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THE SCOPE AND NATURE OF SHORELINE
EROSION PROBLEMS AT CORPS OF
ENGINEERS RESERVOIR PROJECTS:
A PRELIMINARY ASSESSMENT

by

Hollis H. Allen, F. John Wade

Environmental Laboratory

DEPARTMENT OF THE ARMY

Waterways Experiment Station, Corps of Engineers
3909 Halls Ferry Road, Vicksburg, Mississippi 39180-6199

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13. ABSTRACT (Maximum 200 words) Shoreline erosion problems at Corps of Engineers (CE) reservoir projects were reported by 19 CE Districts that responded to an inquiry from the US Army Engineer Waterways Experiment Station in February 1990. Within the reporting Districts' areas of operation, 161 reservoirs were considered to have shoreline erosion problems. Severe erosion was reported at over 5,000 miles of shoreline, with another 5,000 miles being affected by minor erosion. Damage to private property, including private homes, was reported at 50 projects, and damage to government property was cited at 132 projects. Other types of damage included archaeological/cultural sites (79 projects), fish and wildlife habitat (62 projects), water quality (41 projects), and reduction of project life and storage capacity. The Kansas City, Omaha, St. Paul, Huntington, Louisville, Mobile, Fort Worth, and Tulsa Districts each reported erosion damage at 10 or more reservoirs. A process for developing a CE preventive maintenance remedial action plan is suggested.				
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PREFACE

This report of shoreline erosion problems at Corps of Engineers (CE) reservoir projects was prepared and reviewed under the Water Operations Technical Support (WOTS) Program, which is sponsored by Headquarters, US Army Corps of Engineers (HQUSACE). The WOTS is managed by the Environmental Laboratory (EL) of the US Army Engineer Waterways Experiment Station (WES) as a part of the Environmental Resources Research and Assistance Program (ERRAP). Mr. J. L. Decell is Program Manager for ERRAP. Dr. A. J. Anderson is Assistant Manager, ERRAP, for WOTS. Technical Monitors for WOTS are Messrs. James Gottesman and David Buelow and Dr. John Bushman, HQUSACE.

The WES has responded to numerous requests from CE Districts for WOTS technical assistance in identifying low-cost biotechnical methods for solving shoreline erosion problems. Because of these requests, the ERRAP Program Manager perceived the need to document the magnitude of shoreline erosion at CE projects. Information presented in this report was extracted from responses by CE field offices to a WES ONTYME message asking for erosion information.

This report was prepared by Mr. Hollis H. Allen, Botanist, Wetlands and Terrestrial Habitat Group (WTHG), Environmental Resources Division (ERD), EL, and Dr. F. John Wade, Associate Professor of Management at Jackson State University, Jackson, MS. Dr. Wade was employed by WES under the terms of an Intergovernmental Personnel Act agreement.

Technical reviews were provided by Mr. J. Lewis Decell and Dr. A. J. Anderson, ERRAP, WES. The report was edited by Ms. Janean C. Shirley of the WES Information Technology Laboratory.

The work was conducted under the direct supervision of Mr. E. Carl Brown, Chief, WTHG, and under the general supervision of Dr. Conrad J. Kirby, Chief, ERD, and Dr. John Harrison, Chief, EL.

Commander and Director of WES was COL Larry B. Fulton, EN, US Army. Technical Director was Dr. Robert W. Whalin.

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CONVERSION FACTORS, NON-SI TO SI (METRIC)
UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI
(metric) units as follows:

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
miles (US statute)	1.609347	kilometres



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THE SCOPE AND NATURE OF SHORELINE EROSION PROBLEMS
AT CORPS OF ENGINEERS RESERVOIR PROJECTS:
A PRELIMINARY ASSESSMENT

PART I: INTRODUCTION

Background and Purpose

1. Reservoir shoreline erosion has long been recognized as a problem at many Corps of Engineers (CE) projects; however, there has been no formal action to quantify the scope of this problem or to summarize the type and cost of damage created by reservoir erosion.

