CHANNEL AND BANK STABILITY OF OSBORNE CREEK AT U.S. HIGHWAY 45 NEAR WHEELER, PRENTISS COUNTY, MISSISSIPPI

by K. Van Wilson, Jr. and D. Phil Turnipseed

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CONVERSION FACTORS

For readers who may prefer to use the metric (International System) of units rather than the inch-pound units used herein, the conversion factors are listed below:

Multiply inch-pound unit	by	To obtain metric unit
foot per second (ft/s)	0.3048	meter per second (m/s)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m3/s)
foot (ft)	0.3048	meter (m)
foot per mile (ft/mi)	0.018939	meter per kilometer (m/km)
square foot (ft^2)	0.09290	square meter (m^2)
pounds per square foot (lb/ft^2)	47.88	newtons per square meter (N/m^2)
pounds per cubic foot (lb/ft^3)	157.09	newtons per cubic meter (N/m^3)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)

Mississippi State Highway Department Datum: In this report, elevations are referenced to Mississippi State Highway Department Datum (MSHDD), which is to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929 and referred to in this report as sea level.

DEFINITION OF TERMS

Terms used in this report are defined below.

Angle of internal friction -angle of the plane of contact of soil particles with the horizontal at the point of sliding (shearing); angle whose tangent is the coefficient of friction between the soil particles (Cernica, 1982).

Channel-bed aggradation - filling in of the channel because streamflows are not sufficient to transport the material delivered from upstream channel-bed degradation (Simon and Hupp, 1986b).

Channel-bed degradation -headward erosion of the channel bed usually caused by increases in downstream channel gradient and cross-sectional area by man (Simon and Hupp, 1986b).

Cohesion -attraction of adsorbed water and soil particles that produce a body, which holds together but deforms plastically at varying water contents (Sowers, 1979).

Critical bank height -height of channel bank above which failure can be expected, produced by an increased height (channel-bed degradation) or bank angle (over steepening through erosion) (Thorne and others, 1981).

Dry bulk-unit weight -ratio of the weight of the soil solids to the volume of the soil sample (Das, 1984).

Factor of safety -ratio of the resisting force (shear strength of the soil) to the driving force (weight of the soil). If the resisting force is less than the driving force, the factor of safety is less than 1.0, and therefore, failure occurs (Huang, 1983).

Failure-block width -the measured width of the failure block or the distance between affected stems of woody plants growing in bank material that has failed and fallen down slope and the existing top-bank edge (Hupp, 1987).

Iowa Borehole Shear Test -direct measure of shear strength of fine- to medium-grained soils insitu (from inside a borehole) (Handy, 1981).

Knickpoint -an abrupt change in channel-bed elevation along a reach of channel relative to the upstream or downstream direction.

Moisture content -ratio of the weight of the water present to the weight of the soil solids (Das, 1984).

Planar failure -slides along a surface of rupture whereby the mass progresses down and out along a more or less planar or gently-undulatory surface and has little rotational movement or backward tilting characteristics (Huang, 1983).

Rotational failure -landslide along a surface of rupture that is concave upward. The exposed cracks are concentric in plan and concave toward the direction of movement (Huang, 1983).

Shear strength -capacity of a soil to resist shear; in terms of effective stress, it can be given by the equation:

$$s' = c' + \sigma' \tan \phi'$$

where:

σ' = effective normal stress on plane of shear

c' = cohesion or apparent cohesion of the soil; and

ϕ' = angle of internal friction.

(Das, 1984).

Slough-line angle -angle attained by projecting the slope of failed blocks of soil mass (which represents a temporary angle of stability) to its intersection with the top of channel bank (flood-plain level). It is used to determine short-term (10-20 years) bank widening (Simon and Hupp, 1986a).

Temporary angle of stability -the angle from the horizontal extended from the toe to the top of bank in which that bank at that given height is the most stable. It can be estimated by averaging the existing bank angle with the angle of internal friction of the bank material. (Spangler and Handy, 1973).

