PART V: DESIGN CONSIDERATIONS FOR FISHERIES AND WILDLIFE

Routine Considerations

24. This section describes economical environmental considerations that can be routinely implemented to benefit fisheries and wildlife. Individually, borrow sites often pose constraints which limit options of the engineer, environmental planner, and contractor. After limitations to design and excavation have been identified (Part II) and site-specific data (paragraphs 22-23) suggest that routine considerations for fish and wildlife are warranted, users may follow the guidance outlined in this section to make minor changes in borrow pit design to improve fish and wildlife resources.

Basin Morphometry

25. Depth. Whenever suitable depths of borrow materials and ground water permit, sites should be excavated to a depth adequate to permit the formation of a permanent pool of water. At a minimum, borrow pits must exceed 4-foot maximum depth and 2-foot mean depth to retain some water during dry periods. Mean depth is obtained by dividing the volume of the borrow pit by the surface area of the pit. Maximum depths of 7 to 10 feet are recommended, as they are optimal for fish and fishing and overlap the optima for wildlife (4 to 10 feet). Ideally, mean depth should exceed 3 feet.

26. Basin and shoreline shapes. Shoreline slopes should be variable but with slopes of from 3 to 4H:1V on the leveeward and riverward sides of the pit. Steep slopes at these locations increase basin concavity, which will provide a substantial area of water during dry periods and increase the productivity of benthic invertebrates and fish. A slope of 4:1 is gradual enough for wildlife and livestock to traverse and can be safely mowed, if necessary. Upstream and downstream ends of pits and traverses should have slopes of about 10:1 to provide ample shallow area for bass, bluegill, and other sunfishes to spawn and for wading birds and shoreline birds to feed. The bottom slope should be about 25:1, beginning at a depth of 3 feet

along the levee side and tapering to the maximum attainable depth near the riverward side (Figure 2).