2. The US Army Engineer Waterways Experiment Station (WES) has assisted several CE Districts with shoreline erosion problems under the Water Operations Technical Support Program. By January 1990, the number of erosion problems known to WES personnel was large enough to suggest a need for assessment of the magnitude and impacts of reservoir shoreline erosion nationwide. Accordingly, WES queried CE Districts to determine if shoreline erosion may be a ubiquitous problem, and to obtain a general idea of the damage being caused. This information on the general extent of the problem is necessary to determine the cost-effectiveness of conducting a more comprehensive analysis of existing or potential erosion damage at each affected project. This report provides the findings from the query of CE Districts.

Scope

3. The data presented in this paper are preliminary in nature. The estimates of the amount and results of erosion are based on responses with varying levels of quantification by CE Districts.

PART II: APPROACH

4. All of the data for this investigation were supplied by CE Districts, in response to a query from WES sent out through the ONTYME network on 9 February 1990, with a follow-up query to non-respondents on 2 April 1990. The queries did not require a uniform format for response and purposely encouraged a free-form type of response. Some Districts responded in great detail, some provided only general information, and some did not respond at all.

5. Because of the preliminary nature of this study, it was the intention of WES to obtain and consolidate any existing information which the Districts already had on this subject, but not to divert District resources into gathering new data.

Form of Inquiry

6. The query from WES to the CE District offices asked for the following information:

- a. How many reservoir projects does your District have?
- b. Name projects with shoreline loss rates that impact:
 - (1) Archaeological/cultural resources.
 - (2) Private and government facilities (e.g., homes, recreation buildings, other buildings).
 - (3) Water quality.
 - (4) Project life.
 - (5) Fish and wildlife habitat.
 - (6) Other resources.
- c. For each reservoir with shoreline erosion problems, what is the nature of the problem (e.g., loss of private homes and other property, loss of government facilities, loss of archaeological/cultural resources, loss of critical fish/wildlife habitat, etc.)?
- d. For each reservoir with erosion problems, what is your estimate of shoreline miles affected, and your opinion as to severity (i.e., minor, somewhat severe, severe)?

Format of Responses

7. The District responses varied from a 27-page analysis of problems to a brief tabulation penciled on the margin of the WES query. Some of the estimates of erosion problems were quite precise (miles of shoreline, feet or meters per year of shoreline retreat), and some seemed to be merely rough descriptions (e.g., "erosion problems ranging from minor to severe over the entire 111 river miles"). Some Districts provided considerable detail about the type of damage, while others provided almost none. One District provided a helpful summary report prepared by its engineering division, and also included erosion estimates for each project prepared by the project managers.

8. Overall, the Districts provided a good indication of the extent of erosion problems in reservoir projects. However, the unstructured nature of the request resulted in a lack of consistency and completeness in reporting, making it difficult to draw detailed conclusions about severity or types of damage.

Evaluation of Responses

9. The WES summarized the following information from the data furnished by the Districts.

- a. Number of reservoir projects in each District.
- b. Number of reservoir projects with erosion problems.
- c. Number of reservoir projects on which a particular type of damage or threat was mentioned. Because of the spotty reporting, no attempt was made to further quantify this information. Therefore, a report that private homes around a project are endangered was simply counted as "Private Homes Endangered," regardless of whether the number of homes was reported (i.e., one, two, three...).
- d. Miles of shoreline with minor, somewhat severe, or severe erosion. The distinction between "somewhat severe" and "severe" seemed to imply an unwarranted level of precision, particularly as some Districts used the term "medium" instead of "somewhat severe." As these terms were not defined to the Districts, the degree of severity was open to conjecture. For this reason, the "somewhat severe" category was distributed on a 50-50 percent basis into the categories of "minor" and "severe." Where erosion was reported to the fraction of a mile, the value was

rounded to the nearest whole mile, except that all numbers less than 1 mile* were rounded up.

