LAKE SHORE EROSION

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ABSTRACT.—Erosion of lake shores by boat traffic is a serious problem which needs to be given more attention. This erosion contributes to the filling in of reservoirs. A gabion wall is recommended.

Present concern with ecological problems tends to obscure natural geological processes which have been proceeding since the beginning of time and which man is accelerating. This is apparent when a lake is constructed, for any impoundment represents a block to Nature's orderly process. The arresting of water flow behind a dam means that the sediment load carried by moving water cannot be held and is deposited on the floor of the lake. This process is largely overlooked because it is unseen and, depending upon the size of the area contributing runoff, not observed until considerable storage volume has been lost to sediment.

Although most of the deposited sediment has been transported from the total watershed, a portion consists of material eroded from headlands in the lake that have been under attack of wave-generated winds and ice pressure, like the slope shown in Figure 1. When sufficient sediment is eroded to make a protective beach, the rate of headland erosion is greatly reduced.

FIGURE 1. Lake headland eroded by wave action.

However, the process results in the loss of considerable land, generally high-value promentary land. Usually, land owners try to protect exposed erodable areas with seawalls, such as the low barrier pictured in Figure 2. Unless they are well constructed, they require almost constant upkeep at great expense.

Man contributes markedly to this type of erosion through the uncontrolled use of power boats on lakes. This is especially noticeable on narrow lakes where wave-generated waves reach the shore with maximum crests and undiminished force. Even with lake police protection, man-made lakes continue to be damaged by fast boat traffic throughout the months of heavy recreational use. One has only to observe the recreational use of municipally owned and operated lakes to know that boating enthusiasts frequently overstep the rules of safe operation. Especially is this true for water skiers. In making 180 degree turns it is frequently necessary for the boat to make a circular course that almost intersects the shore. Waves generated by this maneuver cause considerable erosion.

Normal wave action generated by boats cruising 100 yards from shore reaches the shore with a dynamic pressure of less than 5 pounds per square foot. A speeding boat pulling a skier at 20 miles per hour as shown in Figure 3 and at a distance of 20 yards from shore can send shoreward waves that exert pressures on the shore of 500 to 1000 pounds per square foot. Obviously, the answer to this kind of

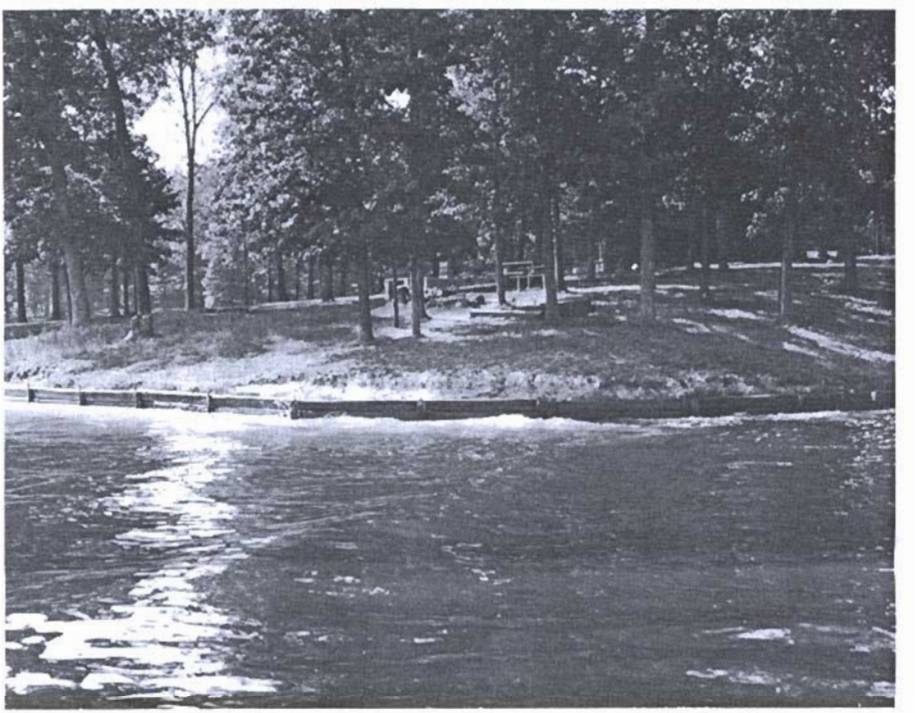

FIGURE 2. Low wood barrier wall.

erosion is the enforcement of stricter rules for boat operation. Since dynamic pressure varies as the cube of the wave height, erosion can be reduced considerably if waves have more distance to travel before they intersect the exposed shore and break with less force.