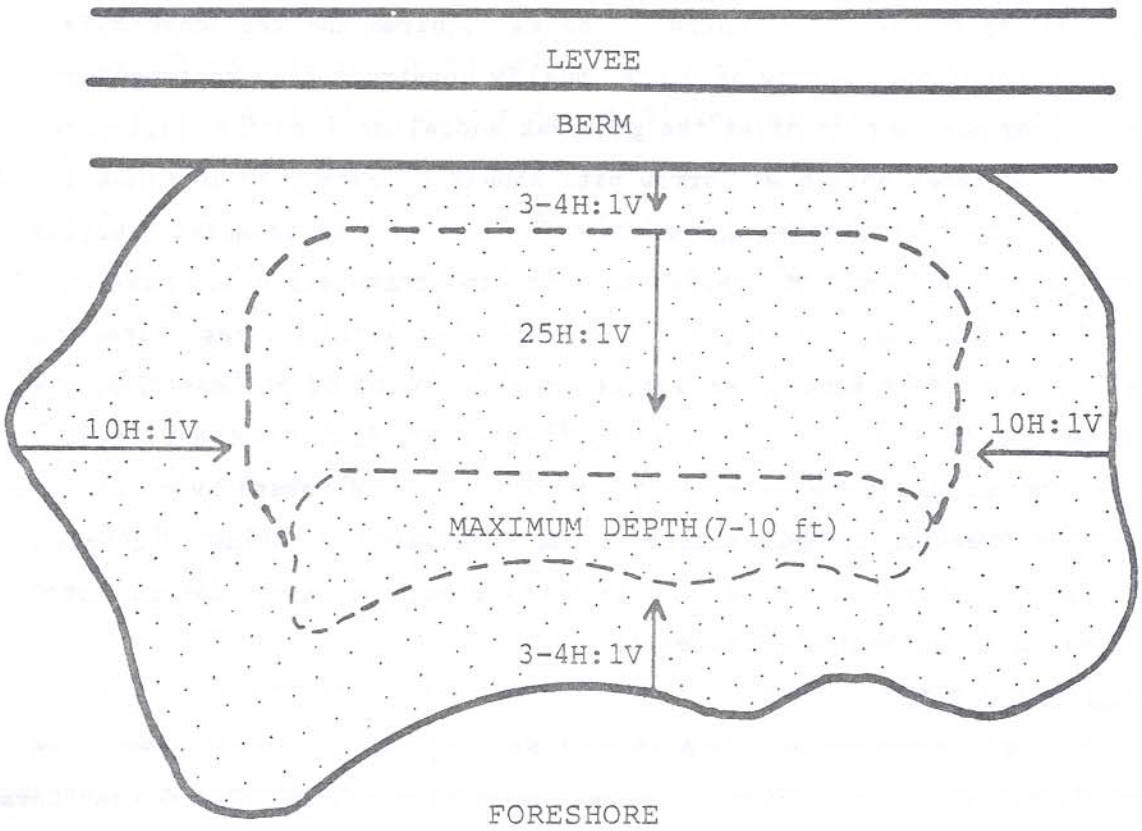

Figure 2. Diagram of a borrow pit, indicating optimal side and bottom slopes and maximum depth

27. Wildlife considerations should be emphasized at shallow borrow pits with maximum depths ≤ 3 feet. The basin shape should be similar to that proposed for deep borrow pits (see Figure 2), with side slopes of 4:1 along the levee and river sides but 20:1 along the ends of the pit and upstream and downstream from traverses. The goal is to increase habitat for shorebirds and wading birds. The bottom slope should be 25:1, beginning at a depth of 1.5 feet along the levee side and sloping toward the river side.

28. Design features that increase the length of shoreline relative to surface area (shoreline development index, SDI) benefit fisheries and wildlife by increasing the amount of nearshore area. Ultimately, borrow pit size will be set by the amount of borrow material required and the acceptable depth of excavation. Borrow pits are usually constructed in rectangular shapes. Long narrow pits offer the greatest shoreline length relative to surface area. When possible, borrow pits should be made 5 to 10 times longer than wide, with traverses at appropriate intervals. For example, a borrow pit 100 yards wide and 1,000 yards long with two traverses would have an SDI of 2.3, a desirable level, and a surface area of 20.6 acres. Otherwise, shorelines should be made irregular to provide an SDI of at least 2.0, the median SDI of 25 borrow pits studied by Cobb et al. (1984) and Buglewicz (1985). The aesthetic value of a borrow pit can be increased by rounding its corners and creating irregularities in the riverward shoreline (Figure 2). These irregularities should be curved gently enough to be easily excavated with available earthmoving equipment.

Cover and Structure

29. Excavation of borrow pits is disruptive to wildlife inasmuch as clearing, grubbing, and stripping remove vegetative cover. The US Army Corps of Engineers (1978) recommends minimizing impacts of construction activities on vegetation. For example, leaving existing woody and brushy vegetation in areas of shallow or poor-quality borrow material provides edge and cover that increase fish, wildlife, and aesthetic values.

30. Whenever possible, trees should be left standing along the foreshore margin and ends of a borrow pit. Natural revegetation of small herbaceous plants and shrubs occurs within 1 or 2 years. However, trees require many years to attain a size large enough to provide cover or shade and nesting, roosting, or denning sites for wildlife. Mature trees left standing along the riverward margin of the borrow pit increase habitat diversity and suitability at minimal project cost. Tall trees and mast-, berry-, or fruit-producing species should be selectively retained because of their special value for wildlife. Trees with cavities are particularly important as they

may furnish den or nest sites. Where they exist, two or three cavity trees or dead snags per acre should be retained in locations where they will not impede excavation.

31. Seeding of ground cover immediately after construction will minimize erosion and provide habitat for wildlife. Natural revegetation is rapid, but seeding mixtures of plant species with high food and cover value increases wildlife use of postconstruction plant communities (see Yoakum et al., 1980). Herbs that produce seed in a single growing season should be established as a part of normal construction activities. Flooding is a primary determinant of plant community composition, and species of plants to be seeded should be selected on the basis of their adaptability to site-specific conditions. Fredrickson and Taylor (1982) provide guidance on selecting plants based on anticipated flooding regimes of the Lower Mississippi River.

