONSERVATION					
g. INACTIVE					

WATERSHED

17. LENGTH OF RESERVOIR	MILES	AV. WIDTH OF RESERVOIR	MILES
18. TOTAL DRAINAGE AREA	SQ. MI.	22. MEAN ANNUAL PRECIPITATION	INCHES
19. NET SEDIMENT CONTRIBUTING AREA	SQ. MI.	23. MEAN ANNUAL RUNOFF	INCHES
20. LENGTH	MILES	AV. WIDTH	MILES
24. MEAN ANNUAL RUNOFF	AC.-FT.		
21. MAX. ELEV.	MIN. ELEV.	25. ANNUAL TEMP: MEAN	RANGE

SURVEY DATA

26. DATE OF SURVEY	27. PERIOD YEARS	28. ACCL. YEARS	29. TYPE OF SURVEY	30. NO. OF RANGES OR CONTOUR INT.	31. SURFACE AREA, ACRES	32. CAPACITY, ACRE-FEET	33. C/I. RATIO, AC.-FT. PER AC.-FT.

26. DATE OF SURVEY	34. PERIOD ANNUAL PRECIPITATION	35. PERIOD WATER INFLOW, ACRE-FEET			36. WATER INFL. TO DATE, AC.-FT.	
		a. MEAN ANNUAL	b. MAX. ANNUAL	c. PERIOD TOTAL	a. MEAN ANNUAL	b. TOTAL TO DATE

26. DATE OF SURVEY	37. PERIOD CAPACITY LOSS, ACRE-FEET			38. TOTAL SED. DEPOSITS TO DATE, ACRE-FEET		
	a. PERIOD TOTAL	b. AV. ANNUAL	c. PER SQ. MI.-YEAR	a. TOTAL TO DATE	b. AV. ANNUAL	c. PER SQ. MI.-YEAR

26. DATE OF SURVEY	39. AV. DRY WGT., LBS. PER CU. FT.	40. SED. DEP., TONS PER SQ. MI.-YR.		41. STORAGE LOSS, PCT.		42. SED. INFLOW, PPM	
		a. PERIOD	b. TOTAL TO DATE	a. AV. ANN.	b. TOT. TO DATE	a. PERIOD	b. TOT. TO DATE

FIG. X1.1 Reservoir Sediment Data Summary Form, Inch-Pound Units

the pool levels surveyed. However, any data obtained concerning sedimentation in the controllable flood-control pool (not including surcharge storage) should be shown under the above items with a footnote reference of explanation under Item 47.

X1.2.5 Use continuation sheets when all data cannot be placed on one sheet.

X1.3 *Specific Items*—Descriptions of the numbered items as they appear in Fig. X1.1, Fig. X1.3, and Fig. X1.5 are given as follows:

X1.3.1 *Name of Reservoir*:

Give the official or most commonly used name. If the dam has another name, give it in parentheses, for example, Lake Mead (Hoover Dam).

X1.3.2 *Data Sheet No.*—The data sheet number is composed of two parts. The first is the river basin map number as shown in the hydrologic atlas compiled under the auspices of the Subcommittee on Hydrology (ICWR), and the second is the sheet reference number periodically supplied by the Subcommittee on Sedimentation when data are compiled for publication. If the map number for the river basin in which the reservoir is located is available, it should be shown here. The data sheet reference number will be supplied later by the Subcommittee on Sedimentation.

X1.3.3 *Item 1*—The name of the person or the organization that owns or operates the structure. If a federal or state government, give both the department and agency having supervision or control over the operation of the dam. (Abbreviate as necessary.)

X1.3.4 *Item 2*—If the reservoir is located on a small stream, the name of which is not known, list the stream as a