In view of the destruction of lake shore lines that could be attributable to boat traffic, it is strange that there are not uniform codes controlling all lake boat traffic similar to the motor vehicle laws. The tendency has been for a situation to develop to a critical stage and then investigate the history of older lakes and adopt some of rules formulated for their protection. Some general practices can be learned in this way.

Rules and Regulations

Article XXIII of the Rules and Regulations of the Illinois Department of Conservation states that it is unlawful for any person to use an outboard motor on any state-owned lake under its jurisdiction that has less than 60 acres of water. On the larger state-owned lakes, the limitation applies to use of an outboard motor of a size larger than 10 horsepower. These regulations are established in accordance with Section 4 of the Fish Code of Illinois, and persons violating provisions are subject to the penalties provided by the Code. The laws supplementing these rules are to be found in Chapter 56 of the Illinois Revised Statutes.

Rules governing boat traffic on municipally owned lakes vary greatly. Lake Bloomington, a 600-acre lake owned by the City of Bloomington, has a limit of 25 horsepower for motor boat operation. Lake Sara, a 735-acre lake built by the Effingham Water Authority, has an upper limit of 75 horsepower for its boat traffic. Lake Springfield, which covers an area of 5000 acres, has no horsepower

FIGURE 3. Pleasure boat producing waves.

limit, with several boats having motors in excess of 300 horsepower. However, hydroplanes are not allowed, and no boat may speed in excess of 35 miles per hour.

License Fees

There is a charge for operation of any boat on practically all Illinois lakes. The State Department of Conservation charges fees varying from $12.50 per season for power boats to $25.00 for pontoon boats.

Approximately 3100 boats are licensed to operate on Lake Springfield. There are regularly 2200 locally-owned boats with licenses, and the remainder come from great distances, often beyond the state's borders. Annual fees vary from $2.00 for a rowboat less than 16 feet in length and having no motor to $10.00 for a boat that is powered by a motor in the range of 51 to 74 horsepower.

At Lake Decatur, which has an area of slightly more than 2400 acres, the schedule of fees blankets all outboard motors under 15 horsepower at $7.50 annually, and $10.00 for larger sizes. Boats with inboard motors are charged $12.50 if the size is under 175 horsepower and $15.00 for more powerful engines. Sailboats are all charged $7.50.

Such fees are collected by city clerks, and the funds are used to help defray the cost of policing the lakes. Violations are punishable with fines, and these also help toward the same costs.

Erosion Barrier Construction

Generally, shore property along Illinois lakes is not provided with protective devices until erosion has progressed considerably. The disturbed owner will then observe the protective devices already installed on other shore properties and will copy them without regard to applicability to a specific situation. Figure 4 is typical of improper planning to curtail bank erosion.

At Lake Sara, wooden seawalls are popular. They are composed of wood posts 6 feet long driven vertically into the shoreline and protruding above spillway crest elevation one or two feet. Wood planks, each 2 by 6-inches by 12 feet, are nailed horizontally to the posts. The wall is also supported from the shore side with

FIGURE 4. Inadequate barrier fails to stop bank erosion.

coarse filler material such as bricks, rocks and cement blocks. Most owners have had relatively good experience with this type of construction, but any unusual high water tends to lift the structure out of the water as shown in Figure 5.

One erosion barrier that has had a fair measure of success consists of a continuous concrete wall approximately 6 inches wide and extending from the ground vertically to a height 6 inches above spillway crest elevation. The wall is strengthened with reinforcing rods and supported on the shore side with rocks, bricks, and broken concrete. Where rods have not been tied together, failure has occurred in the wall at the discontinuity, as shown in Figure 6a. A similar wall may be strengthened at regular intervals with corrugated metal area-way projections 2 feet deep and 3 feet in diameter. They are connected to the main wall with trellis-type wire and filled with concrete. The semicircular shape of the way-walls tends to absorb much of the wave energy. The wall shown in Figure 6b has withstood three years of battering.

