APPENDIX F

CIVIL DESIGN

AND

GEOTECHNICAL

APPENDIX F

CIVIL DESIGN / GEOTECHNICAL

Civil Design

Nature Trails

A proposed nature trail from downtown Jefferson along the top of the existing Corps levee east of downtown was evaluated. It was determined that the best course of action was to use volunteer labor to construct a primitive trail along the top of the levee.

A proposed nature trail from downtown Jefferson to the Powder Magazine was evaluated. Due to the lack of survey data a rough estimate yielding a 1900 ft trail was considered. The trail would begin at Highway 59, southeast of the bayou and continue to the Powder magazine. The trail would be primitive consisting for the most part of cutting a cleared path through existing conditions.

Reconstruction of Breaches

Five breaches exist along the old Corps levee. The first breach starting on the south side of Highway 59 was to allow for passage of the highway and the railroad over the bayou. The second breach allows access to the city=s raw water intake structure. The third breach accommodates the tourist railroad station and rail line. The fourth breach allows access to the city dumping ground. The fifth breach allows for a crossing of the tourist rail line. Since the original intent of each breach must be left intact, it was determined that the breaches would not be structurally rebuilt with earth. Alternatives to include the use of stop-log structures and floodgates were considered.

Due to the high costs inherent with highway and railroad relocations, it was determined that no action be taken at the first breach which includes the highway and railroad crossings.
Stop-log structures 5 ft high by 20 ft wide are proposed at the second, third and fifth breach. In addition the third breach will include a partial earthen rebuild of the levee behind the train station to accommodate the stop-log structure. Each stop-log structure will require a 4,000 lb capacity jib crane. A floodgate 10 ft high by 46 ft wide is proposed at the fourth breach.

Erosion Control of Streambank Containing Powder Magazine

Over a period of time the streambank beneath the Jefferson Powder Magazine has eroded to the point of risking the loss of the structure. To preserve the history of the structure, the means of streambank protection that was considered as a solution was the use of crib walls. These walls are constructed from a variety of structural members stacked to form a series of interconnected boxes or cribs. These cribs are then filled with stone and compacted to form a gravity retaining structure. In keeping with the historical appeal of the structure, the structural members would consist of a treated timber framework lined with a wire mesh to contain filler stone. The cribs gain added stability by driving the corner posts down into the riverbed materials. The crib wall used in this particular case is approximately 245 ft in length with 18 ft sides, 9 ft high and 6 ft deep (See attached sketch). Approximately 1,100 CY of backfill will be required behind the wall.

Cost Estimates (See MCASES Estimate)

Nature Trails:

Primitive Trail: $0 (to be constructed with volunteer labor)
Powder Magazine: $1245.00

Stop-Log Structures:

20' Stoplog @ Raw Water Intake: $21,430
20' Stoplog @ Tourist Rail Crossing: $28,118
20' Stoplog @ Train Station: $36,497

Floodgate:

46 ft wide floodgate @ Dumping Grounds: $98,562

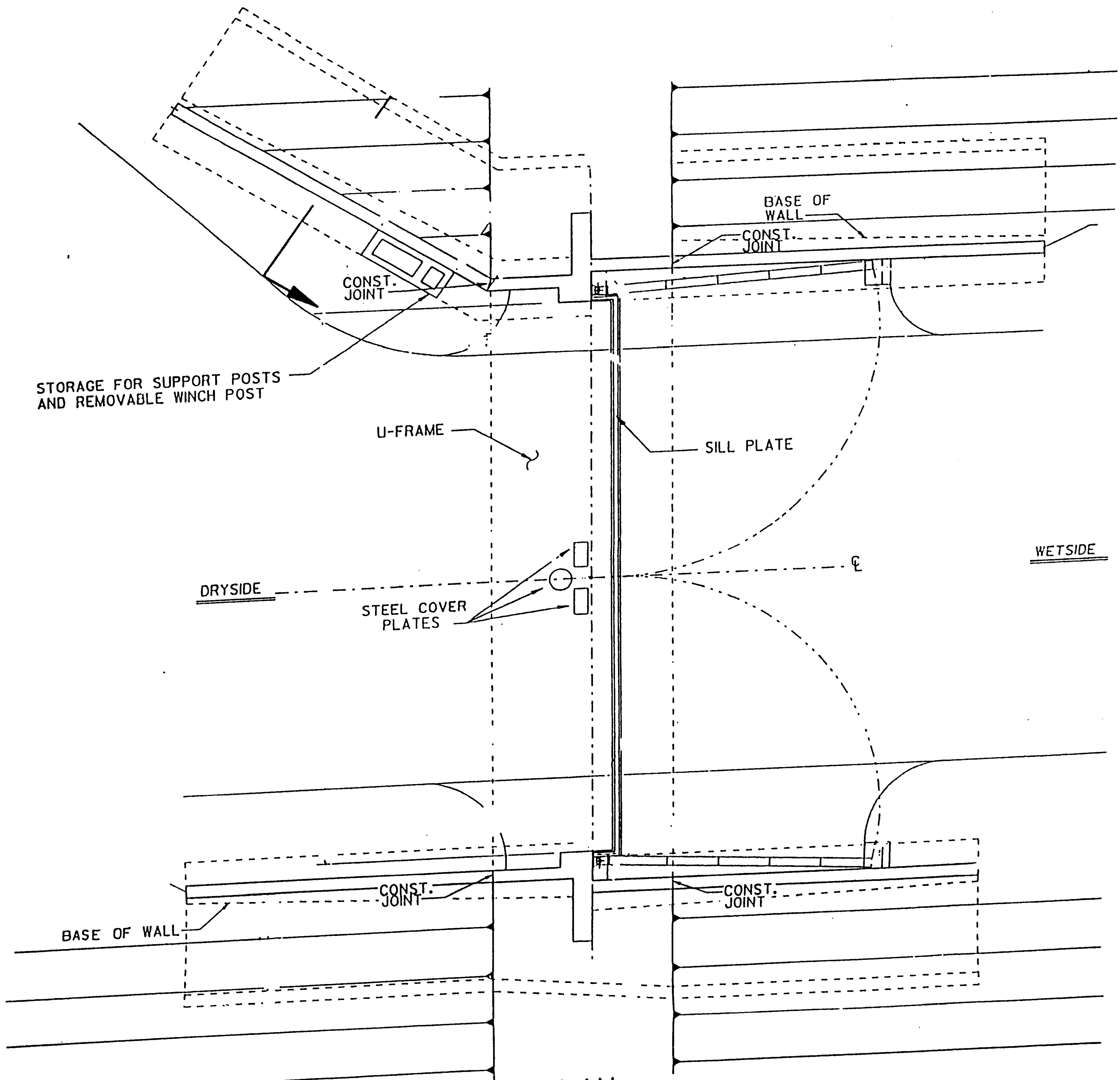
Rock Cribs: $55,441
+ 5,060 (backfill not shown on MCACES)
$60,501