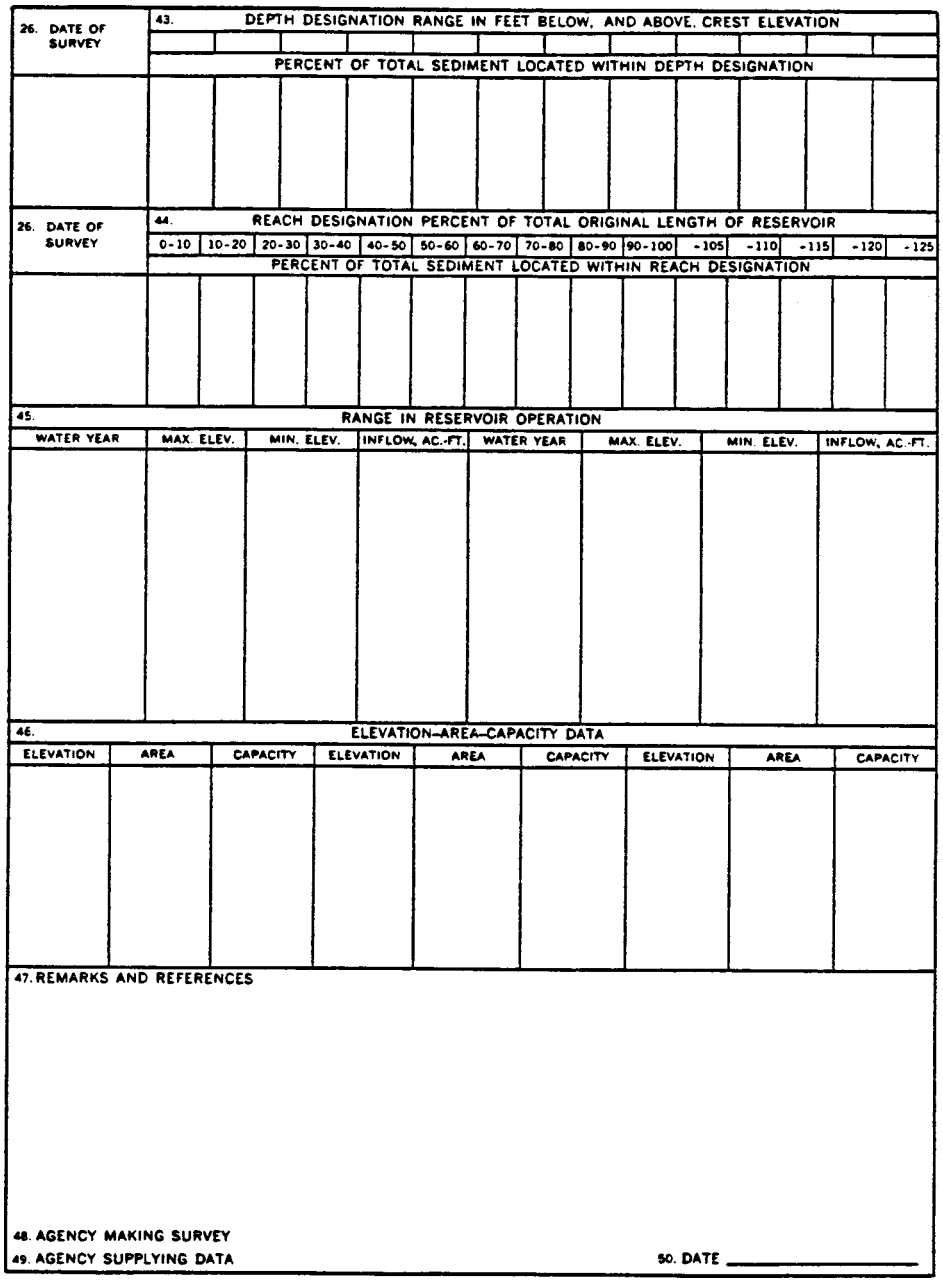

FIG. X1.2 Reservoir Sediment Data Summary Form, Inch-Pound Units *(Continued)*

tributary of the next largest stream, for example, "Trib. of Rock R."

X1.3.5 *Item 3*—If the dam lies in two states, both states should be listed. List first the state that is the location for dam operation headquarters.

X1.3.6 *Item 4*—Give the location of the dam by section, township, and range.

X1.3.7 *Item 5*—Give the name of the nearest post office. If space permits, help pinpoint the location of the dam by adding the distance in miles and the direction of the dam from the nearest post office, such as Tulsa 2 SE.

X1.3.8 *Item 6*—Give the county in which the dam is located. If the dam is in two counties, list first the county that is the location for dam operation headquarters, followed by a hyphen and the name of the second county.

X1.3.9 *Item 7*—Give the latitude and longitude of the dam in degrees and minutes (seconds, if known).

X1.3.10 *Item 8*—The elevation of the top of the dam that is equal to the highest spillway elevation (Item 9) plus freeboard.

NOTE X1.1—In items 8, 9 and 21, if no actual sea level datum elevation is available, an assumed elevation or local datum plane should be given for these items wherever possible so that the height of the dam and the spillway above stream bed can be determined. (Observe X1.2.1 under General Notes.)