10. In order to arrive at an estimate of total shoreline miles affected, it was necessary to assign a definite number of eroding miles to each project. In some cases, the number assigned was known to lack precision, because of the way the District had reported the problem. There were nine Districts which had one or more projects where the exact mileage or severity of erosion was not specifically reported, but where the total shoreline affected was estimated to exceed 30 miles. The procedures for estimating shoreline erosion miles for these projects are shown in Appendix A.

Classification of Damage

11. The major categories in which damage was reported were:

- a. Archaeological/cultural resources.
- b. Water quality.
- c. Fish and wildlife habitat.
- d. Public and private property.

12. Many of the Districts provided detailed listings of property damage or threats caused by erosion. These problems were classified into eight major groups (Table 1).

13. Where damage to private homes or private structures was reported, erosion of private land was also considered to be occurring, even if not specifically stated by the District. Likewise, if damage to government structures, government property, or recreational land was reported, erosion was considered to be occurring on government land. Finally, if a project was reported to have 10 or more miles of severe shoreline erosion, damage to government land was considered to be occurring even if this was not specifically mentioned.

* A table of factors for converting non-SI units of measurement to SI (metric) units is presented on page 3.

Table 1

Classification of Property Damage Caused By Shoreline Erosion Problems

1. Private homes	6. Government/recreation facilities
2. Private structures	Fishing platforms
Private cabins	Parking lots
Septic tanks	Campground facilities/sites
Hospital	Picnic tables/sites
Privately built marina	Boat ramps
3. Private Facilities	Government roads
Concessions	Bike path
Improvements on commercial leases	Light pole
Outgranted recreational facilities	Public facilities
Resort areas	Public cemetery
Private cemetery	Developed recreation areas
Private roads	Day-use facilities
4. Private Land	7. Government property
Private land with flowage	Government land
easements	Trees
Private property	Property
Private homesites	Islands
5. Government/recreational structures	Intake canal
Restrooms	National wildlife refuge
Buildings	Landfill
Picnic shelters	Local government property
Emergency gate (loss of use)	8. Recreational land
Marina structures	Park land
Office/Visitor Center	Recreation sites
Water intake	Low-density recreation areas
Control structure	Beach area
Sewer lines	

PART III: RESULTS

14. Responses were received from 24 Districts and from the Pacific Ocean Division, which has no reservoir projects. No response was received from 13 other Districts, 5 of which are known to have no reservoir projects. It is estimated that, at most, 50 reservoir projects were not reported. The reporting Districts provided information on 276 projects and indicated that 161 of these 276 projects (58 percent) were experiencing some degree of erosion. Severe erosion was indicated at 117 reservoirs (42 percent). Figure 1 shows the percentage of Districts reporting severe, minor, or no erosion problems.

15. Erosion problems appear to be most severe in the central part of the country but are geographically widespread. Figure 2 and Table 2 show the number of projects with problems, by District.

Miles of Shoreline Affected by Erosion

16. For the 276 projects from which data were reported, a total of about 5,400 shoreline miles were rated as having severe erosion problems, with another 5,100 miles rated as having minor erosion. Miles of erosion, by reporting District, are shown in Table 2.

Types of Damage

17. The erosion damages cited were to private property, government property, archaeological/cultural sites, fish and wildlife habitat, and water quality (Table 3, Figure 3). There were also references to reduction in project life and reduced storage capacity. These are not tabulated because they were not categories included in the WES query.

Property damage

18. Table 4 provides more detail on the types of property damage. Because a project may have reported more than one type of damage in a single category, the totals in Table 4 are larger than those in Table 3.