Geotechnical

Problem: Bank erosion on the east bank of the Cypress River threatens the Powder Magazine building, a one-story small brick building of historical significance. River is attempting to meander in that direction, causing a near-vertical 7-foot high escarpment to be formed approximately 30 feet from the building.

Discussion: The public travels on the river, and the erosion solution ideally would blend in and not be too noticeable. Soil material present on the bank ranges from a clay (CL) to a clayey sand (SC).

Solution: Proposed solution is presented in Figure 6. Twelvefoot high gravity retaining wall consists of stacked horizontal sections of 8-inch geocell filled with either compacted soil or gravel. Geogrid is present between every other geocell section, extending back into the embankment. The retaining wall rests on a gravel base that extends out into the channel and back into the embankment. The gravel is wrapped with a woven geotextile. The outer one foot of each geocell section is filled with gravel, with compacted backfill (clay) used to fill the remainder of the section. Vegetation is planted in each of the exposed geocell sections. Topsoil may need to be placed on the extreme outer surface of the wall to aid in the growth of the vegetation. Wall is approximately 100 feet long and has riprap placed on the upstream edge.



PLAN
SCALE : 1/8" = 1'-0"

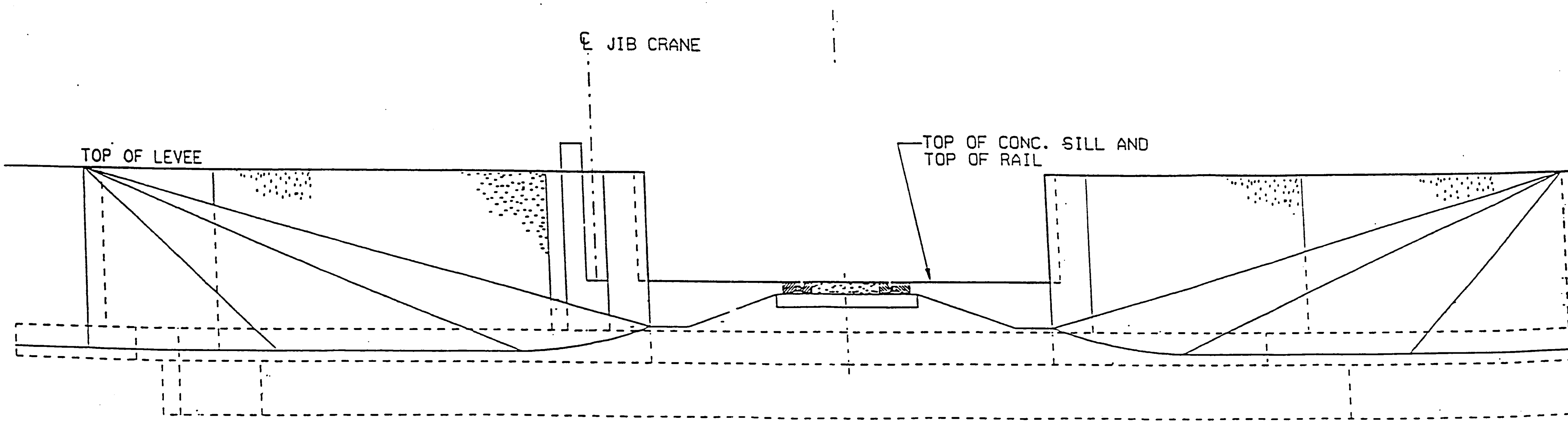
FLOODGATE

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

CYPRESS VALLEY WATERSHED
TEXAS

FLOODGATE PLAN VIEW

FIGURE 2



ELEVATION

SCALE : 3/16" = 1'-0"