X1.3.11 *Item 9*—This is the elevation of the highest spillway. If the spillway is topped by movable gates, give the elevation of the top of the gates in closed position, with an explanatory footnote in Item 47 "Remarks and References." (See X1.2.2 under General Notes.)

RESERVOIR SEDIMENT
DATA SUMMARY

NAME OF RESERVOIR

DATA SHEET NO.

DAM

1. OWNER	2. STREAM	3. STATE
4. SEC. TWP. RANGE	5. NEAREST P.O.	6. COUNTY
7. LAT. ° ′ ″ LONG ° ′ ″	8. TOP OF DAM ELEVATION m	9. SPILLWAY CREST ELEV. m

RESERVOIR

10. STORAGE ALLOCATION	11. ELEVATION TOP OF POOL, m	12. ORIGINAL SURFACE AREA, Km^2	13. ORIGINAL CAPACITY, m^3	14. GROSS STORAGE, m^3	15. DATE STORAGE BEGAN
a. FLOOD CONTROL					
b. MULTIPLE USE					
c. POWER					16. DATE NORMAL OPER. BEGAN
d. WATER SUPPLY					
e. IRRIGATION					
f. CONSERVATION					
g. INACTIVE					

WATERSHED

17. LENGTH OF RESERVOIR Km		AV. WIDTH OF RESERVOIR Km	
18. TOTAL DRAINAGE AREA Km^2		22. MEAN ANNUAL PRECIPITATION mm	
19. NET SEDIMENT CONTRIBUTING AREA Km^2		23. MEAN ANNUAL RUNOFF mm	
20. LENGTH Km	AV. WIDTH Km	24. MEAN ANNUAL RUNOFF m^3	
21. MAX. ELEV. m	MIN. ELEV. m	25. ANNUAL TEMP: MEAN	RANGE °C

SURVEY DATA

26. DATE OF SURVEY	27. PERIOD YEARS	28. ACCL. YEARS	29. TYPE OF SURVEY	30. NO. OF RANGES OR CONTOUR INT.	31. SURFACE AREA, Km^2	32. CAPACITY, m^3	33. C/I RATIO, m^3 PER m^3

26. DATE OF SURVEY	34. PERIOD ANNUAL PRECIPITATION	35. PERIOD WATER INFLOW, m^3			36. WATER INFL. TO DATE, m^3	
		a. MEAN ANNUAL	b. MAX. ANNUAL	c. PERIOD TOTAL	a. MEAN ANNUAL	b. TOTAL TO DATE

26. DATE OF SURVEY	37. PERIOD CAPACITY LOSS, m^3			38. TOTAL SED. DEPOSITS TO DATE, m^3		
	a. PERIOD TOTAL	b. AV. ANNUAL	c. PER Km^2/YEAR	a. TOTAL TO DATE	b. AV. ANNUAL	c. PER Km^2/YEAR

26. DATE OF SURVEY	39. AV. DRY WGT., Kg/m^3	40. SED. DEP., Mg/Km^2/yr		41. STORAGE LOSS, PCT.		42. SED. INFLOW, mg/L	
		a. PERIOD	b. TOTAL TO DATE	a. AV. ANN.	b. TOT. TO DATE	a. PERIOD	b. TOT. TO DATE

FIG. X1.3 Reservoir Sediment Data Summary Form, SI Units

X1.3.12 *Items 10 to 14*—All data corresponding to storage allocations 10a to g refer to original storages in the reservoir, if these data are available, or otherwise, to the first accurate capacities determined after the beginning of storage. Show revisions of the initial storages if recent surveys yield more accurate data than the early surveys.

X1.3.13 *Item 10a and b*—These items designate the purpose of storage space allocation. Multiple-use storage space (Item 10b) is purposely varied, seasonally or alternately, as required to serve two or more purposes. Use a footnote to explain the specific uses in Item 47.

X1.3.14 *Item 10c*—This item ordinarily refers to storage for hydroelectric or direct power development. However, storage developed or allocated specifically for cooling purposes in steam power plant operation should be listed under this item with a footnote explanation in Item 47.

X1.3.15 *Item 10d*—This item refers to water supply for municipal, industrial, domestic or livestock use, and fire protection.

X1.3.16 *Item 10e*—This item refers to storage space allocated specifically for water used to irrigate agricultural land.

X1.3.17 *Item 10f*—This item refers to storage allocated for regulation of low-water flow of streams, navigation pools, recharge of ground water, recreation, fish and wildlife, etc. Specify with a footnote.