CHANNEL AND BANK STABILITY OF OSBORNE CREEK AT U.S. HIGHWAY 45 NEAR WHEELER, PRENTISS COUNTY, MISSISSIPPI

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ABSTRACT

The channel of Osborne Creek at existing U.S. Highway 45 near Wheeler, Mississippi, has degraded about 8 feet and widened about 33 feet since 1936. Channel degradation has totaled about 6 feet in the channel reach in the vicinity of the proposed U.S. Highway 45 relocation. Botanical evidence indicates that several bank failures downstream of the proposed relocation occurred during floods in 1983 and 1987-88.

Rates of channel gradation and widening--as determined from channel descriptions and botanical evidence along the banks--were used in conjunction with soil properties to estimate probable future channel degradation and widening at the proposed relocation through the year 2010. By assuming that channel-bed elevations can be expressed as a power function with time, additional channel degradation through the year 2010 could approach 1 to 2 feet at the existing and proposed crossing of Osborne Creek. By comparison of projections of slough lines and temporary angles of stability with bankfull channel widths as a power function with time, about 10 feet of additional widening could reasonably be expected through the year 2010. These projections are based on the assumption that no additional channel modifications and no unusually large and destructive flooding will occur by the year 2010.

INTRODUCTION

The Mississippi State Highway Department proposes to relocate the U.S. Highway 45 crossing of Osborne Creek near Wheeler, Mississippi (fig. 1). Because channel degradation and bank sloughing have occurred recently on Osborne Creek, the U.S. Geological Survey, in cooperation with the Mississippi State Highway Department, conducted a study of channel and bank stability at existing U.S. Highway 45 and at the proposed U.S. Highway 45 relocation.

Purpose and Scope

The purpose of this report is to describe the existing channel and bank conditions and present the results of a study to determine the potential for near-future (through the year 2010) degradation and widening for Osborne Creek at existing U.S. Highway 45 and at the proposed U.S. Highway 45 relocation near Wheeler in Prentiss County, Mississippi. Past and present channel conditions were determined on the basis of field observations of channel-bed elevations, bank failures, ages and types of trees on the channel banks, and other botanical evidence. The potential for near-future (to the year 2010) channel degradation was estimated using power functions of past channel-bed elevations with time for Osborne Creek at existing U.S. Highway 45. The potential for near-future channel widening was estimated using both the potential for future bank failures based on present channel geometry and the dry bulk-unit weights and shear-strength properties of the bank material at the proposed relocation and application of power functions of past channel widths with time at the existing U.S. Highway 45. This report is the third in a series of reports for selected stream crossings in Mississippi.

General Description of Osborne Creek

Osborne Creek is located in the Black Belt, East Gulf Coastal Plain physiographic region (Thornbury, 1965). The drainage area of Osborne Creek at the proposed U.S. Highway 45 relocation is 11.0 mi^2 (square miles), and the length of the channel upstream of the site is about 7.5 mi (miles). Average channel and valley slopes in the vicinity are about 4.0 and 9.7 ft/mi (feet per mile), respectively. Osborne Creek flows into Twentymile Creek about 3.8 mi downstream of the proposed crossing. Osborne Creek is crossed by existing U.S. Highway 45 about 0.9 mi downstream of the proposed U.S. Highway 45 relocation (fig. 1).

The channel of Osborne Creek in the vicinity of the proposed relocation consists of sandy-chalky clay overlain, in places, by a layer of sand and pea-sized gravel. Lesser discharges are confined to an incised low-flow channel generally 1 to 1½ ft deep; however, scourholes just upstream of the proposed relocation are as much as 6 ft deep. The channel banks average about 12 ft in height.

Channel Modifications to Osborne and Twentymile Creeks

The Osborne Creek Drainage District relocated about a 1-mi reach of channel to the east of the original channel in the vicinity of the proposed U.S. Highway 45 alignment (fig. 1). An unpublished Osborne Creek Drainage District boundary map was used to approximate the location of the original channel. Two field ditches west of the old channel probably were excavated when Osborne Creek was relocated. These modifications probably were done shortly after 1912 when parts of Twentymile and Wolf Creeks were modified.