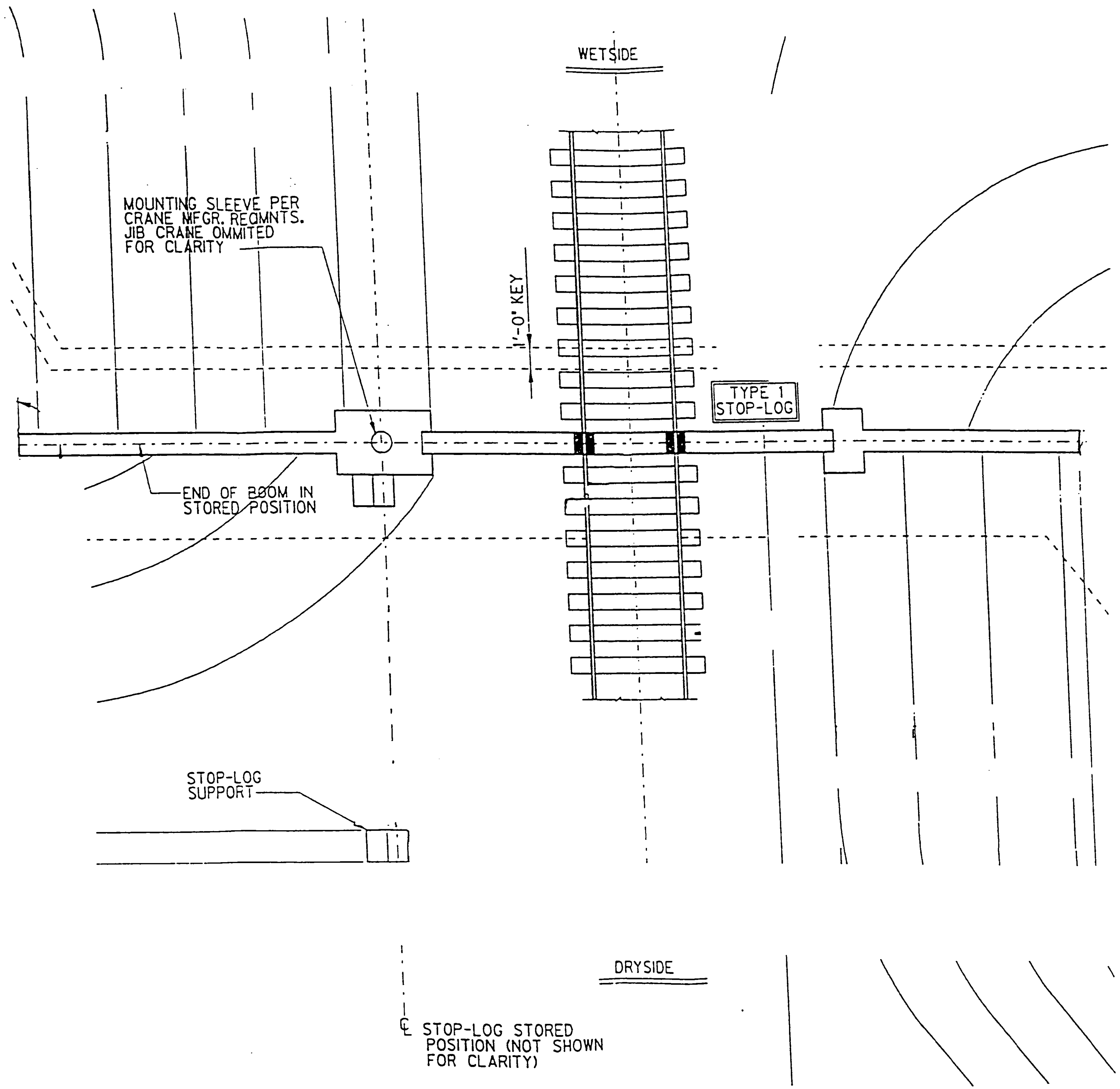
STOP- LOG STRUCTURE

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

CYPRESS VALLEY WATERSHED
TEXAS

STOP-LOG STRUCTURE ELEVATION

FIGURE 3



PLAN

SCALE : 3/16" = 1'-0"