X1.3.18 *Item 10g*—This refers to storage below the lowest outlet in the dam that cannot be withdrawn for any consumptive or beneficial use and is not generally considered to be of significant value for any purposes listed under Item 10f, “Conservation”. This pool elevation in small reservoirs generally is considered by the Department of Agriculture to be the sediment pool elevation. It is the level below which sediment

26. DATE OF SURVEY	43. DEPTH DESIGNATION RANGE IN m BELOW, AND ABOVE, CREST ELEVATION											
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN DEPTH DESIGNATION											

26. DATE OF SURVEY	44. REACH DESIGNATION PERCENT OF TOTAL ORIGINAL LENGTH OF RESERVOIR														
	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	-105	-110	-115	-120	-125
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN REACH DESIGNATION														

45. RANGE IN RESERVOIR OPERATION							
WATER YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, m^3	WATER YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, m^3

46. ELEVATION–AREA–CAPACITY DATA								
ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY

47. REMARKS AND REFERENCES

48. AGENCY MAKING SURVEY

49. AGENCY SUPPLYING DATA

50. DATE _____

FIG. X1.4 Reservoir Sediment Data Summary Form, SI Units *(Continued)*

is generally continually submerged and above which the sediment deposits tend to be more compacted due to periodic exposure to the air.

X1.3.19 *Items 11a to g*—These elevations should correspond to the top of pools listed under Item 10, in terms of mean sea level, if known. Otherwise, an assumed elevation or local datum should be given, as relative elevation to the streambed level, the top of the dam or the spill-way crest. If regulation schedules provide for variation (seasonal or otherwise) in the top-of-pool levels, the maximum elevation should be shown with a reference to the footnote explanation of the other pertinent pool levels.

X1.3.20 *Items 12a to g*—Give the original surface area in acres (square kilometres) at the elevation at the top of each pool shown in Item 11.

X1.3.21 *Items 13a to g*—Give the original storage capacity in acre-feet (cubic metres) for each allocation.

X1.3.22 *Items 14a to g*—Give the total original accumulated storage in acre-feet (cubic metres) from the bottom of the reservoir to the top of each pool elevation indicated. Thus, the uppermost item recorded should be the original capacity of the reservoir below the spillway crest elevation shown in Item 9.

X1.3.23 *Item 15*—Give the date when water was first impounded (month, day, and year, if possible).

X1.3.24 *Item 16*—Give the date (month, day, and year, if possible) that the initial operation for any function started.

X1.3.25 *Item 17*—Give the length of the reservoir, from the dam to the head of the backwater of the contributing stream. If the reservoir is composed of two or more principal arms, give the sum of the lengths and specify the length of each main arm

RESERVOIR SEDIMENT DATA SUMMARY
SCS-34 Rev. 6-66

Six Mile Creek, Site No. 3
NAME OF RESERVOIR

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

23-
DATA SHEET NO.

DAM

1. OWNER Enlo Conserv. District	2. STREAM Six Mile Creek	3. STATE New State	
4. SEC. 25 TWP. 2N RANGE 4W	5. NEAREST P.O. 2 mi. E of Nebo	6. COUNTY Carroll	
7. LAT 37° 17'24"N LONG 87° 34' 15"W	8. TOP OF DAM ELEVATION 131.0	9. SPILLWAY CREST ELEV. 123.0	

RESERVOIR

10. STORAGE ALLOCATION	11. ELEVATION TOP OF POOL	12. ORIGINAL SURFACE AREA, ACRES	13. ORIGINAL CAPACITY, ACRE-FEET	14. GROSS STORAGE, ACRE-FEET	15. DATE STORAGE BEGAN
a. FLOOD CONTROL	123.0	198.0	2091.9	3584.9	April 18, 1948
b. MULTIPLE USE					
c. POWER					16. DATE NORMAL OPER. BEGAN
d. WATER SUPPLY	111.0	124.8	1002.0	1493.0	
e. IRRIGATION					April 28, 1948
f. CONSERVATION					
g. INACTIVE 1/	97.0	60.2	491.0	491.0	

WATERSHED

17. LENGTH OF RESERVOIR	1.34 MILES	AV. WIDTH OF RESERVOIR	0.23 MILES		
18. TOTAL DRAINAGE AREA	10.14 SQ. MI.	22. MEAN ANNUAL PRECIPITATION	25.13 (25 yr) INCHES		
19. NET SEDIMENT CONTRIBUTING AREA	9.83 SQ. MI.	23. MEAN ANNUAL RUNOFF	1.6 (12 yr) INCHES		
20. LENGTH 5.17 MILES	AV. WIDTH 1.96 MILES	24. MEAN ANNUAL RUNOFF	855 (12 yr) AC.-FT.		
21. MAX. ELEV. 398.0	MIN. ELEV. 76.0	25. ANNUAL TEMP: MEAN 58°F	RANGE -3° to 100°F		