Archaeological/cultural sites

19. The Omaha District provided the most comprehensive information on archaeological/cultural sites. This District reported that 525 such sites were endangered by erosion. Of these, 328 are eligible for or have been

Table 2
Shoreline Erosion Problems and Miles. by District

<u>District</u>		<u>Reservoirs with Problems</u>	<u>Total Reservoirs Reported</u>	<u>Miles with Erosion</u>	
				<u>Minor</u>	<u>Severe</u>
LMK	Vicksburg	7	7	387	601
LMS	St. Louis	5	5	31	147
MRK	Kansas City	15	18	414	323
MRO	Omaha	24	26	2,805	2,409
NAO	Norfolk	0	1		
NCB	Buffalo	0	2		
NCE	Detroit	0	0		
NCR	Rock Island	3	3	68	54
NCS	St. Paul	10	16	35	33
NPS	Seattle	2	6	85	85
NPW	Walla Walla	7	8	136	5
ORH	Huntington	11	31	66	96*
ORL	Louisville	12	20	42	129
ORN	Nashville	2	2**	140	84
ORP	Pittsburgh	8	13	25	34
SAC	Charleston	1	1	8	0
SAM	Mobile	12	12	345	530
SAW	Wilmington	3	5	310	505
SPK	Sacramento	5	12	6	9
SWF	Ft. Worth	12	24	158	125
SWL	Little Rock	6	15	48	47
SWT	Tulsa	16	38	28	158
SWG	Galveston	0	2	0	0
SWA	Albuquerque	0	9	0	0
Total		161	276	5,137	5,374

* District reported "25 percent of shoreline affected at least to a minor degree."

** District has eight other reservoirs for which no information was received.

Table 3
Erosion Damage by Type and Number of
Projects Reporting Damage

<u>Type of Projects</u>	<u>Number of Projects</u>
Archaeological/cultural sites	79
Fish and wildlife habitat	62
Government property	
Structures	12
Facilities	69
Recreational land	18
Other land (w/o facilities)	<u>33</u>
	Subtotal = 132
Private property	
Homes	10
Structures	10
Facilities	10
Land only	<u>20</u>
	Subtotal = 50
Water quality	41

* Some projects reported more than one type of damage; therefore these numbers are not mutually exclusive.

recommended for National Register of Historic Places evaluation. Other Districts within the central United States, primarily former prairie regions, also reported numerous projects with this kind of damage.

Table 4

Specific Types of Private and Government Property Damage Cited by Districts

<u>Damage to Private Property</u>	<u>No. of Reports</u>	<u>Damage to Government Property</u>	<u>No. of Reports</u>
Private homes	10	Restrooms	3
Septic tanks	2	Buildings	2
Cabins	1	Marina structures	2
Hospital	1	Emergency gate	1
Privately built marina	1	(loss of use)	1
Other private structures	5	Picnic shelters	1
Concessions	3	Office/visitor center	1
Improvements on commercial leases	2	Water intake	1
Outgranted recreational facilities	2	Control structure	1
Resort areas	1	Sewer lines	1
Private cemetery	1	Other government structures	1
Private roads	1	Developed recreation sites/areas	20
Private land	25	Boatramps	12
Private property	12	Public roads	12
Private land w/flowage easements	10	Campground facilities/sites	11
Private home sites	1	Picnic tables	6
		Parking lots	6
		Day-use facilities	3
		Cemeteries	2
		Fishing platforms	2
		Other govt/recreational facilities	26
		Government land/trees	78
		Government property	52
		Intake canal	1
		Landfill	1
		Local government property	1
		Recreational land/beach	7
		Park land	6
		Recreational site	2
		Low-density recreation areas	3

PART IV: DISCUSSION

20. Based on information received from 24 Districts, it appears that over half of the CE reservoir projects are experiencing some type of erosion problem, with over 10,000 miles of shoreline being affected. Erosion is damaging private property on at least 50 reservoirs. It is also degrading water quality and fish and wildlife habitat on 62 of the reported projects, adversely impacting numerous archeological sites on 79 of the reported projects, negatively impacting water quality on 41 of the reported projects, and reducing the life and storage capacity of many reservoirs.