The U.S. Army Corps of Engineers completed construction of a grade-control structure just downstream from State Highway 362 (about 3.2 mi downstream from the proposed U.S. Highway 45 relocation) in 1983 (D.C. Otto, U.S. Army Corps of Engineers, oral commun., 1988).

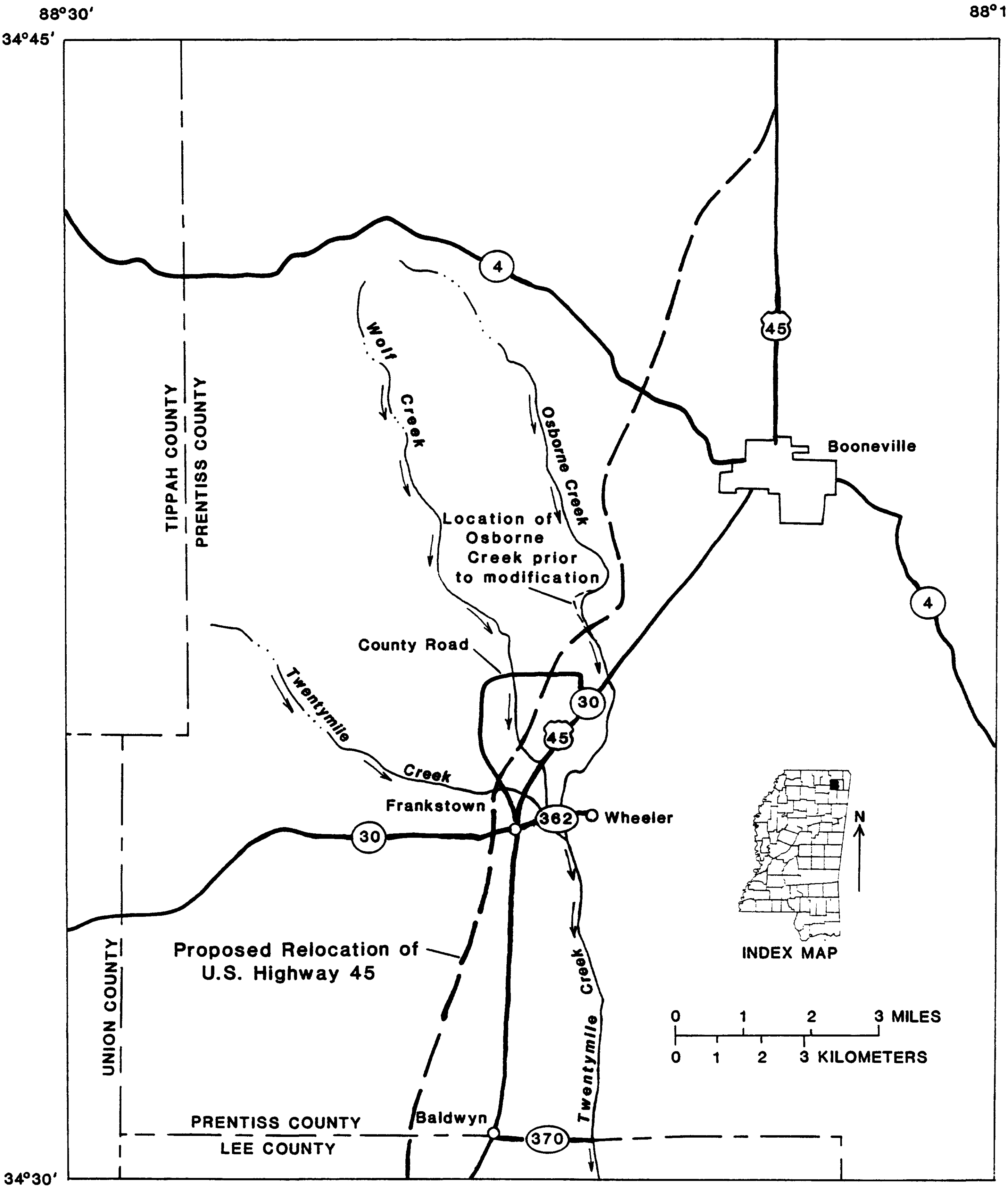

Figure 1.--Location of Osborne Creek at existing U.S. Highway 45 and proposed U.S. Highway 45 relocation near Wheeler, Mississippi.