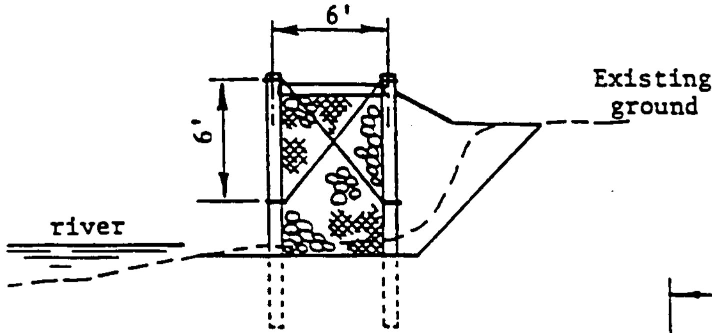
STOP-LOG STRUCTURE

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

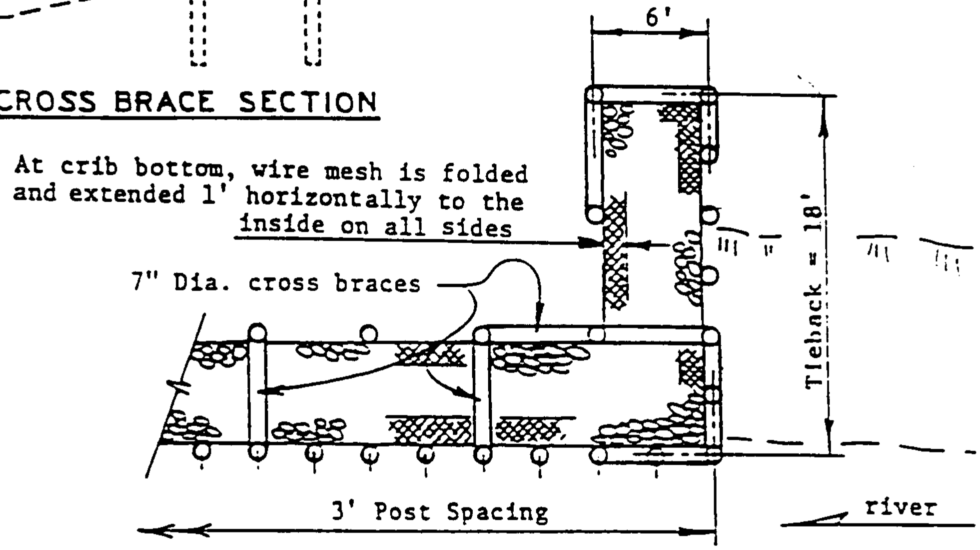
CYPRESS VALLEY WATERSHED
TEXAS

STOP-LOG STRUCTURE PLAN

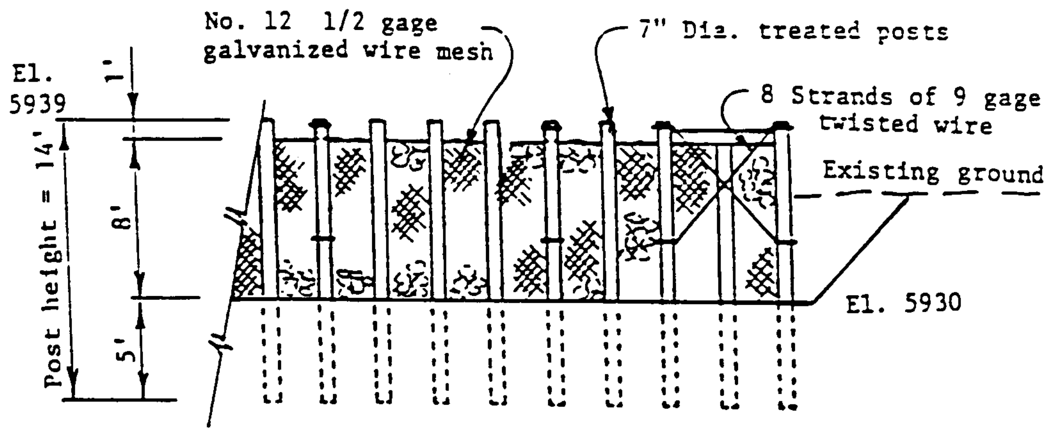
FIGURE 4



CROSS BRACE SECTION



PLAN



RIVER FACE ELEVATION

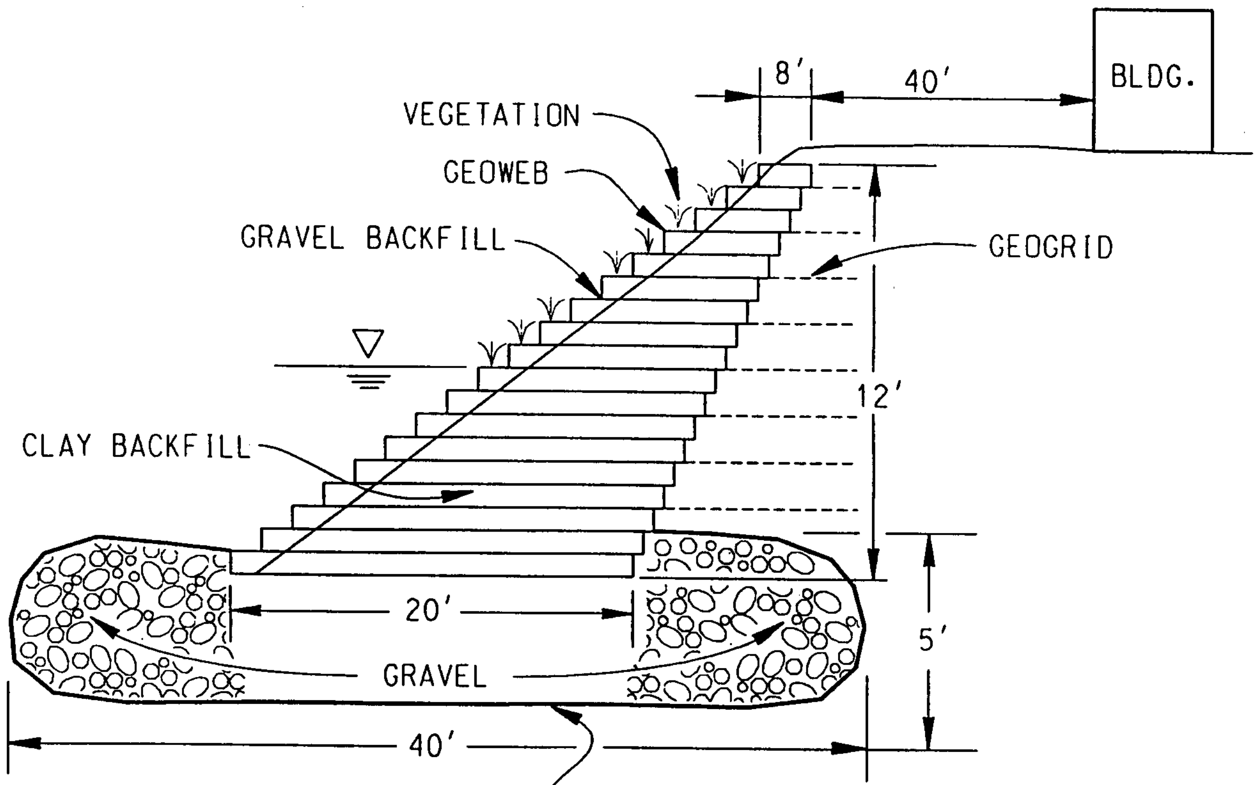
CRIB WALL

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

CYPRESS VALLEY WATERSHED
TEXAS

CRIB WALL STRUCTURE

Figure 5



NOTE: WALL IS 100' IN LENGTH.

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

CYPRESS VALLEY WATERSHED
TEXAS

STREAMANK EROSION
BIO-ENGINEERING SOLUTION 1

Figure 6

APPENDIX G

ENVIRONMENTAL

RESOURCES

APPENDIX G

ENVIRONMENTAL RESOURCES

EXISTING CONDITIONS / STUDY AREA DESCRIPTION

Physical Setting

Location

The Cypress Valley Watershed is located in northeast Texas and northwest Louisiana. The headwaters of Big Cypress Bayou, which is the major drainage in the watershed, originate in the southwest portion of Hopkins County, Texas. From there, the watershed extends throughout all or portions of Franklin, Wood, Titus, Camp, Upshur, Gregg, Morris, Cass, Marion, and Harrison Counties, Texas. For the purposes of this study, the downstream boundary of the watershed is located at Caddo Lake dam, in Caddo Parish, Louisiana. The entire study area encompasses approximately 6,000 square miles.

Physiography and Topography

Most of the Cypress Valley Watershed is within the Pineywoods vegetational region of Texas (Gould, 1969). The far western portion of the watershed transitions into the Post Oak Savannah vegetational region. For the most part, the watershed is characterized by gently rolling to hilly terrain dissected by flat floodplains and terraces. The average elevation of the areas is 200 to 500 feet msl. The major drainages within the watershed include Big Cypress Bayou, Little Cypress Bayou, Black Cypress Bayou, James Bayou, and Frazier Creek (Campo, 1986). The vegetation of this region is dominated by pine and mixed pine-hardwood forests, with cultivated or pasture land, and bottomland hardwood forest and Cypress swamp located along the tributaries and backwater areas. The vegetation in the Post Oak Savannah region of the watershed is characterized by deciduous forest and prairie.

Geology and Soils

The Cypress Valley Watershed is underlain by southeasterly dipping sand, clay, glauconite, and lignite of the Wilcox and Claiborne Groups of Tertiary age. Most of Texas iron ore production comes from formations within the basin.

The Carrizo-Wilcox aquifer extends throughout the Cypress Valley Watershed. It consists of the Wilcox Group and the overlaying Carrizo Formation of the Claiborne Group. The aquifer is made up of fine to medium grained sand and sandstone interbedded with clay and silt, and minor amounts of lignite in the Wilcox Group. Yields of large capacity wills average about 200 gpm, but some in thicker sections produce up to 900 gpm. The water generally contains less the 500 mg/l total dissolved solids and is excessive only in its iron content.