SURVEY DATA

26. DATE OF SURVEY	27. PERIOD YEARS	28. ACCL. YEARS	29. TYPE OF SURVEY	30. NO. OF RANGES OR CONTOUR INT.	31. SURFACE AREA, ACRES	32. CAPACITY, ACRE-FEET	33. C/I RATIO, AC.-FT. PER AC.-FT.
4-18-48	-	-		-	60.2 1/ 198.0 2/	491.0 1/ 3584.9 2/	4.14
6-23-64	16.18	16.18	Range - Contour(D)	21 R 2 CI	50.3 1/ 198.0 2/	293.2 1/ 3322.4 2/	3.84

26. DATE OF SURVEY	34. PERIOD ANNUAL PRECIPITATION	35. PERIOD WATER INFLOW, ACRE-FEET a. MEAN ANNUAL	b. MAX. ANNUAL	c. PERIOD TOTAL	36. WATER INFL. TO DATE, AC.-FT. a. MEAN ANNUAL	b. TOTAL TO DATE
6-23-64	24.81	860	1033	13,930	860	13,930

26. DATE OF SURVEY	37. PERIOD CAPACITY LOSS, ACRE-FEET a. PERIOD TOTAL	b. AV. ANNUAL	c. PER SQ. MI.-YEAR	38. TOTAL SED. DEPOSITS TO DATE, ACRE-FEET a. TOTAL TO DATE	b. AV. ANNUAL	c. PER SQ. MI.-YEAR
6-23-64	197.80 1/ 262.44 2/	12.22 1/ 16.22 2/	1.24 1/ 1.65 2/	197.80 1/ 262.44 2/	12.22 1/ 16.22 2/	1.24 1/ 1.65 2/

26. DATE OF SURVEY	39. AV. DRY WGT., LBS. PER CU. FT.	40. SED. DEP., TONS PER SQ. MI.-YR. a. PERIOD	b. TOTAL TO DATE	41. STORAGE LOSS, PCT. a. AV. ANN.	b. TOT. TO DATE	42. SED. INFLOW, PPM a. PERIOD	b. TOT. TO DATE
6-23-64	67.4(8)	1820 1/ 2422 2/	1820 1/ 2422 2/	2.48 1/ 0.45 2/	40.28 1/ 7.32 2/	20,350	20,350

FIG. X1.5 An Example of a Completed Reservoir Data Summary Form

in a footnote in Item 47. Give the average width by dividing the surface area by the summation of the lengths.

X1.3.26 *Item 18*—Give the entire flow-contributing drainage area above the dam.

X1.3.27 *Item 19*—Give the drainage area exclusive of the surface area of the reservoir at the spillway crest elevation (Item 9) and exclusive of the upstream non-contributing basins or the watersheds above the larger reservoirs that are effective sediment traps.

X1.3.28 *Item 20*—Give the length of the total drainage area along the center line of the main stream valley. The average width is the area in Item 18 divided by the length in Item 20.

X1.3.29 *Item 21*—The maximum elevation would be the highest point of the watershed boundary. The minimum elevation of the watershed should be the lowest original stream-bed elevation at the axis of the dam. This elevation is used to determine the height of the dam.

X1.3.30 *Items 22 to 24*—Give the longest available recorded mean value. If known, include in parentheses the number of years of record.

X1.3.31 *Item 22*—Give the average annual precipitation value for the total drainage area. If the mean annual precipitation varies widely for different parts of the watershed, record the range of values, for example, “18 − 35”.