About 1912, the Prentiss County Twenty Mile Drainage District excavated a ditch about 5.1 mi long, which approximately followed the natural drainage channel of Twentymile Creek from the Prentiss-Lee County line (in the vicinity of State Highway 370) to the vicinity of State Highway 362 (Mississippi Board of Development, 1940b). At about the same time, the Lee County Twenty Mile Drainage District excavated a ditch about 7.4 mi long from the Prentiss-Lee County line to the Lee-Itawamba County line (Ramser, 1930), and the Itawamba County Twenty Mile Drainage District channelized the reach of Twentymile Creek from the Lee-Itawamba County line to the mouth (Mississippi Board of Development, 1940a). This reach was channelized again in 1966 by the U.S. Army Corps of Engineers. A bank-stabilization project was begun by the Corps in 1981 to prevent further bank caving and erosion that began shortly after the 1966 channel-modification project was completed in the lower reaches of Twentymile Creek. This project consisted of constructing numerous grade-control structures on Twentymile Creek and selected tributaries and planting willows and reed grass to provide protection along erodible banks in selected areas along Twentymile Creek (U.S. Army Corps of Engineers, 1983). A project to study the effects of the grade-control structures is currently being conducted by the Waterways Experiment Station in Vicksburg, Mississippi (D.C. Otto, U.S. Army Corps of Engineers, oral commun., 1988).

Acknowledgments

The authors are indebted to members of the Mississippi State Highway Department, Hydraulics Division, who provided bridge-inspection records, and to members of the Soil Mechanics Laboratory, who assisted in the analysis of soil samples in the State soils laboratory. The authors also acknowledge personnel of the U.S. Army Corps of Engineers, who provided channel cross sections and profiles.

CHANNEL-BED STABILITY

Botanical Evidence of Gradation

Trees growing below tops of banks can indicate rates of channel gradation. Trees establish a root collar at the ground surface during germination (Simon and Hupp, 1986a). The thickness of sediment burial or the depth of exhumation relative to the root collar define the degree of aggradation or degradation, respectively. Exhumation from the root collar of trees growing below top of banks along Osborne Creek indicated that the channel bed prior to substantial degradation was at least 3 to 4 ft above the present channel bed just downstream of existing U.S. Highway 45 and about 5 to 6 ft above the present channel bed in the vicinity of the proposed relocation. The presence of perennial grasses in the channel indicates low-flow conditions have predominated in recent years.

A 2½-ft knickpoint is present on the clay channel bed about 300 ft upstream of the proposed relocation. This knickpoint is not the common abrupt change in channel-bed elevation, but more of a gradual change over about 40 ft relative to the upstream or downstream direction. The well-developed root systems of mature riparian vegetation (green ash, river birch, and boxelder) indicate this knickpoint represents a very slow and gradual headward-progressing degradation process.

Gradation Analyses

Channel-gradation processes on an alluvial stream undergoing morphologic change in response to channel modifications generally start at a high rate and diminish with time. Studies of channel-gradation processes on alluvial streams have shown that channel-bed elevation can be expressed as a power function with time (Simon and Hupp, 1986b) in the general form:

$$E = a \cdot t^b \tag{1}$$

where

- E = elevation of the channel bed, in feet above sea level;
- a = regression constant, indicative of channel-bed elevation prior to the onset of the gradation process in response to channel modification, in feet above sea level;
- t = time, in years since beginning of the gradation process (t = 1 during the first year of channel adjustment); and
- b = regression coefficient indicative of the rate of the gradation process (negative for degradation and positive for aggradation).

