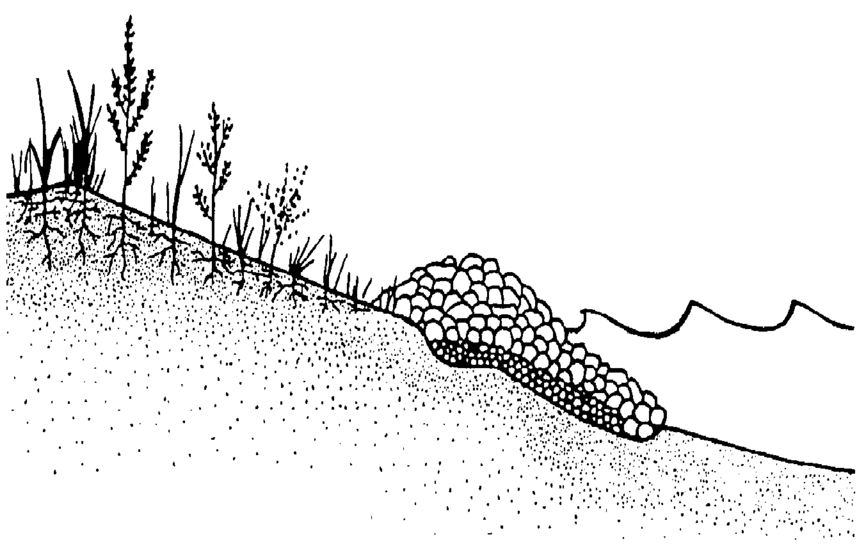
State of Mississippi

MARINE CONSTRUCTION STANDARDS FOR SHORELINE EROSION CONTROL AND SHOREFRONT ACCESS FACILITIES



Department of Wildlife, Fisheries and Parks

Bureau of Marine Resources

State of Mississippi

MARINE CONSTRUCTION STANDARDS FOR SHORELINE EROSION CONTROL AND SHOREFRONT ACCESS FACILITIES

September 1991

by

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for

STATE OF MISSISSIPPI

Department of Wildlife, Fisheries and Parks

Bureau of Marine Resources
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The State of Mississippi Department of Wildlife, Fisheries and Parks presents this information as a public service. Inclusion of any shoreline erosion control or shorefront access method does not necessarily constitute a recommendation, nor is it a guarantee that any particular method will be successful for a specific application.

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PURPOSE

The objective of this pamphlet is to present alternatives for shoreline erosion protection and shorefront access while protecting or enhancing coastal habitats.

This set of standards is intended to be useful in aiding the understanding of options available to individuals for shoreline erosion control and shoreline access.

This publication presents an overview of typical designs for coastal structures, including shore erosion control structures and structures associated with shoreline access. It does not provide a complete guide for design and construction of these structures. A variety of sources such as publications of the U.S. Army Corps of Engineers can provide additional, more detailed information on specific design problems. Coastal Engineers and experienced local contractors can also help ensure a successful project. Additional guidance relating to construction and environmental considerations can be found in the Mississippi Coastal Program, also published by the Mississippi Department of Wildlife, Fisheries, and Parks.

All persons must obtain authorization for any project in the tidal waters of the State of Mississippi from the Mississippi Department of Wildlife, Fisheries, and Parks before construction begins. Also, the Vicksburg or Mobile District Corps of Engineers should be contacted before projects are begun in non-tidal waters of the State.

GENERAL DESIGN

Design Considerations

In designing a structure, numerous decisions on structure location, height and shape must be made. The factors most important to structure design include water levels, wave heights, and environmental impacts. Other considerations include toe protection, soil properties, filtering, and flank protection.

Water Levels determine required elevations of structures to prevent overtopping and structural damage. In tidal waters, the water level is a combination of the tide and a storm surge. Spring tide levels, typically around 2 feet in Mississippi, can be determined from Tide Tables published by the National Ocean Survey. Storm surge levels can be determined from local experience or from Federal Emergency Management Agency (FEMA) publications. Typical storm tides range from 4 to 7 feet in coastal waters. In extreme hurricanes the storm tide can reach up to 20 feet. Most structures in protected coastal waters have finished elevations of 3 to 5 feet above mean high tide, while structures in unprotected areas reach heights of 7 feet above mean high tide.

Wave heights can be limited by the depth of water at the site. The maximum breaking wave height is approximately equal to the depth of water. If the bottom material in front of a structure is easily eroded, such as sand or soft mud, the water depth at the toe of the structure may increase over time. In this case either toe scour protection should be provided, or allowance should be made for increased water depth due to scour.

Wave Runup determines the height to which a shoreline erosion control structure should be constructed to avoid overtopping and damage to the back of the structure. Runup is shown in the figure below.

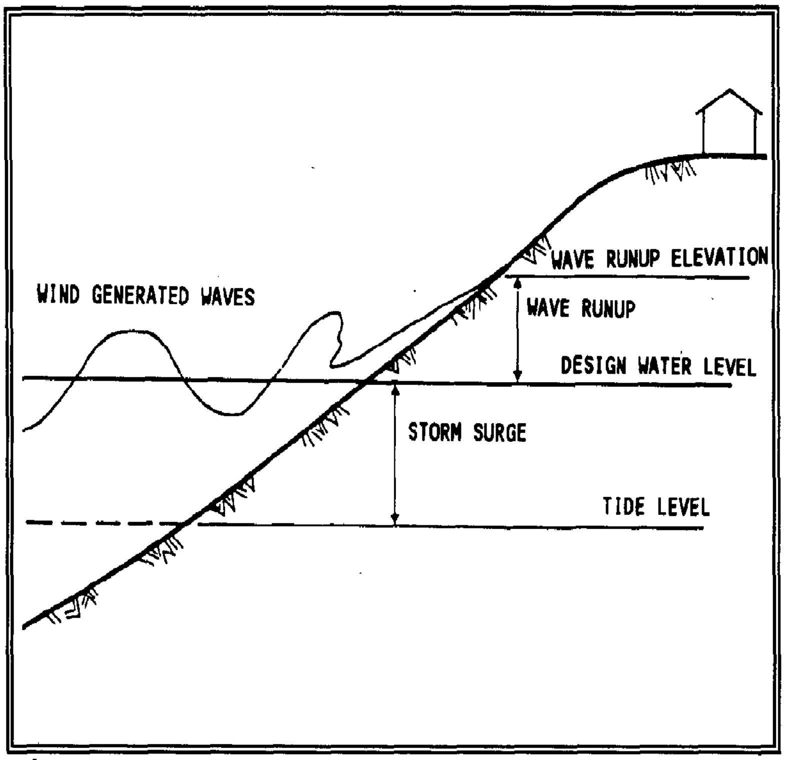

Figure 1, Wave Runup
(University of Wisconsin Sea Grant, 1987)

Runup will typically range from equal to the design wave height for a stone revetment to twice the wave height for a vertical face bulkhead.

Typically it is not cost effective to eliminate all overtopping by building an extremely tall structure. In many cases it will be more economical to allow some overtopping during large storms. In this case, the structure design should incorporate measures to minimize erosion behind the structure due to wave overtopping. This can include a rock apron or paving behind a bulkhead or revetment, or erosion resistant vegetation such as turf grass planted behind the structure.

<u>Design Level</u> refers to the level of protection for which a structure is designed. For instance, a structure can be designed to survive a storm which occurs on the average of once in 10 years more cheaply than it can be designed to withstand a storm which occurs on the average of once in 25 years. However, the risk that the structure will be damaged during it's lifetime will be greater for the 10 year design than the 25 year design.

It is recommended that permanent residential protection structures be designed for a minimum return period of 10 years, and preferably 25 years. Structures designed for 10 year return periods can be expected to require regular significant maintenance costs. Structures designed for 25 year return periods will require less regular maintenance, but may occasionally be damaged by large storms. Major projects should be designed for a 50 to 100 year return period.

Toe Protection is armoring in front of a structure to prevent waves from removing the sediment and undercutting the structure. Bulkheads typically require rubble toe protection, as illustrated in Figure 2. Stone structures often have additional material placed at the toe to prevent scour and damage to the structure.