Property owners have experienced only limited success with protective barriers installed along their water lines, and in many cases failure has occurred within a year. Since permanent walls, such as driven sheet piling, are expensive, it is imperative that effective yet less costly devices be investigated.

One form of protection that should prove beneficial is the gabion. This is a steel wire mesh box made of a complete and continuous fabric, as shown in Figure 7, and filled with stones or rocks. It may be constructed in varying sizes and shapes, although in practice the horizontal width should be at least three feet. The height can be fractions of the width and the length up to four multiples of the width. The wire mesh, having a minimum size of U.S. Steel Wire Gage No. 11, should be galvanized with a minimum zinc coating of 0.80 oz./per square foot of wire surface. The area of the mesh openings should not exceed 8 square inches, and the maximum linear dimension of the opening not exceed 4.5 inches. Strength, elasticity, and flexibility are necessary requirements of gabions so they should be divided into compartments with dia-

FIGURE 5. Wood barrier uprooted by high water.

phragms of the same mesh and gage as the main body. The smaller cells diminish the internal movement of the rock fill. Single unit construction is necessary so that edges of the base, lid, ends, and sides have the same strength and flexibility as the body of mesh.

Cost of erosion Barriers

There is considerable variation in the prices owners have reported for their barrier installations. The wooden post variety with horizontal boards costs about $40 a lineal foot when installed by a contractor. Many do-it-yourselfers have built such walls for about $14 a lineal foot.

Contractors have installed gabion walls at a cost of $69 per running foot. Figure 8 shows a typical gabion wall. A sheet steel type of wall driven to a depth of ten feet costs about $1800 per lineal foot. While this is the best protection, especially where salt water and wave action is great, the gabion has attributes that make it preferable for preventing shore erosion at small lakes. The rock-filled walls are porous and therefore not as subject to hydrostatic pressure deformations, especially concrete ones. As they fill with silt they support plant life and blend in with the natural surroundings. The gabion type of structure protects the headland or "toe" of the shoreline from undermining, which causes most bank failures due to wave action.

Conclusions

Shoreline erosion is a continuing process, even after adequate beaches have developed. However, the average lot owner knows that he will lose some of his water-line property land to wave erosion and generally makes an attempt to protect his shoreline. Unfortunately, the present make-shift schemes used by most property owners do not begin to do an adequate job of protecting lake shore property lines, and costs for this work are expanding. There is need for more adequate information on workable shore protective devices. Cost of experimental devices could be met by the state through bills proposed by legislators for experimental barriers built at specific locations. A state department, such as the Department of Conservation, could then make the results available to all shore property owners.

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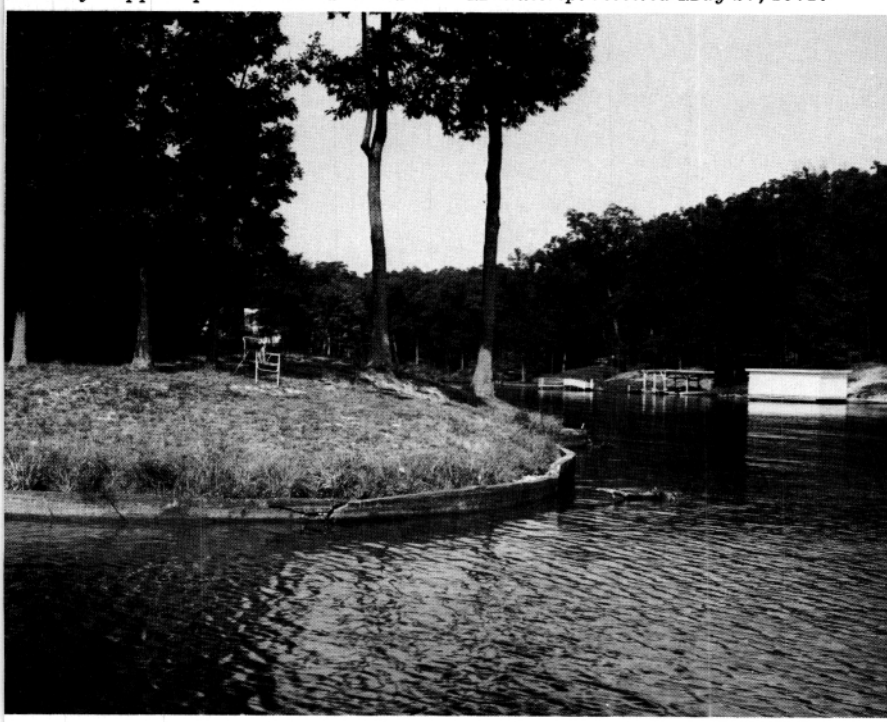

FIGURE 6a. Wall failure where reinforcing rods were omitted.