Datums other than sea level for channel-bed elevations (E) in equation 1 may be used for convenience (for example, when sea level datum is not readily available at a site), but this will affect values of **a** and **b**. If elevations above the assumed datum are greater than the elevations obtained when referenced to sea level datum, the value of **a** will increase, but the absolute value of **b** will decrease. Conversely, if elevations above the assumed datum are less than the elevations obtained when referenced to sea level datum, the value of **a** will decrease, but the absolute value of b will increase. Also, by varying the datum, an imposed logarithmic offset for the log-linear relation will change, thus, in some cases, improving or worsening the log-linear statistical fit of the data points. In previous studies, the effects of channel-bed elevations on gradation trends were analyzed by varying the datum of the study sites, the analysis indicated no significant effects on the gradation estimates (Andrew Simon, U.S. Geological Survey, oral commun., 1988). Elevations in these analyses were referenced to Mississippi State Highway Department Datum, which is to sea level datum.

It is assumed that the general form of equation 1 is applicable for estimating channel-bed degradation in the near future (to the year 2010) on Osborne Creek. Channel-bed gradation processes in the past are assumed to be representative of those in the near future. This assumption could be negated by additional channel modifications or the occurrence of unusually large, destructive flooding, which could alter on-going gradation processes. The channel-bed elevations used in these analyses were obtained from surveys and inspections made by the Mississippi State Highway Department, the U.S. Army Corps of Engineers, and the U.S. Geological Survey (table 1). Some differences in channel-bed elevations may not be absolutely indicative of actual change. The channel-bed elevations used to analyze gradation were obtained in the vicinity of the existing U.S. Highway 45 bridge; no significant evidence of localized scour was observed. Localized scour occurs when flow velocities are increased for a short distance upstream and downstream from a bridge. Increased velocities are caused by the cross-sectional area being substantially reduced by bridge-approach embankments, piers, and other obstructions. The effect of localized scour would be an addition or a subtraction to the ongoing degradation or aggradation processes, respectively, and, therefore, would not be representative of the selected reach of channel studied.

Channel-gradation processes at existing U.S. Highway 45 appear to be representative of processes about 0.9 mi upstream at the proposed relocation. At the proposed relocation, channel-bed elevation data were limited to a 1975 estimate and a 1988 measurement. These elevations indicated a 1.6 ft decrease between 1975 and 1988, which was reasonably consistent with the 2.4 ft decrease at existing U.S. Highway 45 during this period (table 1).

Available data from 1936 to 1988 indicate channel-bed degradation totaling about 8 ft on Osborne Creek at existing U.S. Highway 45 (table 1). Significant variation in the data motivated the use of two possible scenarios to project near-future degradation on Osborne Creek. For the first scenario (fig. 2), a log-linear regression of all available channel-bed elevations (except 1975 and 1980) with respective times was used to define a channel-bed degradation relation ($E = 358.9t^{-0.00539}$, where t is time, in years since 1936). The 1975 and 1980 elevations were omitted