X1.3.32 *Item 23*—Mean annual runoff in inches (millimetres) may be obtained: from direct measurement; from published reports such as USGS Water Supply Papers; by transposing known data from similar adjacent watersheds; or from

26. DATE OF SURVEY	43. DEPTH DESIGNATION RANGE IN FEET BELOW. AND ABOVE. CREST ELEVATION											
	123-120	120-116	116-112	112-108	108-104	104-100	100-97	97-96	96-92	92-88	88-84	84-76
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN DEPTH DESIGNATION											
6-23-64				1	6	19	19	4	10	12	25	4

26. DATE OF SURVEY	44. REACH DESIGNATION PERCENT OF TOTAL ORIGINAL LENGTH OF RESERVOIR													
	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	-105	-110	-115	-120	-125
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN REACH DESIGNATION														
	2	17	19	14	17	10	9	7	10	5					

45. RANGE IN RESERVOIR OPERATION

WATER YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, AC.-FT.	WATER YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, AC.-FT.
1949	123	111	1011	1957	115	83	694
50	120	113	863	58	117	92	912
51	118	112	996	59	119	96	892
52	123	111	1024	60	123	112	1033
53	123	108	989	61	123	111	943
54	119	106	1002	62	119	109	862
55	114	97	868	63	123	109	834
56	117	84	623				

46. ELEVATION-AREA-CAPACITY DATA

ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY
Original Capacity - 1948			96	58.0	442.3	112	127.4	1587.0
123	195.0	3584.9	92	45.7	330.0	108	104.5	1125.0
120	178.4	2832.0	88	32.1	265.7	104	83.4	750.9
116	151.8	2394.2	84	21.3	170.0	100	62.1	461.6
112	128.9	1679.0	80	11.7	73.0	97	50.3	293.2
108	109.0	1228.3	1964 Capacity			96	43.1	247.0
104	94.2	931.9	123	198.0	3322.4	92	26.4	109.6
100	75.3	658.0	120	167.5	2774.8	88	17.2	23.2
97	60.2	491.0	116	150.5	2140.8	84	1.27	0.0

47. REMARKS AND REFERENCES

1/ Sediment pool only

2/ Total reservoir below crest elevation (123.0')

Land Use in Watershed: 21 percent Woodland; 47 percent Pasture; 18 percent Cropland; 6 percent Idle; 8 percent Residential.

Geology: 25 percent Chaco shale; 18 percent Thomas ls.; 57 percent Orville ss.

48. AGENCY MAKING SURVEY: New State Watershed Planning Party, Soil Conservation Service

49. AGENCY SUPPLYING DATA: Soil Conservation Service

50. DATE: Sept. 3, 1966

USDA-SCS HYATTSVILLE MD 1966

Apr. 1966

FIG. X1.6 An Example of a Completed Reservoir Data Summary Form *(Continued)*

average annual runoff maps such as USGS Circular 52. The source of data may be shown by footnote with explanation under Item 47.

X1.3.33 *Item 24*—The mean annual runoff in acre-feet (cubic metres) may be obtained by multiplying Item 23, mean annual runoff in inches (millimetres), by Item 18, total drainage area in square miles (square kilometres), times the conversion factor 53.33 (1000).

X1.3.34 *Item 25*—The mean annual temperature and the average annual range in temperature should be given in degrees Fahrenheit (degrees Celsius).

X1.3.35 *Item 26*—Give the date of the beginning of storage, if used to compute sedimentation, or the average date (month, day, and year) of the first reservoir survey, and of all succeeding surveys used in computing sedimentation. The original data from which the sedimentation record begins and the subsequent data should be given under Items 26, 29, 30, 31, 32, and 33, but the original data should not be repeated under Item 26 below or in parallel boxes from Item 34 through Item 42, inclusive.

X1.3.36 *Item 27*—Give the elapsed period between the beginning of storage or the first survey used to compute sedimentation (whichever is the more recent date) and between the average dates of each succeeding sedimentation survey.

Compute to the nearest 0.1 year. If computations are calculated to the nearest 0.01 year, two decimal places may be shown.

X1.3.37 *Item 28*—Give the accumulative period from the beginning of storage or the first survey used to compute the sedimentation (whichever is the more recent date) to each succeeding sedimentation survey. Compute to the nearest 0.01 year, and show two decimal places.

X1.3.38 *Item 29*—Indicate "Range" or "Contour" and "Detailed" or "Reconnaissance" as applicable. Detailed may be shown by the symbol (*D*), and reconnaissance by (*R*). A detailed range survey is defined as one in which instrumental control of all sounding and spudding positions in the lake was maintained. If this was not done, the survey should be labeled as (*R*). In a few cases where instrumental control was not maintained, but the number of ranges and observations per range were substantially the same as those made on a detailed survey, the designation "Semi-Detailed" may be used. The symbol for this should be (*S*). A contour survey to be labeled (*D*) should conform with at least standards of third order accuracy for topographic mapping (1 in 5000). If the contouring was of a sketchy or very generalized nature, designation should be (*R*). All contouring done with Kelsh Plotters and similar equipment shall be considered (*D*), but sketching contours with portable stereoscope shall be considered (*R*).