32. Most new borrow pits have relatively shallow, smooth basins that afford only limited cover or structure for fish or wildlife. Irregularities in shoreline provide some cover and structure. Islands or peninsulas formed when shallow or undesirable fill materials are encountered also are of value to fish and wildlife. These areas should not be disturbed during borrow pit excavation.

33. Brush provides an efficient way of concentrating fish and providing cover for wildlife. For fish, some trees or root balls could be saved during excavation and pushed into the deeper part of pits to provide cover. Deeper pits ($\geq$7 feet deep) are best suited for fish attractors. These may need to be anchored in areas where flood flows could float them out of the pit. Brush shelters should not exceed 0.1 percent of the borrow pit area, and brush piles could be left on nonaccess margins of pits to provide cover for wildlife. Brush piles for wildlife can be circular (15 to 25 feet in diameter) or rectangular (25 to 50 feet long by 10 to 15 feet wide). They should be placed at a density of not more than one structure per 2.5 acres. The structures should not impair access and should be constructed only in relatively open areas.

Complex Considerations

34. Complex design considerations are intended to substantially improve fish, wildlife, and recreational resources but at additional cost of levee construction. Complex design considerations that are marginally feasible or highly site-specific will be mentioned briefly with accompanying references, whereas considerations that may have broader application will be discussed in more detail.

Basin Morphometry

35. Borrow pit basin morphometry can be modified to benefit fish and wildlife more extensively than the routine considerations outlined earlier. Shaping shorelines and modifying bottom topography have more potential than do modifying basin slopes or water depth. Side and bottom slopes outlined earlier (paragraphs 26 and 27) cannot be improved upon and are also recommended as complex design considerations. Except for environmental management strategies for long sections of levees and island construction, routine guidance on depth (paragraph 25) also is recommended for complex designs.

36. In general, borrow pits with large surface areas are better for fish (>10 acres), fishing (>10 to 25 acres), and wildlife (>30 acres) than those with surface areas <10 acres, if water depths are adequate. In some cases, however, limited depths of suitable borrow materials will result in excavation of large shallow borrow pits. Excavation of wide, shallow pits and associated longer haul distances for borrow material and potential increased right-of-way needs are often required to improve control of underseepage, hydraulic performance, and environmental conditions under certain foundation conditions (US Army Corps of Engineers, 1978).

37. Depth. In areas where long reaches of the main-line levees are being raised or modified, special efforts should be made to excavate at least one deep borrow pit that will have a permanent pool (see paragraph 25) for every mile of levee, especially where construction results in most pits being shallow (≤3 feet deep) due to engineering constraints. Permanent pools in borrow pits are most valuable in areas where permanent standing water is

limited. A single perennial borrow pit pool in a 1-mile section of levee will have value for most wildlife. Although costs of special efforts to obtain a single permanent pool may be high, the benefits to wildlife can be ascribed to a much larger area than the pit itself. When depths are not limited by geological features, all pits should be excavated to depths of 7 to 10 feet (the optimum range) or deeper (see paragraph 25).

38. Basin and shoreline shapes. Borrow pits with irregular shorelines tend to be of more value for recreation, fisheries, and wildlife than rectangular pits. Extremely convoluted shorelines will not necessarily increase the aquatic productivity (see Appendix A, paragraph 48) and may be detrimental in areas subjected to strong flow during floods because of the resulting erosion. Highly irregular shorelines may substantially increase excavation costs if curvatures require special maneuvers of equipment. Aesthetically, gently curving shorelines can make a typical borrow pit seem more like a pond or lake than a remnant of excavation. Fisheries benefit from an irregular shoreline (SDI = 2.0-3.4) because it improves aesthetic qualities and permits anglers to fish more of the borrow pit surface area from shore. However, it is recognized that much borrow pit fishing is from boats and that efforts to increase shoreline relative length for this purpose may not be justifiable in all instances. Wildlife benefits arise primarily from the diversity of habitat (edge) that can be created by an irregular shoreline. Edge results from the border between two different habitats (Yoakum et al., 1980), and benefits are derived from edge formed when water, land, forest, shrubs, open fields, or levees border one another.