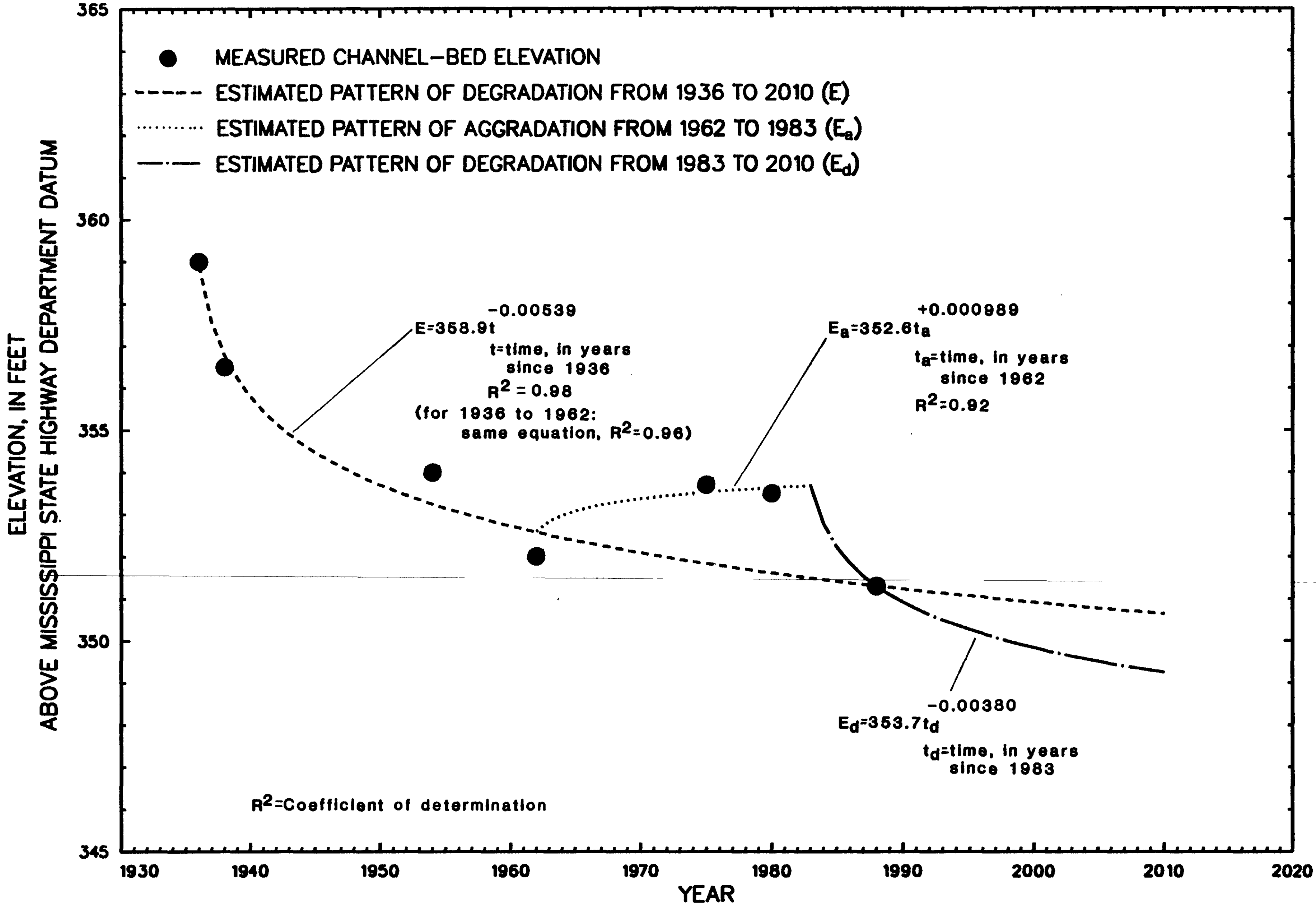

Figure 2.--Estimated patterns of channel-bed gradation processes on Osborne Creek at existing U.S. Highway 45 near Wheeler, Mississippi.

because they represented a temporary fill or possibly have a datum problem. It is uncertain when degradation began on Osborne Creek at existing U.S. Highway 45. Channel-bed elevations prior to 1936 were not available; therefore, the first year of the channel adjustment process was unknown. Relations of channel-bed elevations with their respective times were developed by varying the beginning year. The best statistical fit was with time beginning in the year 1936, which indicated that the effects of degradation on Osborne Creek at existing U.S. Highway 45 may have begun about 25 years after the initial modification of Twentymile Creek and Osborne Creek. This is not totally unreasonable assuming that channel adjustment on Osborne Creek did not begin until the affects of channel modifications on Twentymile Creek proceeded from the mouth of Osborne Creek to existing U.S. Highway 45. This first scenario projected about 1 ft of further degradation by the year 2010.