X1.3.39 *Item 30*—Give the number of ranges or the contour interval. If a reconnaissance survey, give the number of individual measurements. The letter (*M*) should follow to indicate that they are measurements and not ranges. If a combination range and contour survey is made, the symbol (*R*) should follow the number of ranges and (*CI*) should follow the contour interval.

X1.3.40 *Item 31*—The surface area at the spillway crest elevation (use the elevation of Item 9 to obtain the first entry). If the areas of different allocated storages have been determined, each should be referenced with a footnote to be shown in Item 47.

X1.3.41 *Item 32*—The first figure entered should be the original capacity (below the spillway crest elevation, Item 9). If the capacities for different allocated storages have been determined these should be shown and each referenced with a footnote in Item 47. If the original capacity was not determined, give the first accurate capacity determined after the beginning of storage and note the date.

X1.3.42 *Item 33*—Capacity-Inflow ratio (C/I) which equals Item 32 divided by Item 24. Use the maximum capacity for the date (Item 32) for which the C/I ratio is being calculated and divide by the mean annual runoff in acre-feet (cubic metres) (Item 24). This ratio should be adjusted if there are one or more upstream reservoirs that have a significant trap efficiency and control a substantial part of the drainage area (usually more than 25 %).

X1.3.43 *Item 34*—Give the mean annual precipitation over the drainage area for each period of years given in Item 27. If there is a substantial variation in precipitation for different parts of the drainage area, give the range as "10 to 23".

X1.3.44 *Item 35*—In 35a give the average annual water inflow to the reservoir, in acre-feet (cubic metres), for each period of years given in Item 27. The highest annual for each period in acre-feet (cubic metres), is to be given in Item 35b, and the total for each period is given in Item 35c.

X1.3.45 *Item 36*—Give the water inflow in acre-feet (cubic metres), to the reservoir for the accumulated periods of years given in Item 28.

X1.3.46 *Item 37*—n Item 37a, give the volume of capacity loss below crest (Item 9) for the periods of years given in Item 27. Item 37b is obtained by dividing the volume given in Item 37a by the corresponding period of years shown in Item 27. Item 37c is obtained by dividing the value in 37b by the net sediment contributing area shown in Item 19.

X1.3.47 *Item 38*—In Item 38a give the accumulative total sediment deposits below crest for the period or periods of years given in Item 28. Item 38b is obtained by dividing the value of Item 38a by the corresponding accumulative years shown in Item 28. Item 38c is determined by dividing Item 38b by the net sediment contributing area shown in Item 19. If the above-crest deposits exist and are measured, add their volume to the below-crest deposits in Items 38a, b, and c, and also give these total values just under the other values. Where above-crest deposits are included, they should be referenced with a footnote and explained in Item 47, Remarks and References. (See Notes X1.2.3 and X1.2.4.)

X1.3.48 *Item 39*—Weighted average dry weight in pounds per cubic foot (kg/m^3) of sediment in place in the reservoir. Since the dry weight of deposits *tends to increase with time due to compaction*, an average dry weight for the total deposit should be measured or estimated at the time of each survey. If assumed values are used, indicate by an asterisk. (See X1.2.1.) Subsequent dry weights must be equal or greater than preceding weights.

X1.3.49 *Item 40*—Compute the values as follows:

Item 40a = for first survey, item 38c × item 39 × 21.78

Item 40a = subsequent surveys:

[(Item 38a forlatest survey × item 39 for latest survey)
−(item 38a forpreceding survey × item 39 for preceding survey)]
× 21.78/(item 27for latest period × item 19)

(Item 40a = for first survey, item 38c × item 39 × 0.001)

(Item 40a = subsequent surveys:
[(Item 38a for latest survey × item 39 for latest survey)
− (item 38a for preceding survey × item 39 for preceding survey)]
× 0.001/(item 27for latest survey × item 19))

It is imperative that samples of the sediment representative of the entire period of sediment accumulation be obtained at the time of each survey.