The Queen City aquifer occurs in a wide band across the central part of the basin. It consists of fine to medium grained sand, interbedded with clay, glauconite, and lignite. Total thickness ranges up to about 500 feet. Well yields are generally small. However, wells tapping the aquifer may be capable of yielding as much as 20 gpm. Water quality in the aquifer generally is acceptable for municipal, some industrial, and irrigation uses. Dissolved solid content is less than 50 mg/l and meets the standard of drinking water; however, there is an excessive content of iron.

The soils of the upland areas within the watershed contain soils of the Bowie-Cuthbert-Kirvin, Darco, and Cuthbert-Redsprings associations. The Bowie-Cuthbert-Kirvin association consists of gently slopping to steep, well drained and moderately well drained, loamy and gravelly soils. Generally, these soils are characterized by a brown, fine sandy loam surface layer with a subsoil that is yellowish brown to red mottled clays and clay loams. The Darco association is comprised of gently sloping to moderately steep, well drained sandy soils. Typically, Darco soils have a surface layer of brown to light yellowish brown fine sand with a subsoil of yellowish red sandy clay loam with strong brown mottles. The Cuthbert-Redsprings association consists of strongly sloping to steep, well drained, gravelly soils. These soils are brownish gravelly loams to gravelly fine sandy loams underlain by reddish clays.

The stream terraces within the watershed consist of soils of the Mollville-Latch association. These are nearly level, poorly drained and moderately well drained, loamy and sandy soils. Typically, the surface layer is grayish brown very fine sandy loam with a subsoil of sandy clay loam.

The floodplain soils are of the Mantachie-Iuka association. These are nearly level, somewhat poorly drained and moderately well drained, loamy soils. Generally, the surface is brown loam to fine sandy loam with clay loam to fine sandy loam subsoils.

CLIMATE

The climate of the study area is generally subtropical with hot, humid summers and mild winters. Warming winds originate primarily from the southeast during the late spring, summer and early fall, and cooling winds originate from the northwest during late fall, winter and early spring. The average annual air temperature ranges from 94 degrees Fahrenheit in August to 34 degrees Fahrenheit in January. The area receives relatively high rainfall with between 35 to more than 50 inches per year. Thunderstorms resulting from the interaction of cold fronts from the north and warm, moist tropical air from the south produce most of the precipitation. Snowfall is infrequent, occurring about once every two to three years.

Environmental Setting

Terrestrial Resources

Except for its far western portion, the Cypress Valley Watershed is within the Pineywoods vegetational region of Texas (Gould, 1969). Generally, the watershed is characterized by gently rolling to hilly terrain dissected by flat floodplains and terraces.

Pine-hardwood forests dominate the upland areas within the watershed. This forest types consists of loblolly and shortleaf pine, red oak, overcup oak, blackjack oak, post oak, hickory, maple, beech, sweetgum and sycamore. Bottomland hardwood forests, which occur along the floodplains consist of willow oak, water oak, black willow, bald cypress, blackgum, sweetgum, river birch, green ash, water hickory, winged elm, and water elm. Most of the bottomland areas are considered to be wetlands. The original upland forest has been extensively cleared for agricultural purposes, particularly in the western portion of the basin. Some of the bottomland forests have been converted to monocultured pine forest for commercial lumbering. Bald cypress swamps are present along drainages in the eastern portion of the watershed and are significant in Caddo Lake and along Big Cypress Bayou upstream of Caddo Lake.

In addition to the pine-hardwood and bottomland hardwood forests, which are primary and secondary forest types within the watershed, upland hardwood forests, pine plantations, shrub land, grassland, and cropland also occur within the watershed.

Game mammals found in the watershed include fox and grey squirrel and whitetail deer. Common small nongame mammals include armadillo, rabbits, opposum, raccoon, and several species of skunks, bats and rodents. Bobcat, coyote, and gray fox are the principal predators. Snakes, lizards, turtles, and amphibians are also abundant.

At least 216 species of birds have been recorded within the Cypress Valley Watershed. Resident game species include bobwhite quail, wood duck and turkey. Numerous species of waterfowl migrate through or winter along streams, sloughs, swamps and impoundments in the basin, which is located in the central flyway. Nongame birds include various woodpeckers, hawks, owls, warblers, thrushes, and other resident or migrating species found in wooded to partially wooded habitats. Shorebirds are common on impoundments during spring and fall migrations.

Aquatic Resources

The river systems in the Southeast United States are generally characterizedas having broad floodplains, relatively flat stream gradients, and meandering patterns in the landscape.

Certain landscape features of floodplains are created over time by overbank flooding and meandering rivers that cause sediment transport, erosion, and deposition. Some of these features and their definitions are included in the characterization of Eastern North American riparian systems by Mitsch and Gosselink (1993):

1. Natural levees are adjacent to the channel and are composed of coarser materials that are deposited when floods flow over the channel banks. These levees are often the highest elevation on the floodplain.

2. Point bars are areas of sedimentation on the convex sides of meanders or river curves. As sediments are deposited on the point bar, the meander curve of the river tends to increase in radius and migrate downstream. Over time, the point bar will begin to support vegetation that will stabilize it as part of the floodplain.

3. Meander scrolls are depressions and ridges on the convex side of bends in the river. They are formed as the stream migrates laterally across the floodplain. Meander scrolls are also referred to as ridge and swale topography.

4. Oxbows, or oxbow lakes, are bodies of permanently standing water that result from the cutoff of meanders.

5. Sloughs are areas of dead water that form in meander scrolls.

6. Terraces are Aabandoned floodplains@ that may have been formed by the river=s alluvial deposits but are not hydrologically connected to the present river.

Aquatic habitats within the Cypress Valley Watershed are extremely diverse, ranging from large palustrine emergent and forested wetlands at Caddo Lake to intermittent tributaries in the upper portions of the watershed. Other types of aquatic habitats found in the area include perennial streams with riffles, runs, and pools; sluggish flowing bayous with numerous oxbows, sloughs, and backwaters; and man-made water impoundments and reservoirs.

These aquatic habitats support a variety of riparian and aquatic vegetation. Common woody vegetation lining streambanks and overhanging the water include bald cypress, black willow, water elm, river birch, and buttonbush. Emergent and floating aquatic vegetation is generally restricted by the steep banks of streams, but is common in shallow areas of impounded water. Aquatic vegetation is discussed in more detail in the water quality portion of this report.