39. The most efficient method of increasing shoreline irregularity for fisheries and wildlife, without jeopardizing shore stability, is to round otherwise square corners of pits during excavation and design peninsulas or islands (Figures 3 and 4). Traditional traverses are valuable because they are similar to peninsulas and provide visual isolation between pool segments when water levels are low. They also facilitate movement of anglers, landowners, and wildlife across long borrow pits. A single large peninsula with a bifurcate point may increase (a) the amount of shoreline of a borrow pit

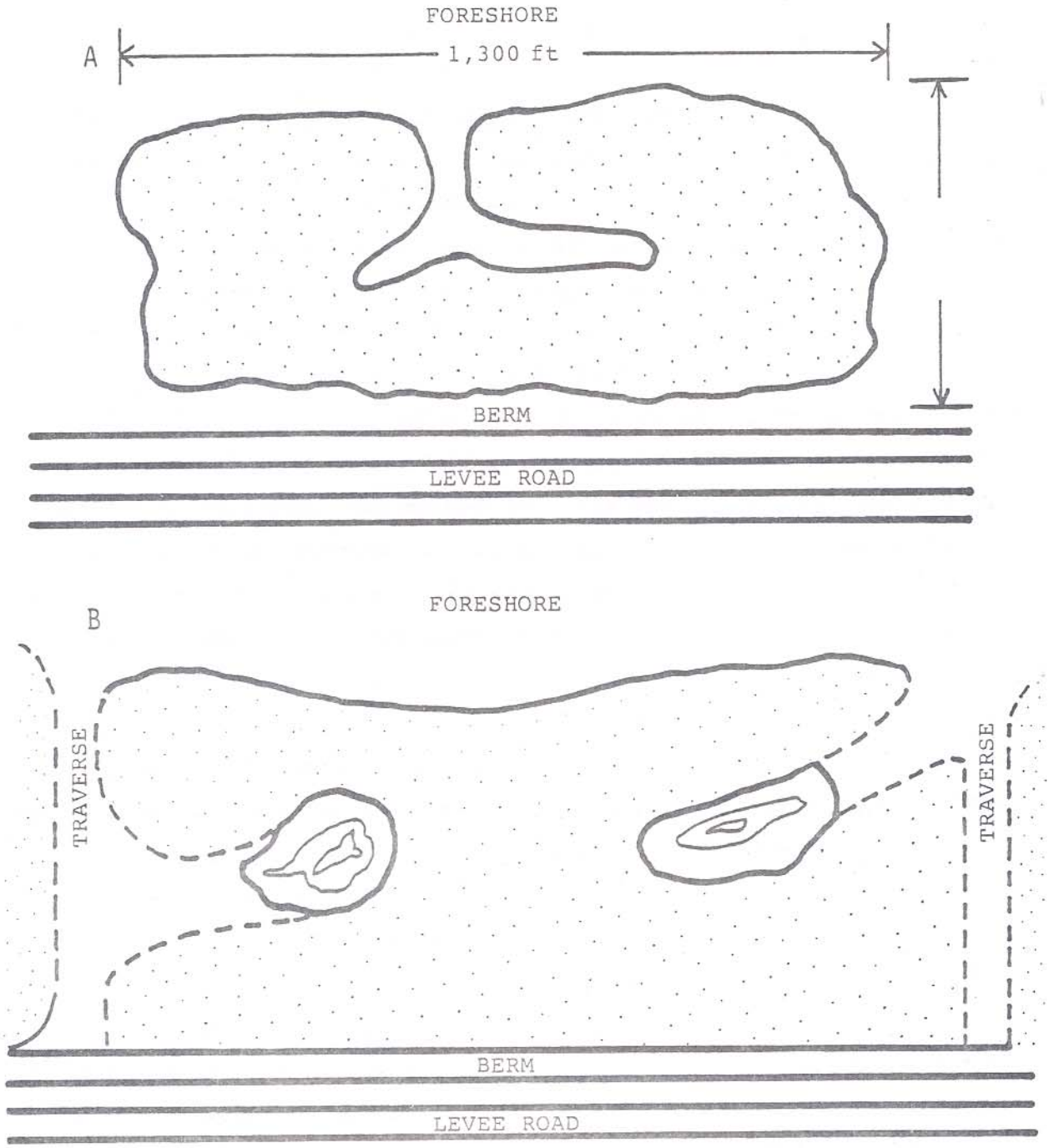

Figure 3. Plan view A illustrates a single forked peninsula that increases shoreline length by about 30 percent. Plan view B illustrates two peninsulas with elevated points that originate from traverses. This design results in peninsulas at normal water levels and islands when water levels are high. It should partially deflect floodwaters away from the levee.