Item 40b = item38c × item 39 × 21.78

(Item 40b = item 38c × item 39 × 0.001)

X1.3.50 *Item 41*—Compute the values as follows:

Item 41a = item 38b × 100/item 14(maximum value in item)

Item 41b = item38a × 100/item 14 (maximum value in item)

X1.3.51 *Item 42*—Compute as follows:

Item42a = [(item 40a × item 27 × item 19
×10^6)/(item 35c × 1359)] = ppm by weight

42a = [(item 40a × item 27 × item 19
(Item× 10^6)/item 35c] = mg/L)

$$\text{Item 42b} = [(\text{item 38a} \times \text{item 39} \times 10^6)/(\text{item 36b} \times 62.4)] = \text{ppm by weight}$$

$$(\text{Item 42b} = [(\text{item 38a} \times \text{item 39} \times 10^3)/\text{item 36b}] = \text{mg/L})$$

X1.3.52 *Item 43*—If elevation-capacity curves are developed, select the appropriate intervals in feet (metres) below and above the crest. Give the percentage of the total sediment deposits located within each depth designation (elevation zone). For example:

$$\frac{\text{(depth range)}}{\text{(sediment, \%)}} = \frac{122\text{–}100}{4}\ \frac{100\text{–}85}{5}\ \frac{85\text{–}70}{6}$$

$$\frac{70\text{–}60}{7}\ \frac{60\text{–}50}{7}\ \frac{50\text{–}40}{9}\ \frac{40\text{–}30}{10}\ \frac{30\text{–}20}{12}\ \frac{20\text{–}10}{15}$$

$$\frac{10\text{–crest}}{18}\ \frac{\text{crest}-+15}{5}\ \frac{+15-+25}{2}$$

X1.3.53 *Item 44*—The sediment distribution in percent according to distance from the dam. The reach designation is the percent of the distance from the dam to the maximum upstream extent of the spillway-crest contour at the elevation given in Item 9 at the date of the beginning of storage. Thus, 20 % would be ⅕ of the distance from the dam to the head of backwater at the original crest stage.

X1.3.54 *Item 45*—List the maximum and minimum water elevations and the total inflow in acre-feet (cubic metres) for each water year of record.

X1.3.55 *Item 46*—Give data from the elevation-capacity curve for the latest survey shown on Item 26. Be sure to label each survey date on the form. If space permits, give data from the elevation-capacity curve for the original survey.

X1.3.56 *Item 47*—List here all published and unpublished reports on sedimentation surveys of this reservoir. All footnote explanations are to be shown in this space. Also note and give any pertinent data, including dates of abnormal operational occurrences, such as reservoir evacuation; sluicing out sediment; releasing density currents; extreme floods and droughts; changes in spillway-crest elevation; use of flash boards; and the installation of upstream control structures. Briefly describe the sediment and any available textural analyses. If needed, use continuation sheets.

X1.3.57 *Item 48*—Give the department, agency, and division, branch, or field office responsible for each survey.

X1.3.58 *Item 49*—Give the agency and department reporting the data.

X1.3.59 *Item 50*—Give the date this form was prepared by the office listed in Item 49.

X2. COMMENTS ON RESERVOIR MORPHOLOGIC SURVEYS

X2.1 When tonnage of accumulated sediment is reported, the unit weight of the sediment should be indicated as measured (number of samples) or estimated. Details concerning measurement technique should be provided; also, if a weighted unit weight is reported, indicate how this was determined.

X2.2 The method of measuring water depth, the number of stations and the number of ranges should be reported. Dry land surveys should indicate precision and the number of points surveyed per unit area.

X2.3 Map contouring for volume computations based on the contour-area method should be performed by computer methods.

X2.4 Reservoir sediment design life volume and significant runoff elements should be reported.

X2.5 The investigation report should include the storage location of the survey data and documentation of watershed characteristics (if appropriate to the purpose of the survey).

REFERENCES

(**1**) *National Engineering Handbook*, Section 3, Chapter 7, U.S. Department of Agriculture, Soil Conservation Service, pp. 1–31.

(**2**) *Contracting Specifications for Reservoir Sedimentation Surveys*, U.S. Department of Agriculture, Soil Conservation Service.

(**3**) *National Handbook of Recommended Methods for Water-Data Acquisition:* Office of Water Data Coordination, USGS, 1978, pp. 3–57 to 3–69.

(**4**) Blanton, James, III, "Procedures for Monitoring Reservoir Sedimentation," *U.S. Bureau of Reclamation Technical Guideline*, October 1982.

(**5**) *Measurement of Hydrographic Parameters in Large Sand-Bed Streams from Boats*, Task Committee on Hydrographic Investigations of the Committee on Waterways of the Waterway, Port, Coastal, and Ocean Division, 1983, American Society of Civil Engineers, New York, New York 10017.

(**6**) *Hydrographic Manual*, Fourth Edition, National Oceanic and Atmospheric Administration, 1976.