The diversity and quality of the aquatic habitat within the watershed support a large and varied fishery. Several fish surveys have been conducted in the Cypress Bayou system since the 1950's (Killgore and Hathorn, 1987). According to a draft report on fishes of the Cypress Bayou system (Hoover, Douglas, Killgore and Matthews),that compiles fishery data collected over the years, eighty-seven species of fish have been collected in the watershed. Major sport fishes that occur include largemouth and spotted bass, channel and flathead catfish, white bass, white and black crappie, and various sunfishes. Primary forage species include gizzard and threadfin shad, small sunfishes, minnows, and shiners. Spotted sucker, freshwater drum, carp, longnose and spotted gar, and black and yellow bullheads are the primary rough fish species.

Threatened and Endangered Species

The following species have been federally listed as threatened or endangered in the Cypress Valley Watershed within the state of Texas. The bald eagle (*Haliaeetus leucocephalus*)is listed as endangered and is a winter resident throughout the study area. Although its current range is south of the Cypress Valley Watershed, the historic range of the endangered red-cockaded woodpecker (*Picoides borealis*) extended into the Cypress Valley. Threatened species include the arctic peregrine falcon (*Falco peregrinus tundrius*) and piping plover (*Charadrius melodus*) which are migrants throughout Texas, and the Louisiana black bear (*Ursus americanus*). Also, the paddlefish (*Polyodon spathula*) is on the Texas Endangered Species List.

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PROBLEM IDENTIFICATION

Environmental Restoration / Preservation

The various habitat cover types within the Cypress Valley Watershed are discussed in the Cypress Valley Resource Inventory, and depicted in the vegetation/land cover map that was generated using satellite imagery, ground-truthing, and Geographic Information System technology.

Forest Restoration

The Cypress Valley Watershed is located within the Pineywoods vegetational area of Texas (Gould, 1969) and was historically dominated by forested land. Currently, mixed pine-hardwood forest is the predominant forested cover type in the watershed (Campo, Cloud). These forests occur on uplands and are dominated by loblolly pine mixed with water oak, willow oak, red oak, post oak, sweetgum, maple, elm and sugarberry.

Bottomland hardwood forests occur along drainages, floodplains, and at lower elevations where they are generally inundated or saturated with surface or groundwater periodically during the growing season. (Bottomland hardwoods can also be classified as wetlands, depending on hydrology, soil type, and vegetation composition). Bottomland hardwoods is the second most common forest type within the Cypress Valley Watershed. The predominant bottomland hardwood forest types that occur within the study area are the water oak/willow oak association and the elm/sugarberry association (Cloud, 1995).

Because of their natural resource values and threat of conversion to other land cover types, bottomland hardwoods are the focus of forest restoration recommendations in this report.

Animals inhabit places where their food, water and cover requirements are met. Bottomland hardwood forests have particular importance to wildlife because all three of these requirements can be provided. The large amount of mast-producing trees and fruit-bearing shrubs and vines provide a food base for mammals and birds. Mature trees with a dense canopy cover, mid-story trees and shrubs, snags, and fallen logs create a multi-level physical structure that provides excellent cover for many birds and wildlife species. By definition, bottomland hardwood forests are located near water, and in fact, need the hydrologic conditions provided by fluctuating water levels caused by periodic flooding for their establishment and continued development.

Bottomland hardwood forests have other functions and values in addition to wildlife habitat. Among these functions are flood control (flood waters are slowed down and absorbed), water quality (sediments are filtered out, soil erosion is reduced by rooted vegetation), and groundwater recharge.

Historically, the amount of loss of these valuable forests has been substantial. In the contiguous United States, bottomland hardwood forests have suffered a five percent loss from the mid-1970s to the mid-1980s. Prior to European settlement, bottomland hardwood forests covered approximately 21 million acres of the Mississippi River alluvial floodplain, compared to approximately 5 million acres today (Mitch and Gosselink, 1993). Approximately 13 percent of these bottomlands are in public ownership. In the Pineywoods vegetational area of Texas (an area of approximately 15 million acres in East Texas and within which the study area is contained) there are approximately 1.8 million acres of bottomland hardwoods. Only 3 percent of these bottomlands are in public ownership (U.S. Fish and Wildlife Service, 1985).

Many of the bottomland hardwood forests that remain today are seriously fragmented and have lost many of their original functions. Loss of bottomland forest habitat is caused by clearing for development, conversion to pasture land or other types of agriculture, and timber production.

Another threat to bottomland hardwood forests is construction of water control structures, primarily reservoirs. Restoration efforts within the Cypress Valley Watershed would involve revegetating bottomland hardwood species in areas that once supported this forest type, and providing the hydrologic regime required for their establishment and development.

Wetland Restoration

Bottomland hardwood wetlands are the principal wetland type in the Cypress Valley Watershed. Cypress swamps, shrub swamps, vegetated littoral zones of open water, and emergent wetlands or marshes are other types of wetlands that occur in the watershed (Cloud, 1995). Wetlands perform multiple functions that are both valuable to man and the environment. These functions include flood flow alteration, sediment stabilization, sediment and toxicant retention, groundwater recharge, nutrient removal and transformation, production export, fish and wildlife habitat, and aesthetic and recreational opportunities. Wetlands are often located at the ecotones between dry terrestrial systems and aquatic systems. As such, they have an intermediate hydrology and generally high productivity and diversity (Mitsch and Gosselink, 1993).

Various estimates by researchers have been made over the years to determine the amount of wetlands in the United States. These estimates vary greatly depending on the information that was available at the time the estimate was made (maps, documented field studies, remote sensing), and for what purpose the estimate was made (in the early 1900's, the U.S. Department of Agriculture studied wetland abundance to determine Athe amount and location of swamp and overflow lands in the United States that can be reclaimed for agriculture.@) Nevertheless, most of these studies indicate a rapid rate of wetland loss in the United States, particularly prior to the 1970's. It has been estimated that 53 percent of the wetlands in the contiguous United States have been lost since European settlement in the late 18th century (Mitsch and Gosselink, 1993). The State of Texas has lost approximately half of its original wetlands.