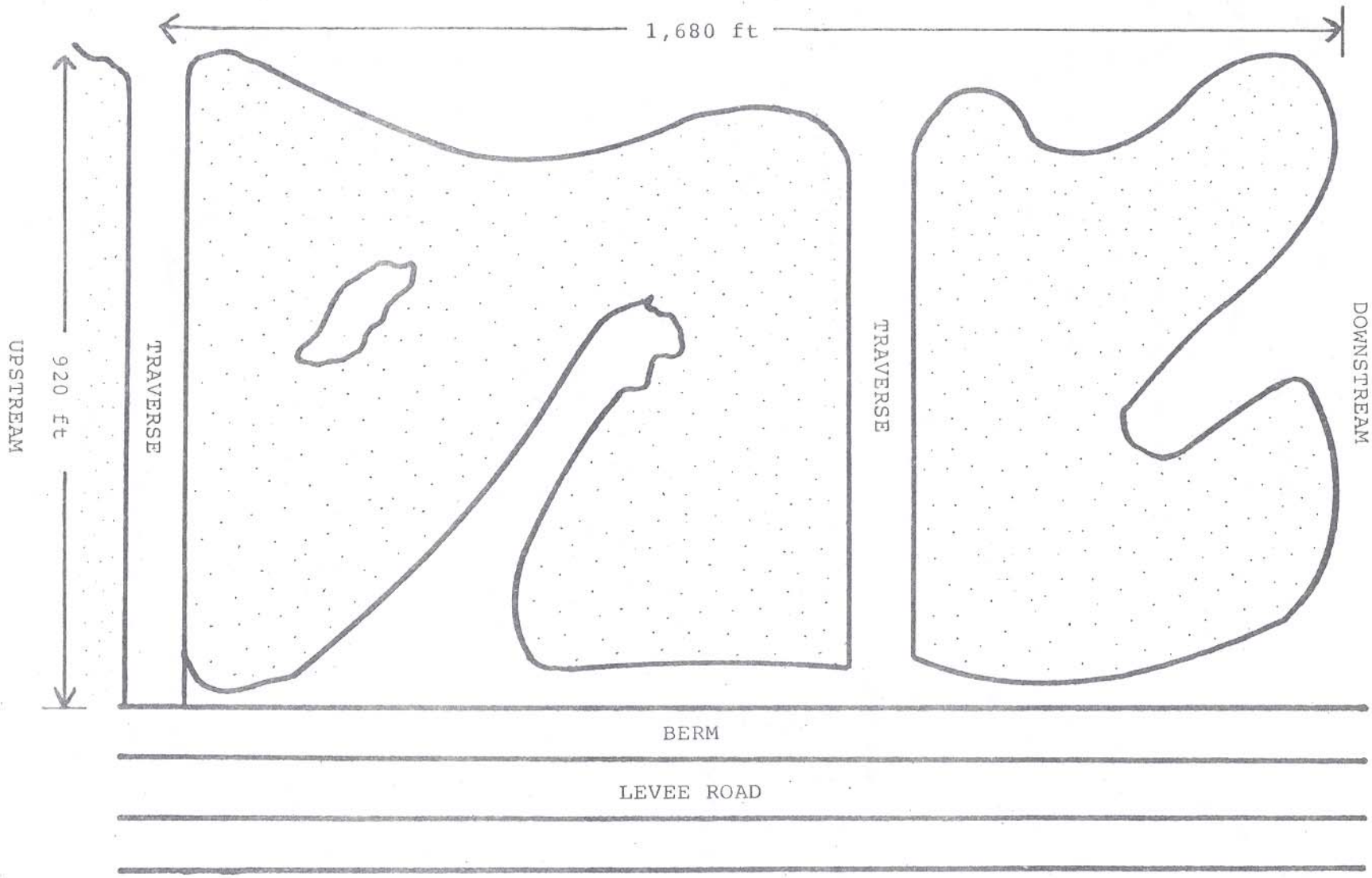

Figure 4. Orientation of islands and peninsulas to limit deflection of floodwaters into the levee and impediments to hauling borrow material to the levee during construction