21. Erosion is usually a slow process, so erosion control is often given a low priority until the cumulative effects create an acute problem requiring a quick and sometimes expensive solution. Preventative maintenance and inexpensive methods of damage control can often be effective if they are implemented early in the erosion process before structures and expensive property are threatened.

22. Development of a CE preventative maintenance remedial action plan would have at least three phases:

- a. Phase 1. Fully characterize, quantify, and prioritize existing and potential problems resulting from shoreline erosion at CE projects so that erosion control decisions can be properly made (based on this study, it is anticipated that further investigation would reveal additional erosion damage reported to important property and resources).
- b. Phase 2. Identify or develop methods or techniques for preventing and repairing erosion and related problems and make preliminary cost estimates for such actions.
- c. Phase 3. Develop policies and priorities for coping with the various types of erosion using the methods or techniques developed.

PART V: CONCLUSIONS AND RECOMMENDATION

23. About half of the CE Districts (19 of 37) and a majority of CE reservoir projects (161 of 276 reported) have significant erosion problems. Over 10,000 miles of shoreline at over 161 reservoirs are affected in 19 Districts. There is damage or a threat of damage to private and public property at 11 and 29 percent, respectively, of the reporting reservoirs. At least 29, 22, and 15 percent, respectively, of the projects reported erosion problems affecting archeological/cultural and fish and wildlife resources, and water quality. The open-ended design of the queries to the CE Districts contributed to the difficulty in assessing the extent and severity of erosion at reservoir projects, but the responses to the queries did confirm that shoreline erosion is a serious problem to be considered in the management of CE reservoirs. It is recommended, therefore, that a more complete study to classify and quantify these problems is needed as a first step toward developing an overall plan of action and establishing policies for preventing or repairing various types of erosion damage.