Wetland losses are due to clearing and filling for agriculture, urbanization and development, and construction of water control structures. Water impoundments alter the hydrology of downstream areas by reducing flood flows, thereby drying up the flood plain and increasing access and development of areas that were previously too wet. Hydrology is probably the most important defining factor of a wetland and the most crucial factor in wetland restoration. Wetland restoration efforts within the Cypress Valley Watershed should be focused in areas where hydrology can be manipulated, namely in floodplain areas. Small scale water control structures could be strategically placed in the floodplain to intercept and hold back flood water before it drains into the river. The amount and duration of flood water retention can be manipulated depending on the type and complexity of the control structure.

Environmental Preservation

One of the unique features of the Cypress Valley Watershed merits consideration in this section. In previous sections of this report, the importance of wetlands, including bottomland hardwood forests, and their functions and values to the natural environment have been discussed.

Caddo Lake, located at the eastern boundary of the study area, is characterized by its unique stands of bald cypress swamp, emergent wetlands, and shallow vegetated open water. The bald cypress swamp wetland habitat type at Caddo Lake occupies less than one percent of the Cypress Valley Watershed and represents one of the best examples of this habitat type in the state of Texas. Caddo Lake provides high value habitat for numerous fish and wildlife species, including restrictive wetland species such as the American alligator and river otter. The U.S. Fish and Wildlife Service (FWS) has designated Caddo lake as Resource Category 1. The mitigation planning goal of this resource category is Ano loss of existing habitat value.@ The upper portion of Caddo Lake, namely the Caddo Lake State Park and Wildlife Management Area, has been recognized by the Ramsar Convention as a *Wetland of International Importance* (U.S. Fish and

Wildlife Service, 1993). The Ramsar Convention, which went into effect in 1975, is an intergovernmental treaty that provides a framework for international cooperation for the conservation of wetland habitats. More than seventy countries from all regions of the world are now contracting parties to the Convention.

Caddo Lake has been internationally recognized for its unique flora and diverse fauna. There are other areas within the Cypress Valley Watershed that also merit special consideration, namely areas along Big Cypress Bayou, Black Cypress Bayou, and Little Cypress Bayou that have been identified as priority sites by the U.S. Fish and Wildlife Service under the Texas Bottomland Hardwood Preservation Program (1985). It is important for private landowners, local, state, and federal governments to recognize these and other high quality habitats and to work together to preserve them.

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PLAN FORMULATION AND CONCEPTUAL SOLUTIONS

Environmental Restoration and Mitigation Banking

Section 1135 Program

Under Section 1135 of the Water Resources Development Act of 1986, the Corps is authorized to modify the structures or operations of projects that were constructed prior to 1986 for the purpose of improving the quality of the environment in the public interest.

Projects conducted under the authority of Section 1135 must be cost-shared with a non-Federal sponsor on a 75% Federal / 25% non-Federal basis. Section 1135 projects must propose a modification in the structures or operations of a permanent water resources project constructed by the Secretary of the Army in response to a Corps construction authority. The objective of the project modification should be restoring degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition, which will involve consideration of the ecosystem=s natural integrity, productivity, stability and biological diversity.

A Section 1135 project is currently underway in the Cypress Valley Watershed. The specific project area is Big Cypress Bayou and its floodplain between Lake O= the Pines dam and Caddo Lake. The construction of Lake O= the Pines has altered the hydrology of the study area by reducing peak flows and overbank flooding. The goals of the Big Cypress Bayou Section 1135 Habitat Restoration project are to restore nesting, brood rearing and wintering habitat for waterfowl, and to restore spawning habitat for fish, particularly the paddlefish.

Modification of the scheduled releases from Lake O= the Pines to provide overbank flooding during the fall would create beneficial conditions for resident wood ducks and migrating waterfowl. Establishing nest box structures would also contribute to increasing the habitat value for waterfowl.

The paddlefish (*Polyodon spathula*) was once endemic to the Big Cypress Bayou area and was placed on the Texas Endangered Species List in 1977. The Texas Parks and Wildlife Department is currently stocking paddlefish in the Big Cypress Basin as part of the Texas Paddlefish Recovery Program. Providing high flows in Big Cypress Bayou during the spring and creating gravel bars would create beneficial conditions for paddlefish spawning, which would contribute to the efforts of the Recovery Plan.

The waterfowl and paddlefish habitat restoration projects will be covered in detail under a separate report on the Big Cypress Bayou Section 1135 project.

Bottomland Hardwood Forest Restoration

Forest restoration efforts would involve revegetating bottomland hardwood species in areas that once supported this forest type and providing the hydrologic regime required for their establishment and development. Because hydrology is such an important factor to bottomland hardwoods, revegetation efforts should be restricted to areas that receive frequent flooding or in areas where hydrology can be manipulated (as discussed in the following section on wetland restoration). Several sites were identified during roadside observations as having potential for bottomland hardwood revegetation. These sites have recently been logged over and their locations are shown in Figure 4-1. Additional potential sites were identified by the U.S. Fish and Wildlife Service in their report in Appendix J. These sites have been identified for general information on potential restoration opportunities within the Cypress Valley Watershed, and any further planning should involve the cooperation of local landowners and the appropriate local, state, and federal resource agencies.

Wetland Restoration

Lake O= the Pines was constructed on Big Cypress Bayou in 1958 for the purposes of flood control and water supply. The water control gates on the dam will release a maximum of 3000 cfs. Wetland restoration along Big Cypress Bayou would involve manipulating releases from Lake O= the Pines dam to increase overbank flows to sloughs, oxbows, depressional areas, and meander scrolls in the floodplain. Increased flows would saturate the floodplain soils or pool in areas that were already saturated. Field observations conducted by COE, FWS, and TPWD personnel during the fall of 1994 indicate that substantial overbank flooding starts to occur when 1500 cfs is released from the dam. However, inundated areas in the floodplain drain fairly rapidly when water levels in Big Cypress Bayou decrease. Placement of various types of retention structures in internal drainage areas, sloughs, and breeched sections of the natural berm along the bayou would withold floodwaters in the floodplain. Retaining floodwaters with control structures would have to be done in cooperation with local landowners. Some possible areas of wetland restoration are identified in figure 4-1. Other possible restoration sites have been identified by the U.S. Fish and Wildlife Service in their report that appears in Appendix J. Again, these sites have been identified for general information only, and further planning efforts should be coordinated among appropriate private landowners and resource agencies.