by 30 percent (Figure 3A), (b) the visual segregation of parts of the pit, and (c) the ability of anglers to fish more surface area from shore. With the peninsula facing the levee side of a pit, hauling of borrow materials to the levee would not be greatly impeded.

40. Peninsulas and islands in pits located near the river where floodwaters may develop measurable flow should be oriented to deflect flowing water away from the levee (Figures 3B and 4). Less caution is needed in borrow pits 0.5 mile or more from the river, especially those with a forest buffer between them and the river. Peninsulas and islands oriented to deflect flows away from levees (Figure 4) should not impede efforts to haul borrow materials to the levee as much as peninsulas or islands oriented parallel to the levee.

41. To be stable, peninsulas and islands should have side slopes of about 4:1 and a width of at least 30 feet when the borrow pit basin is full of water. Their surfaces should be raised 2 feet above the bank-full elevation to ensure that they will not be submerged when pits are full of water. Side slopes of 4:1 will allow fishermen to fish from edges and provide wildlife with easy access to and from the water. With a width of 30 feet, these features should withstand annual flooding and afford ample room for anglers or wildlife. A peninsula originating from a traverse need only be raised above the elevation of the traverse at its point (Figure 3B). During construction, excavation equipment can move over the neck of such peninsulas to haul materials to the levee. When flooded, peninsulas originating from traverses will form islands; they will be continuous with the traverse when water levels are low. Islands and peninsulas are not expensive to construct (see Appendix A, paragraph 38); however, more rights-of-way may be required to make up for the borrow material that must be left in the pit to form these features. They have high value for aesthetics, fisheries, and wildlife and are recommended for all borrow pits, including those warranting only routine considerations, when they are at least 7 feet deep.

Cover and Structure

42. Planting and seeding. Vegetative ground cover should be established immediately following construction to control erosion. Seeding also improves habitat for wildlife and enhances aesthetic values. Natural revegetation will usually occur rapidly; however, the quality of vegetative cover at construction sites is improved for wildlife when mixtures of herbs, grasses, shrubs, and hardwoods are planted. Plantings of trees may be desired to increase visual isolation and aesthetics in areas surrounding borrow pits. Routine revegetation of areas subject to erosion can benefit wildlife at little increase in project cost if mixtures of grasses and herbaceous plants of high food value are seeded.

43. Survival of plants selected for seeding is enhanced when they are well adapted to the annual flooding cycle at a specific site. Therefore, planting recommendations should be made by a wildlife planning specialist with consideration of soils, duration of flooding, vegetative communities in the surrounding area, anticipated land use, and physical characteristics of the borrow site.

44. Shelters. Borrow pits with maximum depths ≥ 7 feet are most suitable for the addition of brush or artificial shelters to attract sport fish. These shelters can be made from natural or artificial materials cabled together and anchored to withstand flood flows. They represent a one-time project investment and should be installed after excavation is complete.

45. Shelters can be fabricated from a variety of materials, but brush and hardwood logs are easiest and least expensive to obtain. Brush or logs can often be obtained during clearing activities. These can be stacked, cabled, and anchored at selected locations to provide artificial shelters. Cabling may be necessary to prevent woody materials that dry out during drought from floating away when the area floods. Logs can also be tied together to form a variety of configurations, then weighted and anchored in designated locations. A large pole driven into the pit bottom with brush or tires attached around its base forms a permanent structure.

46. A relatively small area of shelter (about 0.1 percent of the pit area) will attract sport fish and improve fishing. This represents one structure 20 feet long, 10 feet wide, and 3 to 4 feet high for each 5 surface acres of water. Shelters should be placed in deep water near the river side of the pit so that they remain submerged during periods of low water. They should be identified with a pole driven into the bottom at the site, as described in the previous paragraph. The pole would also provide a tie-up for anglers in small boats.