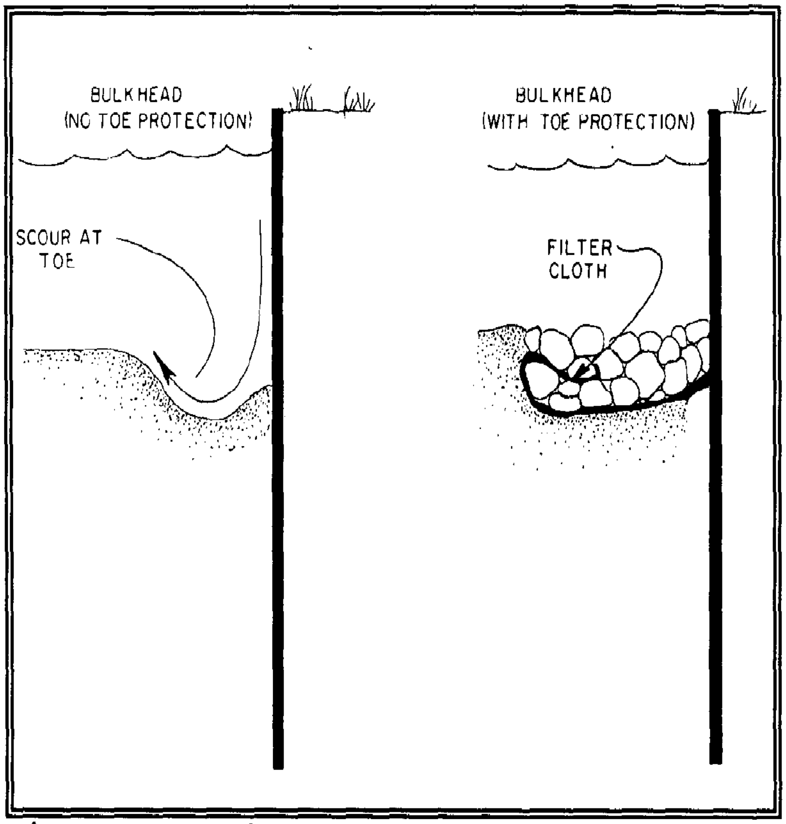

Figure 2, Typical Bulkhead Toe Protection (U.S. Army Corps of Engineers, 1981)

Filtering is generally required if fine material is to be confined by a structure. A filter layer can either consist of graded stone, a synthetic filter fabric, or often a combination of the two. The effect of inadequate or no filtering versus a proper filter design is illustrated in Figure 3.

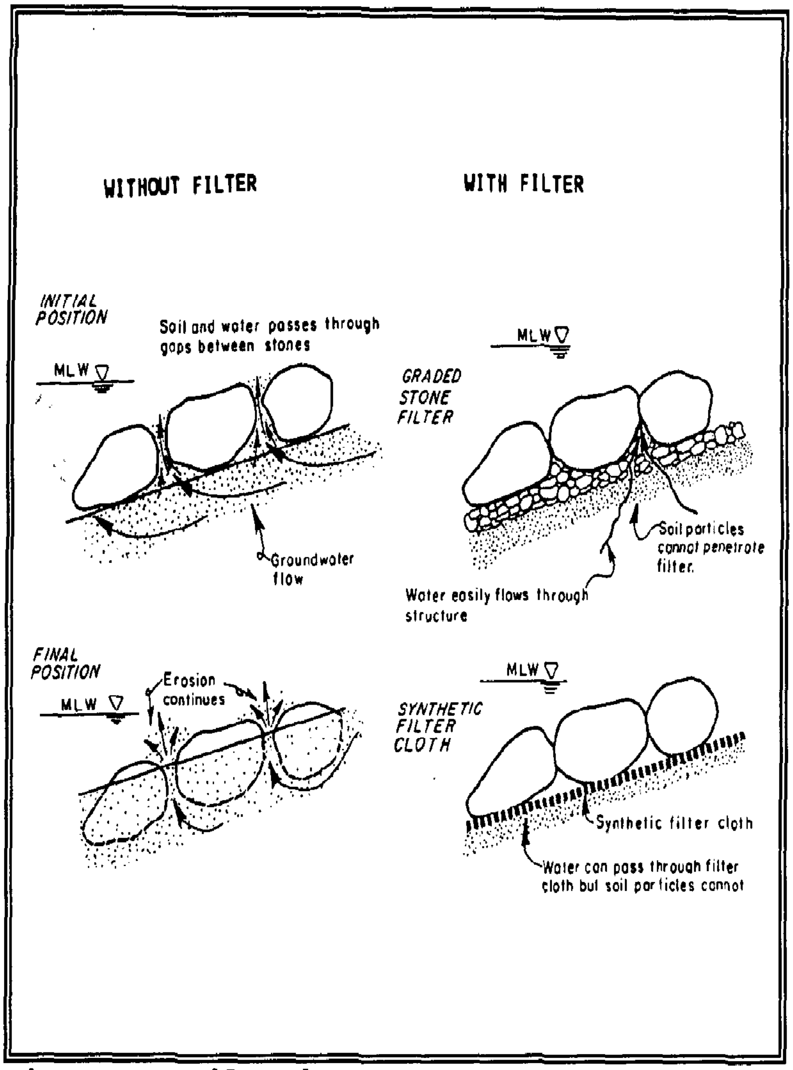

Figure 3, Filtering for Stone Structures (U.S. Army Corps of Engineers, 1981)

<u>Flank Protection</u> is often required because many shoreline erosion control structures are vulnerable to erosion around the end of the structure, which can lead to failure. Return sections are recommended during initial construction, as shown in Figure 4, although in many cases periodic increases in the length of the return structure may be necessary as erosion in adjacent unprotected areas continues.