276 RESERVOIRS

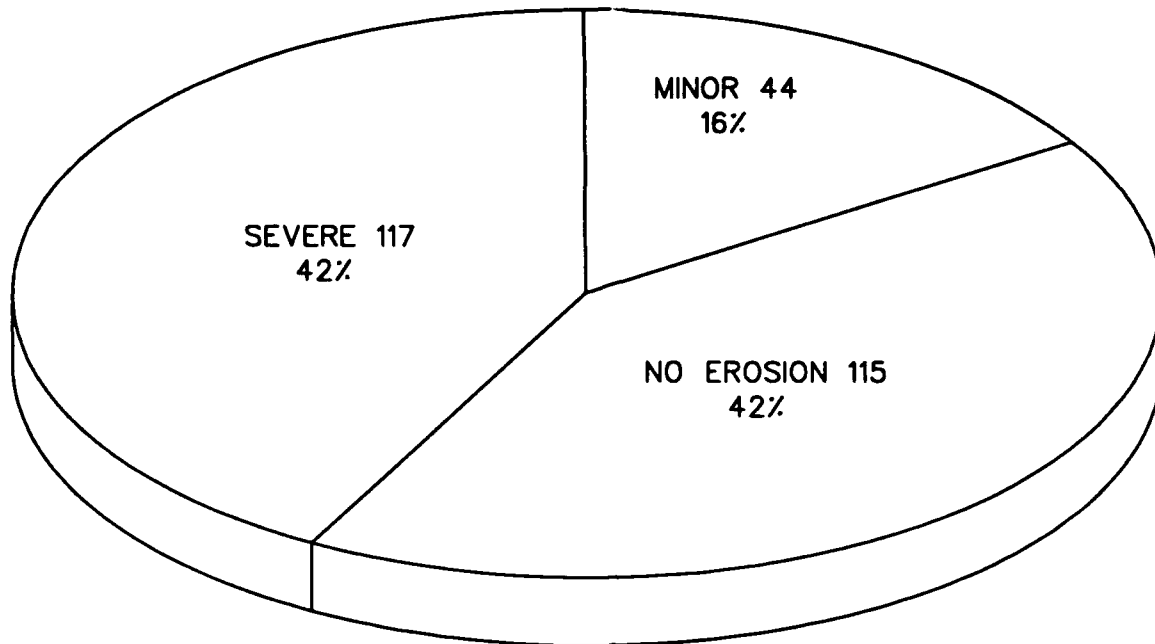


Figure 1. Corps of Engineers projects with severe, minor, or no erosion

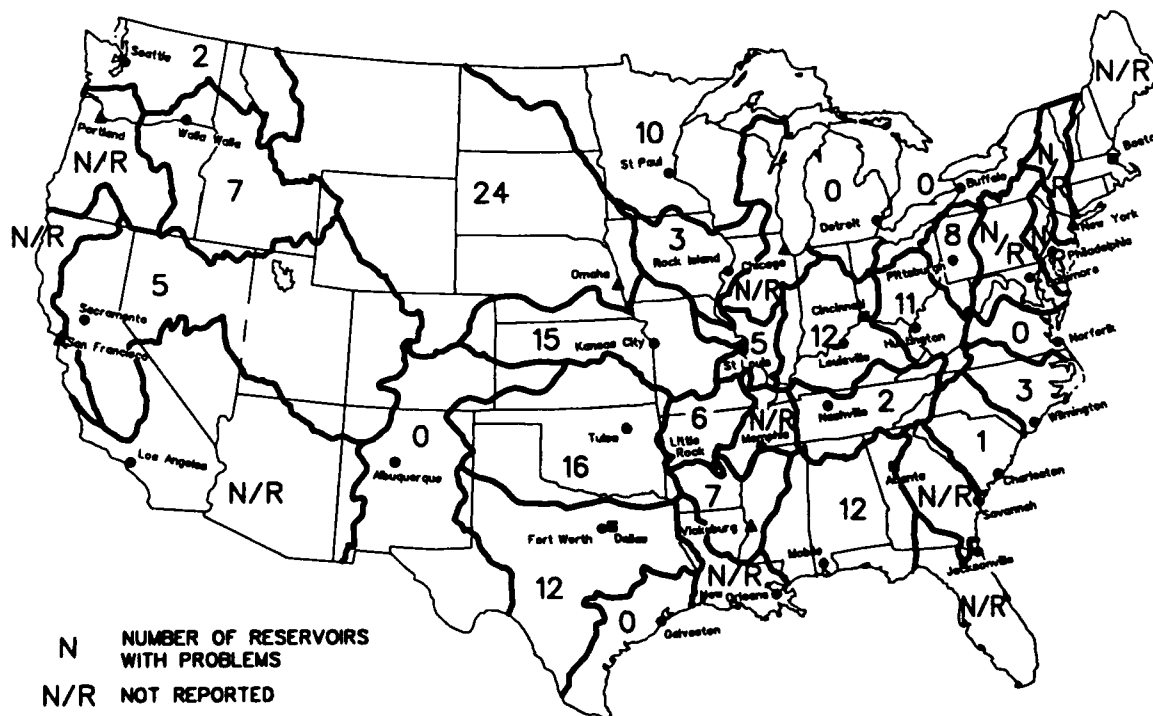


Figure 2. Number of projects with erosion problems, by District

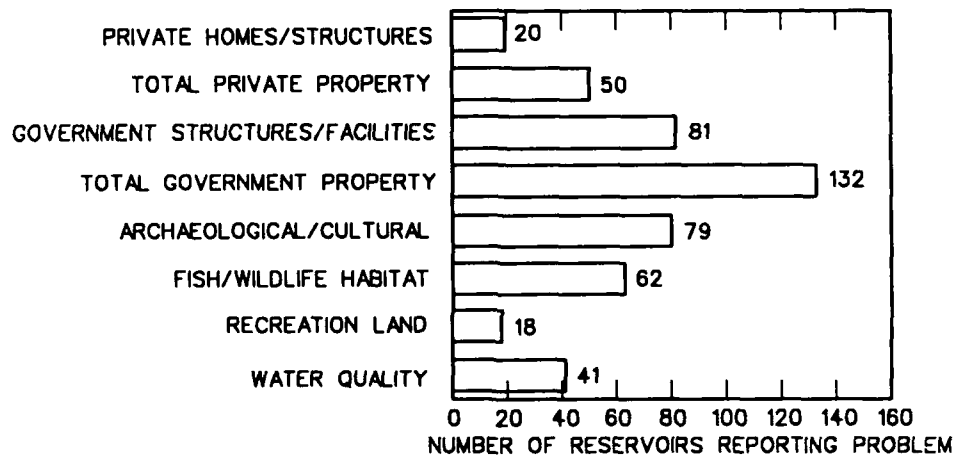


Figure 3. Reservoirs reporting damage or threat,
by type of damage

APPENDIX A: PROCEDURES FOR ESTIMATING SHORELINE EROSION MILES

1. In order to tabulate total shoreline miles affected by erosion, it was necessary to convert the rough estimates of several Districts into specific mileage figures. A list of these estimates follows:

- a. The Fort Worth District report included the following: Bardwell Lake: "30 miles .. severity ranging from minor to severe." Canyon Lake: "80.5 miles with minor to somewhat severe erosion." Lake O' the Pines: "An unknown distance of shoreline has severe erosion. Also (sic) 32.2 miles of shoreline are severely affected.." Somerville Lake: "85 miles has minor to severe erosion." The US Army Engineer Waterways Experiment Station (WES) tabulated the total for these four lakes as follows:

	<u>Minor</u>	<u>Severe</u>
Bardwell Lake	15	15
Canyon Lake	61	20
Lake O' the Pines	0	32
Somerville Lake	43	42

- b. The Huntington District reported that of their 31 reservoirs, 5 had severe erosion problems, 3 had moderate problems, and 3 had minor problems. They stated that "at least 25% of the shoreline of these projects is affected, at least to a minor degree." The average shoreline of a project in this District is 60 miles. WES tabulated the erosion mileage as:

Minor: 66 miles
Severe: 96 miles