47. Shelters should last many years with proper selection of materials. Hardwoods such as oak will decay more slowly than softer woods such as black willow or sycamore. Selection of larger diameter wood also results in a slower rate of decomposition. Woody materials that are permanently covered with water last much longer than those exposed to the air every year.

48. The cost of constructing brush shelters can vary significantly, depending on the type of material used and the size and location of the structure. By using woody materials obtained at the construction site, costs would arise primarily from the labor and materials required to anchor the structures. Some labor would be required to dispose of cleared vegetation if it were not used to construct brush shelters.

49. Wildlife brush shelters provide protection for a variety of small game and nongame species. However, they appear to have only limited application for borrow areas. Brush piles constructed for wildlife should be placed on the river side of borrow pits. If these areas will be exposed to high-velocity flows during flooding, shelters should be securely anchored and cabled. Their use should be restricted to areas where natural cover is limited. These structures should be of the size and density recommended in paragraph 33.

50. Vegetative cover for islands should consist of a multilayered canopy of trees, shrubs, and seed-producing plants or ground cover, because islands are well suited as habitat for nongame birds. They also are valuable for animals such as beavers and turtles. Where islands are constructed, ground cover should be established by seeding mixtures of grasses, forbs,

and shrubs. Trees with high potential wildlife value should be planted at a density of one tree per 100 square feet to augment natural seeding and accelerate the development of a tree canopy by several years. Planting should take place as soon as construction has been completed.

Recreation Development

51. Development of recreation facilities at selected levee borrow pits is a possibility along the Lower Mississippi River. Construction of recreation facilities such as boat ramps would have to be cost-shared by the local project sponsor, who would also have to acquire fee title to needed lands. Recommended recreation facilities would have to be justified and the cost-sharing agreement approved under Federal rules and regulations for such projects. Given these constraints, therefore, development of recreation facilities at levee borrow pits would be rare.

Landside Borrow Pits

52. Opportunities for managing borrow pits to improve fish and wildlife resources are sometimes better for pits on the land side than on the river side of levees because riverine flooding does occur. One major problem with landside borrow pits, however, is the influx of poor-quality water, especially in agricultural areas. Management possibilities for fisheries include eradication of undesirable species, stocking of desirable species, and water-level manipulation. Possibilities for wildlife include creating artificial marshes that can be flooded at appropriate times to attract waterfowl or shore, water, or wading birds. In addition, prevention of annual flooding can benefit populations of small ground-dwelling mammals and the nesting success of perching birds (Fredrickson, 1979; EL, 1985).

Water-Control Structures

53. Water-control structures could improve riverside borrow pit habitat for fish and wildlife by maintaining water levels during low-flow dry periods of the year. However, these structures are impractical for most sites, as few borrow pits have a dependable source of ground water or a watershed of sufficient size to maintain water levels through summer and fall or to refill a pit if it were drained for management purposes during these

seasons (Hynson et al., 1985). A dependable water source (watershed or ground water) that exceeds expected losses to evaporation and seepage is needed.

54. Unless water can be pumped from a nearby source and water levels manipulated (a common practice on wildlife refuges, see Fredrickson and Taylor, 1982), water-control structures should be considered only for borrow pits with 3 to 5 acres of watershed for every acre-foot of water capacity (Soil Conservation Service, 1971, 1973). For example, a 20-acre borrow pit with a mean depth of 4 feet (volume = ca. 80 acre-feet) should have a watershed of from 240 to 400 acres. Sites suitable for water-control structures will be few, but they might be found in a broad drainageway or at a low point in a natural depression. A site survey would be required to assess the size of the watershed relative to the volume of a proposed borrow pit. If a proposed borrow pit has a sufficient watershed and elevational gradient for drainage or a dependable ground-water source, as well as the potential for water-level management, several useful references for further information include the Soil Conservation Service (1971), Atlantic Waterfowl Council (1972), Yoakum et al. (1980), and Hynson et al. (1985).