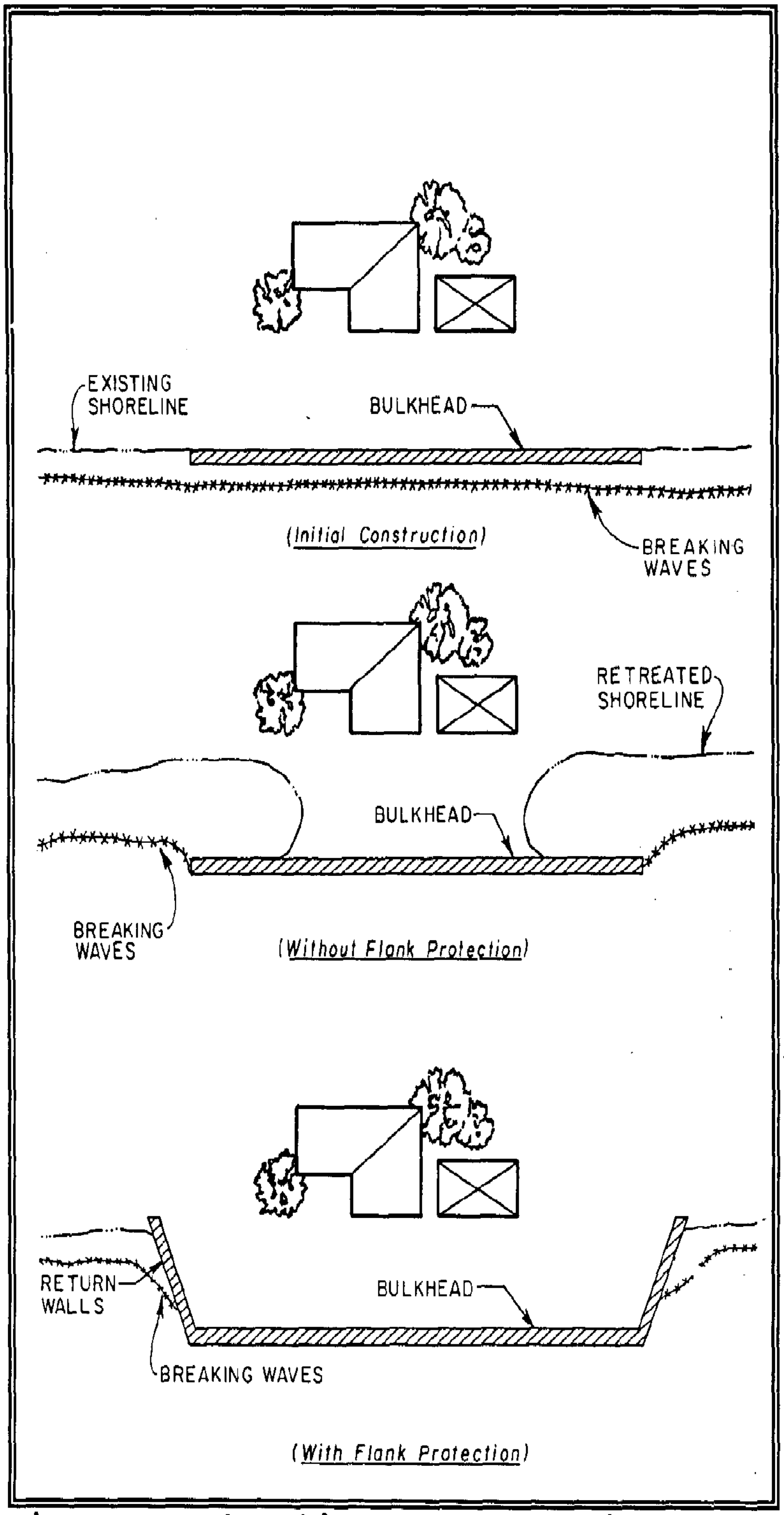

Figure 4, Schematic Flank Protection (U.S. Army Corps of Engineers, 1981)

Soil Properties are important to the long term stability of coastal structures. Settlement, pile embedment, toe stability and scour are determined by the surface soil properties.

For small private projects, the knowledge of local contractors is often the best source of information on requirements for pile embedment, settlement and scour. For larger projects, a soils exploration program will be justified.

General suitability of various general soil types for coastal structures is as follows:

Gravel: Difficult driving for sheet piling. Excellent for stone structures. Not usually found in Coastal Mississippi except near rivers.

Sand, Silty Sands: Good for sheet piling, but toe protection will be required. Suitable for stone structures, but stone structures will also generally require toe protection. Commonly found along beaches and rivers. Sheet pile embedments typically range from 6 to 12 feet. Pile embedments range from 15 to 30 feet. Embedment lengths should be evaluated by an experienced engineer or contractor for suitability for a particular location and situation.

Fine Grained Soils: Good for piles if firm. If soft, long embedment lengths may be required. Good for stone structures if firm. Excessive settlement may occur if soft. Sheet pile embedments typically range from 10 to 20 feet. Pile embedments range from 25 to 40 feet. Embedment lengths should be evaluated by an experienced engineer or contractor for suitability for a particular site.

Organic Soils, Peats: Generally not acceptable unless piles bear on an underlaying strata. May result in large settlement of stone structures unless the layer is thin. These soils usually occur in low lying areas such as marshes.

Design Methodology

1) For erosion control structures, obtain cross-sections of the bank to be protected at 50 foot intervals, extending from the upland bank to minus 1 or 2 feet below mean low water. Reference horizontal measurements to a local baseline, and vertical measurements to mean low water.

For offshore access structures, measure water depths at the estimated location of the structure.

2) Estimate design water levels (tide plus storm surge) and potential wave heights to determine the design wave height for the site. Check the breaking wave height at the structure. Use the lesser of the design wave height and the breaking wave height for design.

3) For erosion control structures, estimate the wave runup on the structure. If the structure will be overtopped, consider using vegetation or a stone or shell apron behind the structure to reduce erosion. A certain level of erosion behind the structure may have to be accepted during large storm events.

4) Obtain information on soils in the area of construction. Based on soils choose an appropriate design and size of structure.

5) Lay out the structure using the cross-section survey. Check with the Mississippi Department of Wildlife, Fisheries and Parks, Bureau of Marine Resources agency for environmental limitations on construction and for information on the permitting process.

SHORELINE EROSION CONTROL STRUCTURES

There are a variety of publications regarding shoreline erosion control available which can provide additional detail on design methods. Among the most useful are "Low Cost Shore Protection -A Guide For Engineers and Contractors" (U.S. Army Corps of Engineers, 1981) and "Shore Protection Manual" (CERC, 1984). It is advised that these sources be reviewed prior to attempting to design any shoreline erosion control structure.

Description of Shorelines

Shorelines can consist of a variety of shoreform types, each with its own erosion problems. Different shoreforms call for different shore erosion control solutions.

Banks are steep shoreforms consisting of soft erodible material such as clay, sand or gravel. Bank erosion is typically due to a combination of seepage of groundwater within the bank, and erosion by wave action at the base. The most appropriate erosion protection may consist of a combination of a drainage system plus wave erosion protection such as a revetment at the toe.

Marshes are areas that are saturated with water for much of the time and support vegetation adapted to saturated conditions. Previously often drained or filled to create new upland areas, marshes are now protected by federal and state regulations. Protection of marshes will often consist of a non-structural solution incorporating the planting of erosion resistant marsh grasses.

Beaches are the most common shoreform in the United States. Beaches are typically very dynamic, with the sediment moving onshore, offshore, and along shore in response to wind and wave conditions. Cutting off or interrupting the movement of sediment by jetties or groins can often have a detrimental effect to beaches adjacent to the construction.

Shore Protection Methods

Bulkheads are vertical walls which retain fill and protect the shoreline behind the structure from erosion, as shown below.

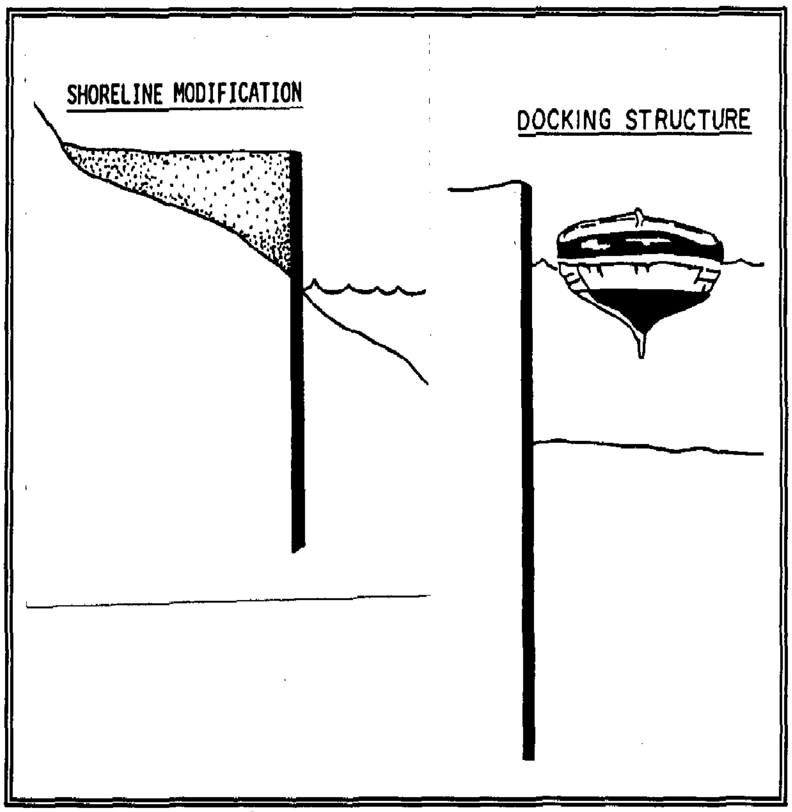

Figure 5, Typical Uses of Bulkheads (U.S. Army Corps of Engineers, 1981)

Revetments are sloping erosion control structures, generally made out of stone laid over a prepared base including filter cloth and bedding stone.

Breakwaters provide shoreline erosion control by reducing the wave height impacting the shoreline, and by trapping sediment on the landward side.

Vegetation consists of planting an eroding area with an appropriate species of erosion resistant grass, perhaps in conjunction a low stone sill and minor filling with an appropriate material such as sand.

Other options which are often used in conjunction with one or more of the above erosion control techniques include infiltration and drainage controls and slope flattening. These actions stabilize banks against erosion due to flowing water and may be required even when all erosion due to waves at the base of the bank is prevented by a revetment or some other means. Figure 6 shows an example of a well designed shore protection system incorporating drainage control, slope flattening, vegetation, and a revetment.