Table 1.--*Channel-bed elevation and degradation on Osborne Creek at existing U.S. Highway 45 near Wheeler, Mississippi*

Year	Channel-bed elevation (feet above Mississippi State Highway Department Datum)	Total degradation since 1936 (feet)
1936	359.0	0.0
1938	356.5	2.5
1954	354.0	5.0
1962	352.0	7.0
1975	353.7	5.3
1980	353.5	5.5
1988	351.3	7.7

Data from Twentymile and Wolf Creeks indicate that the March 1955 flood caused the ongoing degradation process on those streams to cease and a period of channel aggradation to begin. The 1975 and 1980 elevations for Osborne Creek indicate possible aggradation but, based on the 1962 elevation, it is not likely to have resulted from the March 1955 flood event on Osborne Creek. The 1988 elevation for Osborne Creek indicates additional degradation subsequent to the apparent aggradation. Osborne Creek experienced a relatively large flood (recurrence interval of about 20 years) in May 1983. Because of no available channel-bed elevations between 1962 and 1975, the second scenario was based on the assumption that Osborne Creek underwent degradation from 1936 to 1962, aggradation from 1962 to 1983, and degradation from 1983 to 1988. Therefore, log-linear regression of channel-bed elevation with time was used to define a channel-gradation relation for each time period: for 1936 to 1962 (same as the first scenario, as previously presented), 1962 to 1983 ($E_a = 352.6t_a^{+0.000989}$, where t_a is time, in years since 1962) and 1983 to 1988 ($E_d = 353.7t_d^{-0.00380}$, where t_d is time, in years since 1983). The second scenario projected 2 ft of further degradation by the year 2010 (fig. 2).

In summary, the channel bed of Osborne Creek at existing U.S. Highway 45 has degraded about 8 ft since 1936. Channel-bed gradation processes at existing U.S. Highway 45 appear to be representative of processes at the proposed relocation. About 1 to 2 ft of further degradation could reasonably be expected through the year 2010 at existing U.S. Highway 45 and at the proposed relocation.

CHANNEL-BANK STABILITY

Botanical Evidence of Widening

Bank failures along unstable reaches may kill, tilt, or scar existing woody plants, and create fresh surfaces upon which plants may become established. Scars and sprouts from parental stems of tilted plants yield accurate dates (within 1 year, often within one season) of bank failures (Hupp, 1987, 1988, Sigafoos, 1964).

Eccentric growth, resulting in anomalous tree-ring series, occurs when the stem is inclined. This type of growth is determined easily from tree cross sections where concentric-ring formation abruptly shifts to the eccentric because ring width is greater in the upslope direction. Eccentric-ring patterns can be used to determine dates, usually accurate within one season, of tilting. Dating of stems that have established on disturbed surfaces yields minimum ages for the surfaces (Simon and Hupp, 1986a).

Table 2.--*Dry bulk-unit weight and shear-strength properties of soil as determined from borehole tests on the right (south) bank of Osborne Creek about 50 feet downstream from the proposed U.S. Highway 45 relocation near Wheeler, Mississippi*

[ft, feet; lb/ft^2, pounds per square foot; lb/ft^3, pounds per cubic foot]

General soil description	Borehole depth (ft)	Dry bulk-unit weight (lb/ft^3)	Cohesion (lb/ft^2)	Angle of internal friction (degrees)
Orange-brown, gray-mottled clay	0-8.5	104	640	24.9
Gray, sandy-chalky clay	8.5-11.5	100	*0	26.9

* 100 lb/ft^2 was used for bank stability analyses in this report.

Trees growing on unstable bank surfaces along Osborne Creek near the proposed relocation show the effects of recent bank sloughing in their stem morphology, anatomy, and ages. Channel banks on both sides of the stream appear to have gradually sloughed in a combination of planar and rotational failures. Botanical data were collected by taking cross sections or increment borings of sprouts from tilted trees and of saplings and mature trees to determine their ages and by measuring bank failure-block widths. Mature trees on the tops of banks are providing an armoring effect against channel widening, but scallop-like slumps (2 to 4 ft in width) have occurred between trees, which may eventually cause some trees to fall into the channel. It should be noted that botanical evidence of previous bank failures may have been obscured with time and (or) by succeeding large floods (Simon and Hupp, 1986a).