Mitigation Banking

In 1988, the National Wetlands Policy Forum, a group consisting of representatives from state and local governments, agricultural, and environmental groups, published a report that presented the goal of Ano net loss@ of wetlands. Specifically, the Forum stated that:

> A...the nation establish a national wetlands protection policy to achieve no overall net loss of the nation=s remaining wetlands base, as defined by acreage and function, and to restore and create wetlands, where feasible, to increase the quality and quantity of the nations=s wetland base.@

As a response to the Policy Forum, the Water Resources Development Act of 1990 contains Section 307 which establishes, as part of the Corps of Engineers water resources development program, a Agoal of no overall net loss of the Nation=s remaining wetland=s base, as defined by acreage and function, and a long-term goal to increase the quality and quantity of the Nation=s wetlands, as defined by acreage and function.@

The concept of mitigation banking is based on the premise of providing advanced compensation of unavoidable losses from development activities that are subject to permitting regulations. There has been added emphasis on creating wetland mitigation banks since the Ano net loss@ goal was presented and because impacts to wetlands and other aquatic resources are subject to federal regualtions. Therefore, the following portion of this report will focus on wetland mitigation banking. It should also be noted that depending on hydrology, soil type, and vegetational composition, bottomland hardwood forests can be classified as wetlands.

Federal guidance for the establishment, use, and operation of mitigation banks was recently published in the Federal Register, Volume 60, Number 43, dated March 6, 1995. This publication contains policy guidance for the Army Corps of Engineers, the Environmental Protection Agency, the Natural Resources Conservation Service, the Fish and Wildlife Service, and the National Oceanic and Atmospheric Administration. The purpose of the guidance is to "clarify the manner in which mitigation banks may be used to satisfy mitigation requirements associated with" the permit program of the

Clean Water Act and the wetland conservation, or "Swampbuster" provisions of the Food Security Act (60 FR 43, 6 March 95).

A mitigation bank is established when land is acquired to create, restore, or enhance a wetland system, thereby increasing its functional value. The increased value of the system can be institutionalized as credits or a positive bank balance that can be drawn from to mitigate future unavoidable habitat losses. The use of a professionally accepted and standardized evaluation technique, such as the U.S. Fish and Wildlife Services' Habitat Evaluation Procedure, can provide scientifically-based information from which banking values can be established. Mitigation credits may be purchased by developers who need to compensate for project induced wetland losses. The bank is operational as long as it maintains a positive balance.

Banks are designed to provide mitigation for multiple development activities, and differ from specific mitigation projects that are designed to fulfill requirements for a single project. As such, mitigation banks must be created where large tracts of land are available for acquisition. This design has both an environmental and economic foundation. Creating a large-scale mitigation bank with contiguous, unfragmented habitat will usually result in a higher quality system that supports a diversity of plants and animals, which, in the long term, may have more value than smaller, individual mitigation sites. Given the high cost of habitat creation, restoration, and maintenance, it is more economically feasible to develop a larger habitat system that will have a higher functional value, increased self-maintenance, and resilience to degradation. Within the Cypress Valley Watershed, large tracts of undeveloped land are located along floodpains and terraces of Big Cypress, Black Cypress, and Little Cypress bayous. Since most, if not all, of these areas are in private ownership, participation and coordination among private landowners would be paramount to establishing a mitigation bank in the study area.

When is the use of a mitigation bank appropriate? It is important that all development projects that incur wetland impacts that are subjected to federal regualtions, go through a sequenced evaluation process. First, a project should be relocated or modified, when feasible, to avoid the impacts altogether. Second, any projects that cannot be relocated or redesigned to avoid impacts should be modified to minimize impacts. When impacts cannot be avoided or minimized, they must be compensated. This raises the question of how and where the lost functions and values of the impacted area can be regained. In most cases, it is preferable to create, restore, or enhance a wetland system that is at or near the project site where impacts will occur, or at least within the same watershed. This is to maintain, to the highest extent possible, the hydrologic, biologic, and biogeochemical integrity of the landscape. Off-site compensatory mitigation is considered when on-site alternatives are unavailable or deemed infeasible.

Mitigation banking should be considered not only when on-site compensation opportunities are not practicable but when the use of a mitigation bank is environmentally preferable to on-site compensation. For example, the loss of wildlife habitat may be more successfully compensated by an off-site mitigation bank that provides large-scale, contiguous habitat and biodiversity. However, other wetland functions such as flood storage, groundwater recharge, and water quality, which have regional value or watershed-based functional importance, would be more successfully compensated by on-site mitigation.

One of the advantages of a mitigation bank is that advanced compensation is provided for unavoidable impacts. The mitigation bank must be in place and functioning as a viable system in order for it to become operational. This reduces the risk and uncertainty of whether or not a mitigation project will actually replace lost habitat functions and values. However, the mitigation bank must be continuously monitored and managed to ensure that the system remains viable.

The danger of developers using mitigation banking as a pay-off to pave the way for their projects, or as a means to justify impacts that could otherwise be avoided or minimized, is a valid concern. Again, mitigation banking should be considered as part of an impact evaluation process that involves developers, resource agencies, and regulatory agencies. The objective of the parties involved should be to use resourcefulness, innovation, and flexibility in developing and operating a mitigation bank while not losing sight of the regulator's obligations or the developer's interests.

Success of a mitigation bank depends highly on how it is established and managed. Operators and participants of a bank must coordinate with, and enter into a formal agreement with the appropriate regulatory agencies to set up guidelines for establishment, use, and maintenance of the bank. Professionally accepted scientific techniques must be used to evaluate the functions and values of the bank and to provide a basis for calculating available mitigation credits. The mitigation credits must be recognized by the regulatory agencies as providing suitable and acceptable compensation for wetland impacts.

Early and open coordination among participants, good planning techniques, and scientific principles must be utilized in order to reduce the risk and increase the success of establishing, operating, managing, and maintaining a functionally viable mitigation bank. If participants follow this framework, then mitigation banking can become an effective tool in rebuilding and strengthening the nation's natural resource base.

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