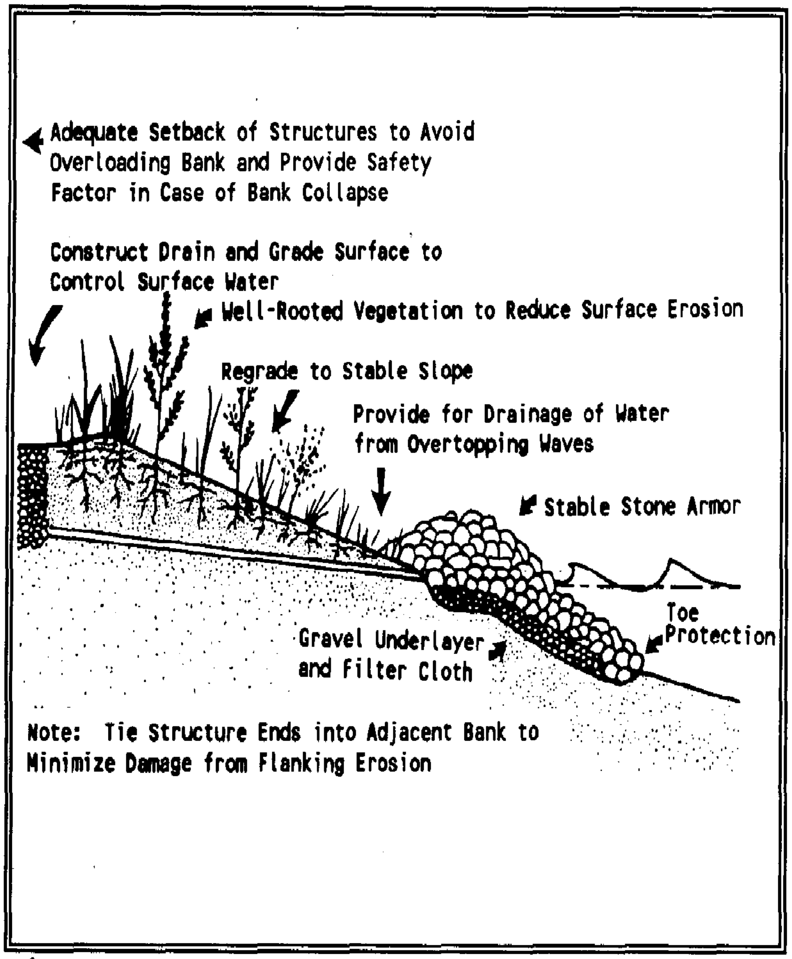

Figure 6, Well Designed Shore Protection
(University of Wisconsin Sea Grant, 1987)

Impacts of the Various Erosion Control Options

No Action consists of allowing nature to take its natural course, without attempts to slow erosion. This option will often have the least objectionable environmental consequences and will obviously have the least cost.

Relocation consists of removing vulnerable structures from behind an eroding shoreline, either to another site or far enough from the shoreline to give an acceptable service life before again being threatened by erosion. This option will also generally have minimal environmental impacts on the marine environment, although relocation can have detrimental impacts on upland areas in some instances.

Bulkheads are often the least environmentally acceptable alternative because they provide no habitat or protected areas for marine life, increase erosion of the shoreline, and create access problems to the shoreline. Bulkheads may be the best alternative when some water depth is required at the shoreline for boating activities.

Revetments of placed stone cause less scour of the sediment in front of the structure than do bulkheads, and can provide a habitat for marine life. Revetments can hinder access to the shore for recreational purposes, but they often provide an excellent permanent shoreline erosion protection solution when complete erosion control is required. Revetments can harm downdrift beaches by removing the supply of sand which has been nourishing the beaches.

Breakwaters provide an area sheltered from waves, and beaches built up in the sheltered area behind the breakwater can provide enhanced recreational potential. Breakwaters can hinder circulation and cause water quality problems, and high structures may also intrude on the view of the water. Rubble breakwaters provide habitat for biota, and they may also provide a sheltered area where submerged aquatic vegetation will thrive.

Vegetation generally greatly improves the natural habitat, but hinders other uses of the shore because travel through the plantings must be restricted. Vegetation must be protected from pedestrian use.

Specific Design Recommendations

Bulkheads

* Bulkheads should not, in general, be used for shoreline erosion control in situations where other alternatives will work. This is because bulkheads do not provide habitat for marine life, and will often cause scouring of the shoreline, further damaging the environment.

* Bulkheads may provide the best solution when a maximum of upland area is required or deep water is required at the bank.

* When bulkheads are required their impacts can be reduced by providing a substantial stone toe. This will protect against toe scour and provide habitat.

* A typical wooden sheet pile bulkheads is shown in Figure 7. They will typically be constructed with 12 to 16 foot long sheets with 8 to 12 feet embedded into natural ground, depending on the soil type and density. Each design should be checked for stability based on site conditions.

* Other typical vertical face bulkheads found in coastal Mississippi are made of concrete and corrugated aluminum metal alloys. Heavy duty plastic bulkheads are beginning to come into use.

* Bulkheads must be built at or above the mean high tide mark.

* In areas where there is substantial tidal marsh, vertical face bulkheads should not be constructed. In these cases, revetment solutions should be explored.

* Marine grade treated lumber should be used for wooden bulkheads. Use of creosote treated timber bulkheads is discouraged.

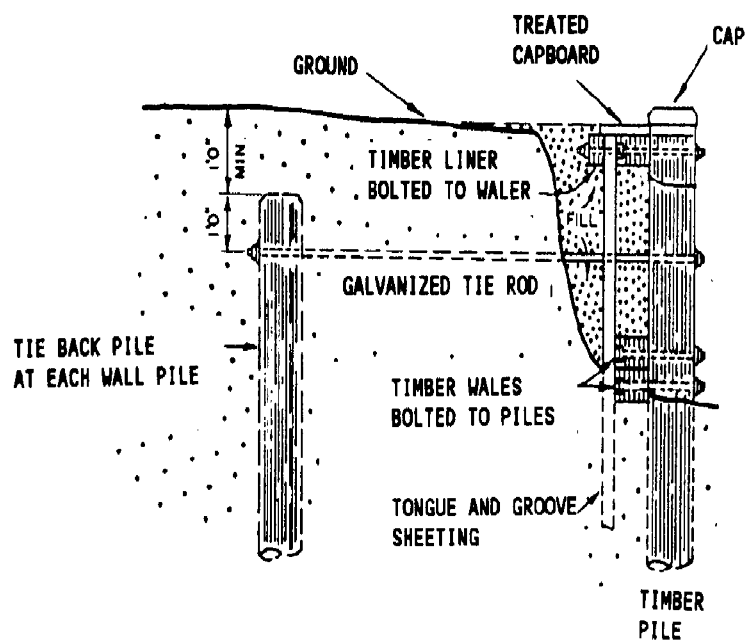

Figure 7, Wooden Sheet Pile Bulkhead (State of Maryland, 1982)

Revetments

* Revetments are generally suitable for protecting high or low banks from erosion when a recreational beach in front of the bank is not required. In some cases beaches may form or remain in front of revetments, but the revetment structure will often cover narrow beaches, and scour from increased wave reflection may reduce the amount of sand deposited in front of the structure.

* Revetments must have toe protection designed into the structure when it is constructed on easily eroded material such as sand. Revetments also must be designed so that erosion cannot outflank the structure and cause erosion around the ends of the structure. This can be done by either attaching the ends to existing structures or extending return walls back into the bank.

* Revetments are most commonly constructed from stone. If local stone is not available, other designs such as concrete armor units, wire gabions, etc. may be more economical. In many cases manufacturers or vendors will provide design services. Concrete rubble revetments should be free of exposed steel, paint or petroleum based products. Asphalt should not be used as revetment material. Since revetments are highly visible, only uniform materials should be used.

* Figure 8 shows some of the design features of a typical armor stone revetment.