- c. The Kansas City District reported that Harry S. Truman Lake had "less than 5% (48 miles) of its 958 shoreline miles severely or somewhat severely eroding. As much as 25% (240 miles) may have minor erosion problems." WES tabulated this as:

Minor: 250 miles (26% of shoreline)
Severe: 28 miles (3% of shoreline)

- d. The Little Rock District reported that Dardanelle Lake has 78 miles eroding. The severity "varies from minor to severe..." WES tabulated this as:

Minor: 39 miles
Severe: 39 miles

The District also implied that Ozark Lake had erosion problems but gave no details. WES did not include this lake in our tabulations.

- e. The Nashville District reported erosion on the Tennessee River between Lake Barkley and Cheatham Lake as "ranging from minor to severe over the entire 111 (river) miles." There are at least 222 shoreline miles involved on this reach of the river. WES tabulated the problem as:

Minor: 138 miles (63%)
Severe: 84 miles (37%)

- f. The Pittsburgh District reported 32 miles of erosion which is minor at winter pool and somewhat severe at summer pool. WES tabulated this as:

Minor: 16 miles
Severe: 16 miles

- g. The St. Paul District reported erosion on Lake Traverse as "30 miles, Minor to Somewhat Severe." WES tabulated this as:

Minor: 22 miles (73%)
Severe: 8 miles (27%)

- h. The Tulsa District reported that John Redmond Reservoir had 59 miles of erosion. "Erosion is somewhat severe to severe." WES tabulated this as:

Minor: 15 miles (25%)
Severe: 44 miles (75%)

- i. The Vicksburg District reported that Lake Ouachita has 690 miles of shoreline erosion with "most areas having somewhat severe to severe problems. WES tabulated this as:

Minor: 240 miles (35%)
Severe: 450 miles (65%)