FIGURE 6b. Corrugated area-way projections provide strength to erosion barrier.

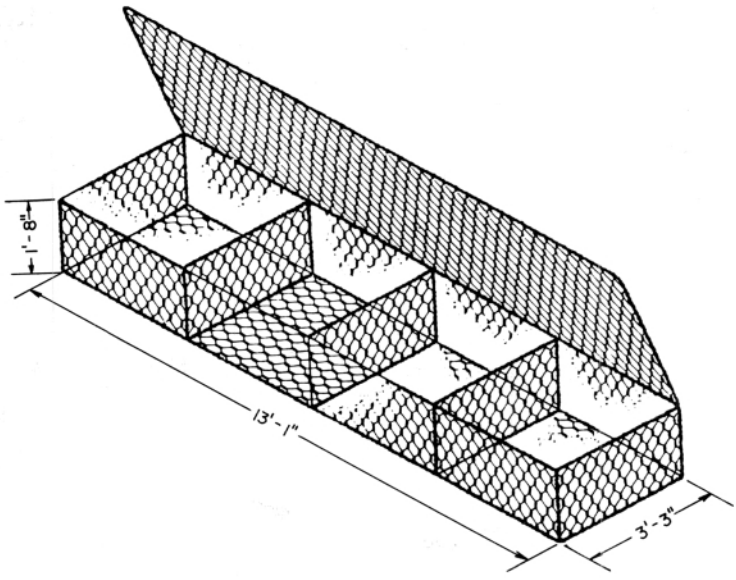

FIGURE 7. Gabion fabricated from heavy steel wire mesh.

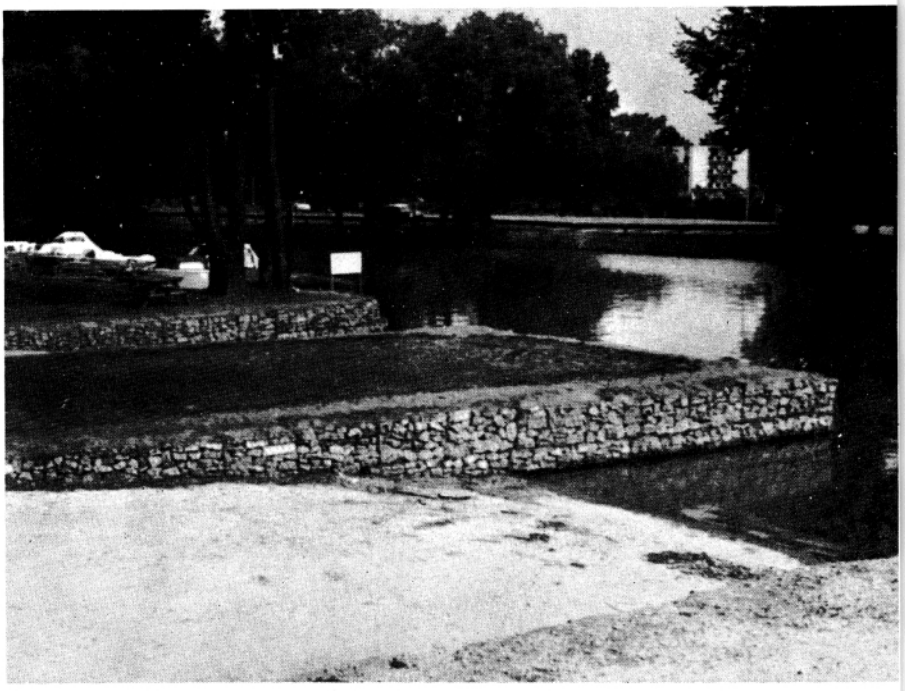

FIGURE 8. This gabion wall protects lake-front property.