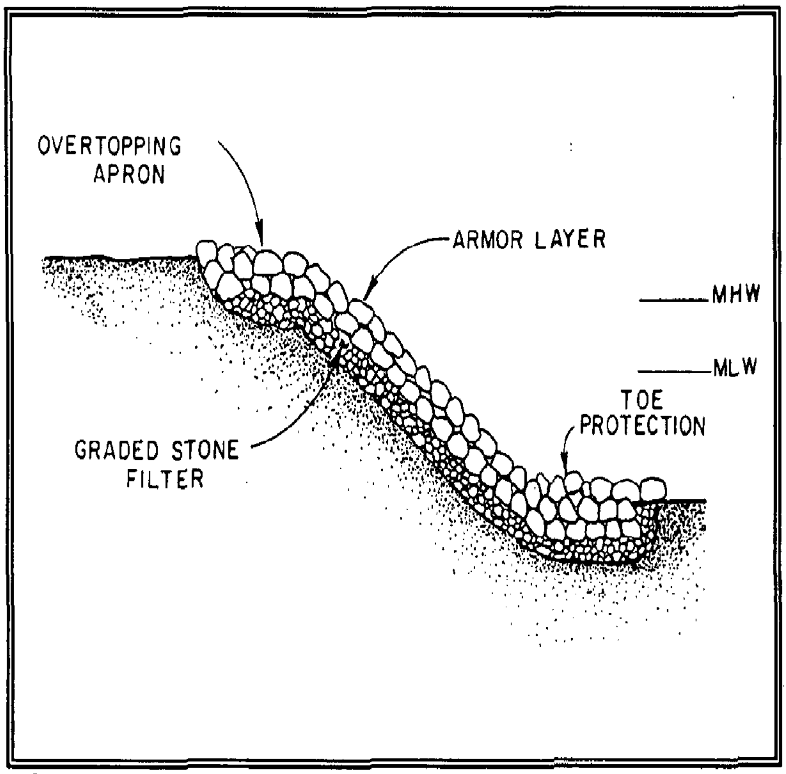

Figure 8, Armor Stone Revetment
(U.S. Army Corps of Engineers, 1981)

Breakwaters

* Offshore breakwaters are sometimes suitable when a public recreational beach is desired and offshore water depths are shallow. One advantage of offshore breakwaters is that they allow a portion of the wave energy to reach the beach, maintaining some transport of sand along the shoreline. This helps prevent erosion of beaches due to blocking sand movement.

* Breakwaters which are long compared to the distance offshore will tend to accumulate sediments behind them, extending the beach offshore. In the extreme case, the beach will eventually extend all the way

to the breakwater. This may interrupt the movement of sediment to downdrift beaches and may also reduce water circulation, causing water quality problems.

* Due to the complexity of positioning offshore breakwaters, it is recommended that professional assistance be obtained for design.

* Figure 9 shows an example of a small armor stone breakwater cross section used in conjunction with vegetation planting. Stone sizes should be based on local site conditions, using Table 1.

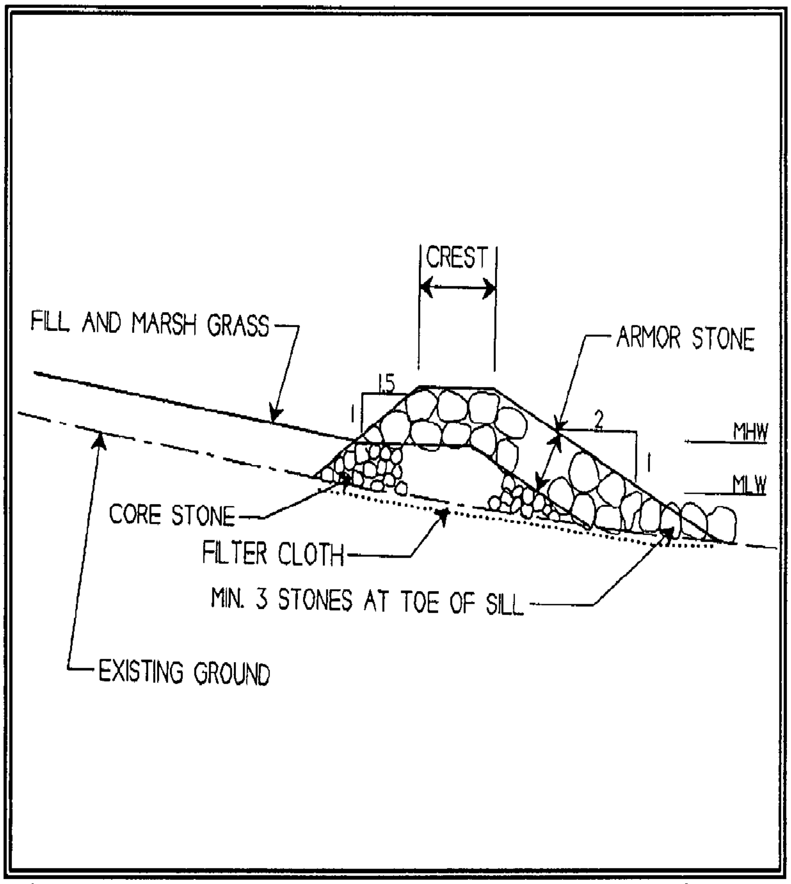

Figure 9, Armor Stone Breakwater Section, with Marsh Creation

ESTIMATED WEIGHT OF ARMOR STONE		CORRECTION FOR SLOPE		CORRECTION FOR UNIT WEIGHT	
WAVE HEIGHT H (ft)	ESTIMATED WEIGHT W (lb)	SLOPE (ft/ft)	K_1	UNIT WEIGHT w_r (lb/ft^3)	K_2
0.5	1	1:2	1.0	120	4.3
1.0	10	1:2½	0.8	130	2.8
1.5	20	1:3	0.7	135	2.4
2.0	50	1:3½	0.6	140	2.0
2.5	100	1:4	0.5	145	1.7
3.0	160	1:4½	0.4	150	1.5
3.5	260	1:5	0.4	155	1.3
4.0	390	1:5½	0.4	160	1.1
4.5	550	1:6	0.3	165	1.0
5.0	750			170	0.9
5.5	1000			175	0.8
6.0	1300			180	0.7
6.5	1650			185	0.6
7.0	2100			190	0.6

EXAMPLE

GIVEN: The wave height (H) is 3.0 feet and the structure slope is 1 on 3 (1 Vertical on 3 Horizontal) and one cubic foot of rock weighs 155 lbs (w_r)

FIND: The required weight of armor stone (W) from the tables (Dashed Line)

W = 160 lbs x 0.7 x 1.3 = 145 lbs

TYPICAL UNIT WEIGHTS PER CUBIC FOOT:

CONCRETE -- 144
GRANITE -- 165
LIMESTONE -- 156

Table 1, Calculation of Armor Stone Weights (U.S. Army Corps of Engineers, 1981)

Vegetation

* The success of vegetation as shoreline erosion control depends on such factors as climate, soil properties, wave exposure, and salinity regimes.

* Typically, Gulf Coast marshes include saltgrass and gulf cordgrass, as well as smooth cordgrass, saltmeadow cordgrass, and black needle rush. See Table 2.

* The range of vegetation erosion control can be extended through the use of structures such as low breakwater sills, as shown in Figure 9, which remain permanently in place, or temporary wooden or brush fences. These structures reduce the wave height while the plants become established.

* Vegetation should be protected from pedestrian use by fences and signs. Access paths through the vegetated areas should be provided to public beaches or other recreational areas.

PLANTING SPECIFICATIONS FOR GULF COASTS MARSH PLANTS

Type	Planting Time	Plant Form	Spacing	Location
Smooth Cordgrass	March-May	Sprigs 15 Week 6 Month or Plugs	3' apart 1.5' 1.5'	MLW to MHW
Saltmeadow Cordgrass	March-May	Sprigs 15 Week	3' apart	MHW to high tide
Gulf Cordgrass	March-May	Sprigs 15 Week 6 Month	1.5'-3' 1.5' 1.5'	MHW & above
Salt Grass	Spring	Seedlings	1.5'-3'	MHW & above
Black Needle Rush	Spring	Seedlings	1-5% of cordgrass plantings	Above MHW
Common Reed	Spring	Sprigs	1.5'-3'	Above MHW

Table 2, Planting Guide for Marsh Plants (U.S. Army Corps of Engineers, 1981)

SHOREFRONT ACCESS FACILITIES

Description of Access Facilities

This section describes shorefront structures designed to provide access to coastal waters. Typical structures most commonly built in coastal Mississippi include mooring and fishing piers, boat ramps, dredged boat slips, boat houses and berthing facilities.

Piers for mooring purposes are usually built parallel to the shoreline. In cases where water depth is a factor, piers are constructed perpendicular to the shore with boats being moored along side. Commonly when there is adequate navigation clearance a "T" or "L" section is attached to a perpendicular pier for mooring. Mooring piers are also used for fishing access and many pier are used exclusively for fishing or passive recreation.

Boat ramps for both residential and public use are very popular in coastal Mississippi. Most public boat ramps are constructed for high volume use, while residential boat ramps are not built to the same degree of improvement.

Many property owners choose to moor their boats by creating a boatslip from the upland portions of their property. In the past, boatslips were dredged deep into the upland property creating a square or rectangular boatslip with upland on three sides. This type boatslip exhibits poor water quality conditions because of the lack of water movement in and out of the boatslip. This type of boat slip is no longer permitted in coastal Mississippi. A new type of boatslip is now being constructed along the coast, with the slip parallel to the shoreline and sides angled to allow better water flow through the boatslip.

Often there is a need to protect moored boats from the weather. In these cases boathouses are constructed over the mooring area. In addition to a weather proof roof, many boats are hoisted out of the water for additional protection.

On occasion, individuals and local agencies desire to provide facilities for the berthing of many boats. Marinas usually require extensive planning and professional assistance. However, some guidance for berthing facilities is included in this publication as this guidance can be used for other applications.

Specific Design Recommendations

Small Craft Launching Facilities

This section describes the design of boat launching ramps generally used for public use. Private boat launching ramps will typically be less elaborate.

* Public launching ramp lanes should be 15 feet wide on ramps of two or more lanes. If the launching ramp consists of a single lane it is recommended that the lane be 20 feet wide, and never less than 16 feet wide. One launching lane will handle approximately 50 launchings and 50 retrievals per day.

* Launching ramps should have a minimum slope of 1 (vertical) on 9 (horizontal) and a maximum slope of 1 on 6. The slope should

be kept constant if possible.

* A vertical curve should be incorporated into the head of the ramp to provide a smooth transition between the launching ramp and the parking area, as shown in Figure 10. The vertical curve keeps trailer hitches from striking the launching ramp at a change in grade, and enhances driver's vision while backing. A 15 to 20 foot vertical curve is recommended.

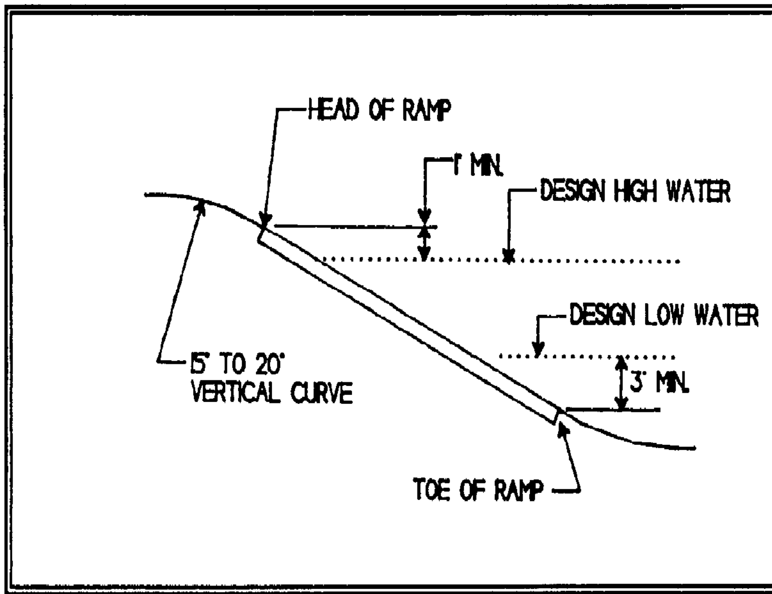

Figure 10, Small Boat Launching Ramp (State of California, 1991)

* Private individual boat launching ramps will typically be narrower (approximately 15 feet or less) and will not extend as deeply into the water (generally no deeper than -3 feet MLW) as described here.

Construction Details:

* Concrete should have a minimum of 3 inches of cover over rebar. Concrete should

be a total of 6 inches thick in fresh water and 8 inches thick in salt water. Minimum steel reinforcement should be #4 bars at 12 inches both ways, or as required by the design engineer.

* Precast concrete planks should be designed to bolt, cable, or key together during installation. Planks should be placed over geotextile fabric to prevent the foundation soil from being washed through the gaps.

* In areas subject to undermining from currents or waves, the ramps must be protected by a 3 to 5 foot perimeter of riprap or other means of protection.

* It is recommended that boat ramps be finished with V-grooves aligned at 60 degrees to the longitudinal axis of the ramp. The grooves should be 1" by 1". This is especially important in salt water where slick marine growth will frequently be present. Spinning tires will quickly wear away the growth on the peaks of the grooves to provide traction.

* Private individual boat ramps not using concrete should use 6 to 8 inches of clean compact shell, limestone or gravel.

Shoreside Facilities:

* Where possible, parking areas should be located immediately adjacent to the launching ramp with all spaces within 600 feet of the ramp.

* Garbage receptacles for marine trash

should be provided as close to the launching ramp as practical.

* A minimum of 20 to 30 car/trailer parking spaces per launching lane should be provided. Pull-through trailer spaces are recommended to the maximum extent possible.

* Car/trailer spaces should be 10' wide by 40' long. Additional car-only spaces should be provided for picnic, day-use and other activities in the vicinity of the launching area.

* One handicap parking space should be provided for every 50 car/trailer spaces and every 40 single car spaces, with a minimum of one handicap parking space. Handicap spaces should be located near the launching ramp and restroom, and should conform to all State and local regulations.

* No overhead power lines should be permitted over parking areas, launching ramp areas, or any other areas where a vehicle can drive while towing a boat trailer within the project area, due to the possibility of trailerable sailboats with metal masts using the facilities.

Environmental Concerns:

* Launching Ramps will not be permitted for construction in marsh areas.

* Care in the placement of launching ramps should be taken to avoid interrupting the natural movement of beach sand. This may lead to the buildup of sand on the updrift side of the ramp and erosion of the beach on the downdrift side of the ramp.

* Boat Launching Ramps should be located in areas where there are no underwater obstructions to interfere with launching or navigation near the facility.

* Stormwater runoff from launch approaches and parking areas should be filtered through sand or vegetated areas and should not be directed down the boat ramp.

Piers

* All public piers shall be handicapped accessible with safety rails and wheelchair guards, and shall be at least 6′ wide.

* Piers used for mooring or docking shall provide a combination of safety rails and wheel chair guards to accommodate handicapped individuals.

* Public piers should be lighted.

* Piers shall not obstruct or create hazards to navigation.

* Piers, including the width of the boat moored at the end, should not extend more than 1/4 of the way across the water body in which they are located. See Figure 11 for typical pier layouts.

* Piling design should be based on local conditions, including water depth and geotechnical conditions. Local knowledge will often be the best guide for small private facilities. Larger facilities will require the services of an engineer and a soils exploration program to determine required pile sizes and embedment depths. See Figure 12 for typical pier sections.

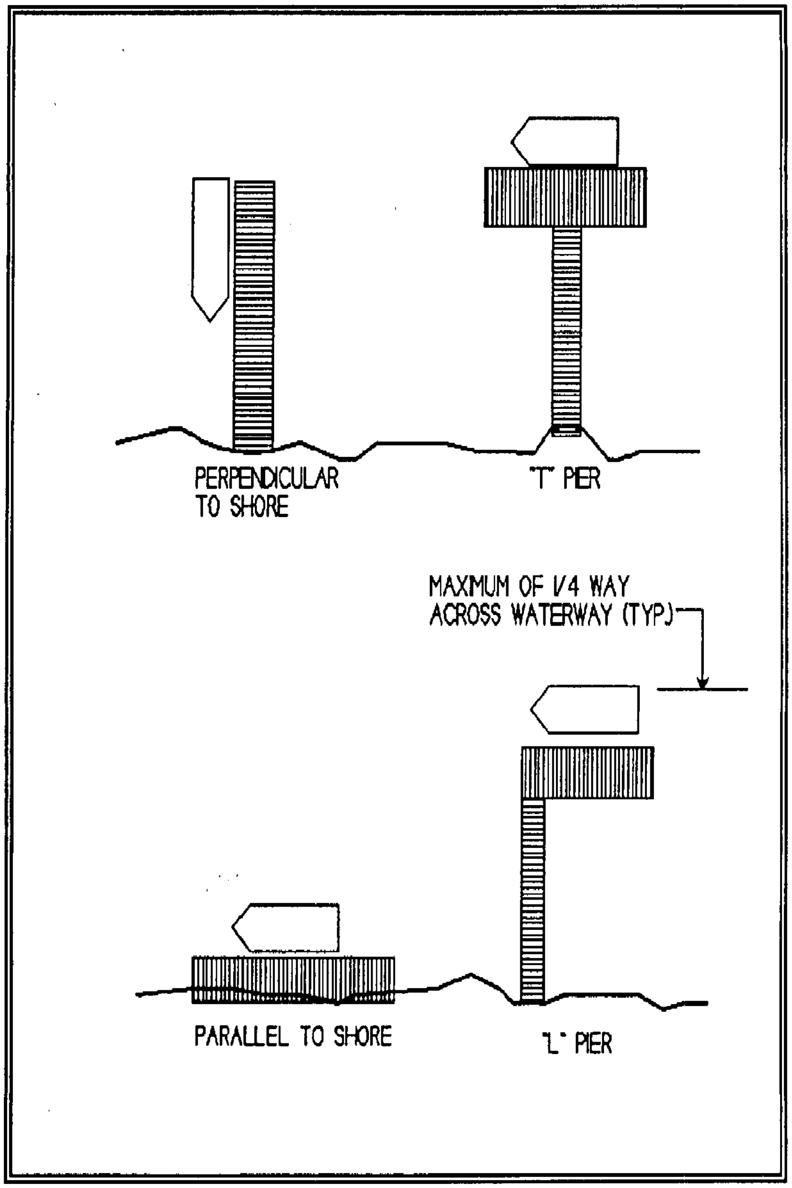

Figure 11, Typical Pier Alignments

* Good foundation conditions and moderate water depths will typically require piles with embedment lengths of 15 to 30 feet with butt diameters ranging from 10 to 12 inches maximum to 6 to 8 inches minimum. Soft foundation soils will require embedment lengths ranging from 25 to 40 feet.

Construction Details:

* All piers should have railing capable of withstanding a horizontal force of twenty pounds per linear foot, applied at the top of the railing. Top rails should be 42" in height and be sloped on a 30 to 40 degree angle to reduce sitting on the top rail.

* Typical wooden deck planks should be 6 or 8 inches wide and be placed with the heart side down. Spacing should not be more the 1/4" between deck planks to facilitate wheelchair use.

* Typical residential piers have pier bents that range from 6' to 10' apart, with 8 to 12 inch wide cross beams, 6 to 10 inch cross bracing, and 8 to 12 inch wide deck joists.

* Public piers with handicapped access should have handrails with the top rail 32 inches above the deck on all sloped pier sections.

Environmental Considerations:

* For piers four feet wide or greater, elevations of the pier deck should be a minimum of 1 foot above vegetated bottoms for every 1 foot of pier width, and provide 1 inch spacing between decking boards to prevent the shading of vegetation. Public piers accessible to the handicapped should provide turn around areas with 1/4 inch spacing at ends of piers or every 100 feet. Minimum turnaround areas shall be 5 feet by 5 feet in dimension.

* Pilings supporting piers should be concrete or chemically treated in accordance

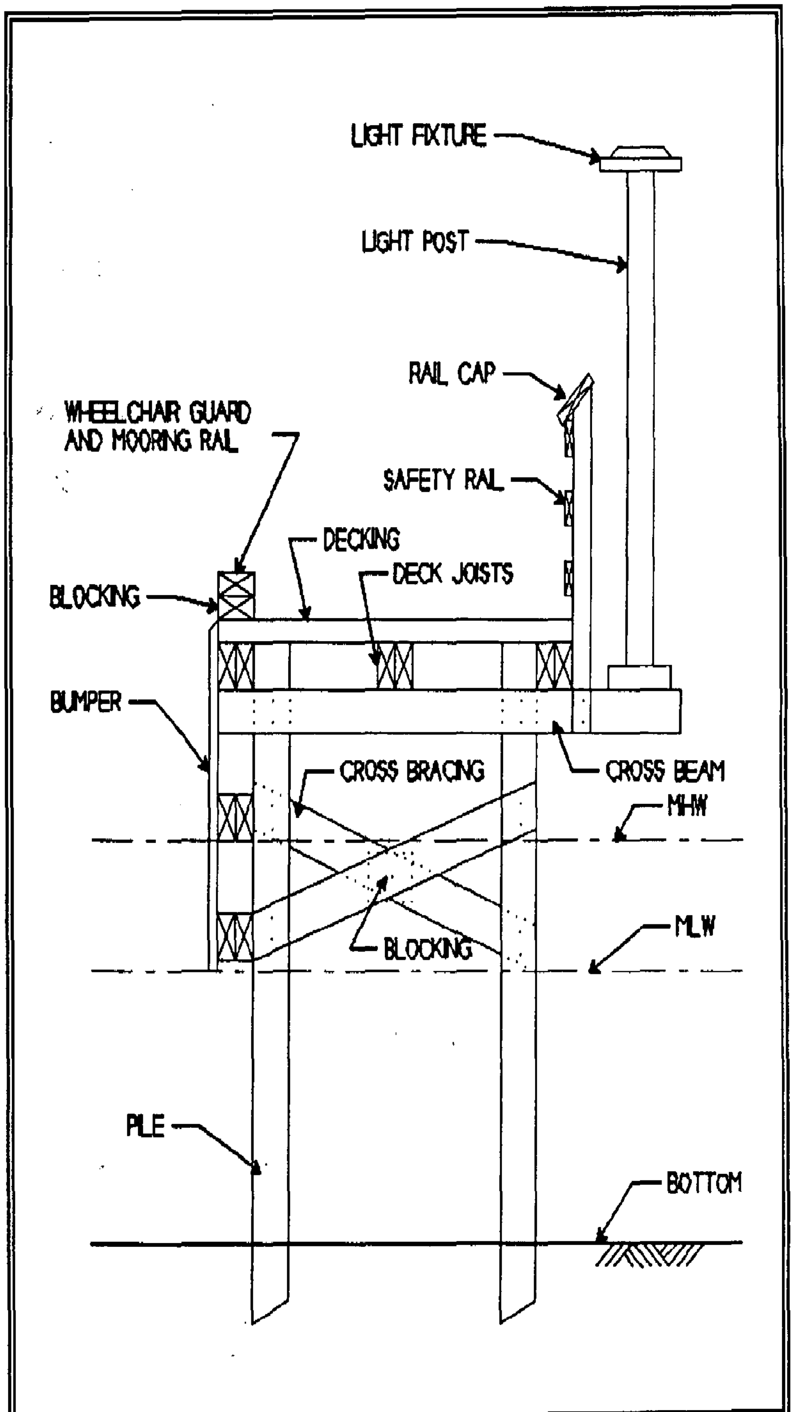

Figure 12, Typical Public Pier Cross-Section with American Wood Preserver's Association recommendations for the environment in which the piling will be placed. Generally, wood should be treated with 2.5 CCA for saltwater and .6 CCA for freshwater.

* The use of creosote treated lumber is discouraged.

Berthing Facilities

Channels and Fairways:

* Entrance Channels should have a minimum width of 75 feet at the design depth or bottom, and a minimum depth of 3 feet below the anticipated deepest draft vessel or 5 feet, which ever is greater.

* Interior Channels should have a minimum width of 75 feet at the design depth, and a minimum depth of 2 feet below the anticipated deepest draft vessel, or 4 feet, which ever is greater.

* Fairways should have a minimum width of 1.75 times the length of the longest berth where berths are perpendicular to the fairway, or a minimum width of 1.5 times the length of the longest boat where boats are berthed parallel to the fairway.

* Fairways should have a minimum depth of 6 feet for boats up to 45 feet in length, 8 feet for boats up to 55 feet in length, and 10 feet for sailboats up to 65 feet in length.

Berths:

* Berths should have the same water depth as fairways.

* It is recommended that berth widths be provided based on expected boat lengths:

Boat Length	Berth Width
20′	10′
24′	12′
28′	13′
32′	14′
36′	15′
40′	16′
50′	17′

* Main walkways should be 6 feet wide. Finger piers should be a minimum of 2.5 feet wide up to 20 feet long, 3.0 feet long up to 35 feet long, 4.0 feet wide up to 60 feet long and 5.0 feet over 60 feet long.

Land Areas:

* A minimum of 0.6 parking spaces per recreational boat berth should be provided. This is in addition to parking needs for other areas such as restaurants, public fishing piers, launching ramps, etc.

* Parking areas should be located such that no parking space is more than 1,000 feet from any berth.

* Approximately 2% of all parking spaces, but not less than one space, shall be reserved for handicap parking.

* Runoff should be controlled through the use of grassed swales, detention ponds, or other filtration methods to protect the

quality of the receiving water.

Services:

* All shoreside utilities should be underground, and should conform to accepted practice and all applicable codes.

* All utility lines shall be installed so they are not exposed on the deck of the structure. For floating piers, utility lines should have not less than 6 inches of clearance above the waterline under dead load conditions, nor less than 2 inches clearance under dead load plus live load conditions.

* All water lines shall be equipped at the shore end with appropriate anti-siphon devices.

* Fire protection shall be provided in sufficient locations to afford protection to all structures and boats in the marina at a rate of not less than 40 gpm at 40 psi. Marina designers should check with local fire officials for other requirements for fire fighting at specific sites.

* It is recommended that circuit breakers equipped with ground fault interrupters be provided at all berth power outlets. GFI's should be tested and maintained at regular intervals to insure that the devices remain in working order, especially in a salt water environment.

* A minimum of one shoreside pumpout installation must be provided at every marina. This facility should be approved by the local authority having jurisdiction over sewage disposal.

Dredged Boat Slips

* Residential boatslips cut into the shore shall have each side cut at 45 degrees or less to the shoreline, as shown in Figure 13. The slip width should be based on the berth widths indicated in the previous section. Boats should generally be moored in the boatslip parallel to the shore.

* The back side of the boatslip shall be equal to or slightly longer than the boat proposed to be moored.

* Boatslips shall not be dredged in or through marsh areas.

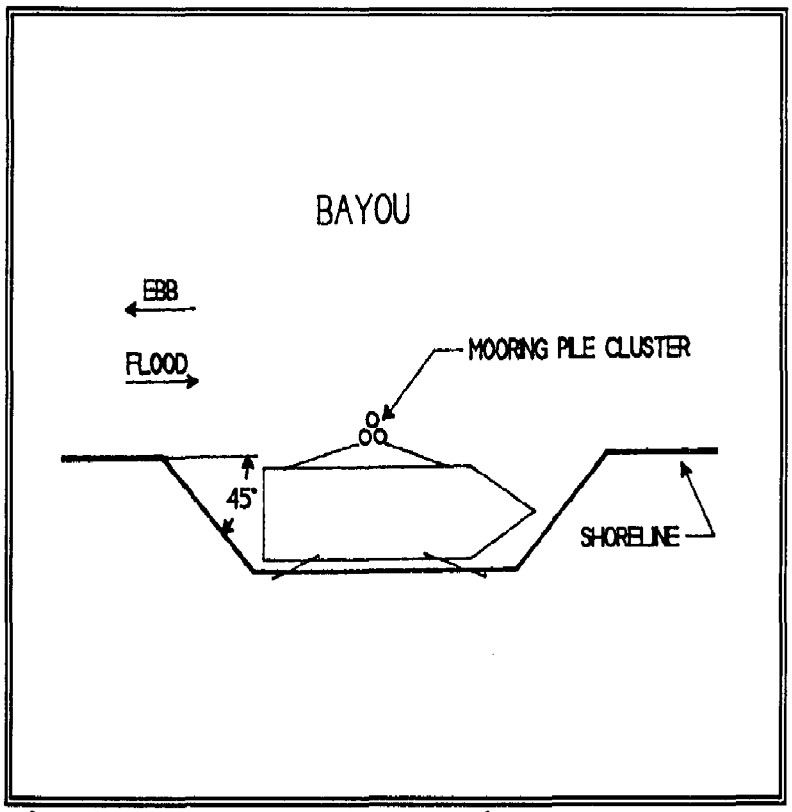

Figure 13, Indented Boatslip

Boat Houses

* Boat houses should be designed to be visually unobtrusive. Completely enclosed structures are discouraged.

* Boat houses constructed seaward of the shoreline should be as near the shoreline as water depths allow.

* Boat houses with motorized boat hoists should have sufficient structural capacity to accommodate the boat to be lifted.

* Electrical service to boat houses should incorporate ground fault interrupters.

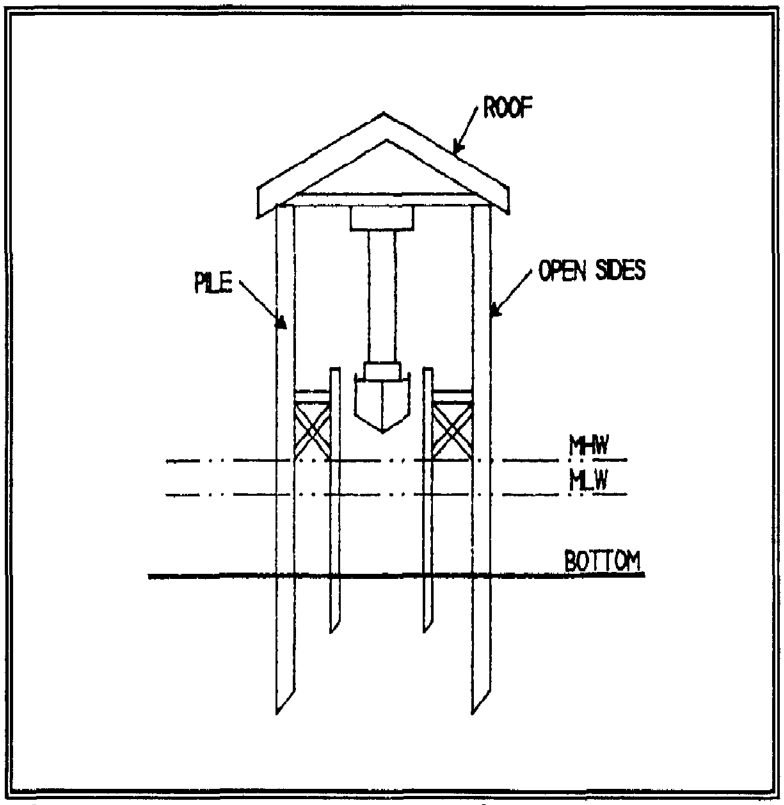

Figure 14, Boat House Section

CONCLUSION

There are a wide range of options available for controlling shoreline erosion and providing access to the shoreline without degrading the natural environment. This pamphlet presents suggestions, and in some cases requirements of the State of Mississippi, which will help provide cost effective measures which have been proven to have the least impact on our shorelines.

Individuals planning on constructing shoreline erosion control or shorefront access facilities are urged to contact the State of Mississippi Department of Wildlife, Fisheries and Parks for guidance before beginning construction. Engineers and contractors with local experience can also be of help in planning a project, obtaining required permits, and insuring that the project is properly built.

By taking proper care in planning and constructing shoreline structures, we can enjoy our natural resources while preserving the environment for future generations.

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