Stability Analyses

Shear-strength properties of the channel banks were determined on the right (south) bank of Osborne Creek about 50 ft downstream from the proposed relocation with the Iowa Borehole Shear Tester[1] (BST), (Handy and Fox, 1967). Dry bulk-unit weight and shear-strength properties of soil obtained at the site are given in table 2. The average moisture content of the soils during testing was about 24 percent.

Shear-strength data obtained using the BST have compared reasonably well with the results of other standard laboratory procedures for the determination of soil strength (Thorne and others, 1981, Wilson and Turnipseed, 1989a). BST results for individual soil strata (except for cohesion of the sandy chalky clay) were used in stability analyses. Soil cohesion measured in the field for the gray, sandy-chalky clay that forms the channel bed on Osborne Creek in the vicinity of the proposed relocation was zero (table 2). An assumed cohesion of 100 lb/ft^2, which is still a low value for clay, was used for bank stability analyses (Mississippi State Highway Department, oral commun., 1988).

The factor of safety is the ratio of the resisting force (shear-strength of the bank material) to the driving force (weight of the

[1]The use of trade or product names in this report is for identification purposes only, and does not constitute endorsement by the U.S. Geological Survey.

bank material). Therefore, if the resisting force is equal to the driving force then the factor of safety is 1.0. Theoretically, when the factor of safety is less than 1.0, failure occurs, and when it is greater than 1.0, failure does not occur. This is based on the assumption that all the forces are accountable. A factor of safety of at least 1.5 generally is used in design. Factors of safety for bank failures at selected percentages of bank saturation were determined by using the dry bulk-unit weights and shear-strength properties of the bank material at a typical cross section just downstream from the proposed relocation of U.S. Highway 45. Computer programs REAME (Rotational Equilibrium Analysis of Multilayered Embankments) and SWASE (Sliding Wedge Analysis of Sidehill Embankments) developed by Huang (1983) were used to perform an iterative search to determine the minimum factor of safety for each percentage of bank saturation analyzed.

Analysis of both planar and rotational bank failures indicated rotational bank failures were more critical. Factors of safety for rotational bank failures ranged from 3.66 to 1.93 at 0- to 100-percent bank saturation, indicating that the banks of Osborne Creek just downstream from the proposed relocation are fairly stable. The critical rotational-failure surfaces with their respective factors of safety for 100-percent bank-saturation conditions are shown in figure 3. On the right (south) bank, the failure-block width is about 2 ft and on the left (north) bank, failure-block width is about 4 ft. Similar failure-block widths were observed in the field, although, a large recent upper-bank failure 8 ft in width was observed about 1,000 ft downstream from the proposed relocation.

Widening Analyses

Channel-widening processes on an alluvial stream undergoing morphologic change in response to channel modifications generally start at a high rate and diminish with time. Channel-bed degradation increases bank heights and angles and causes channel widening by mass wasting. Depending on the soil properties of the bank material, some time generally elapses between the beginning of degradation and the beginning of widening. In this report, the time interval is assumed to be negligible because of insufficient data to support any other assumption. Channel-width information was available at the existing U.S. Highway 45 crossing of Osborne Creek to develop a power function of bankfull channel width with time, a technique used by Wilson and Turnipseed (1989b), in the general form:

$$W = c \cdot t^{d} \qquad (2)$$

where

- W = bankfull channel width, in feet;
- c = regression constant indicative of bankfull width prior to the onset of widening processes in response to channel modification, in feet;
- t = time, in years since beginning of the widening process ($t = 1$ during the first year of channel adjustment); and
- d = regression coefficient indicative of the rate of widening.

Channel-widening processes in the past are assumed to be representative of those in the near future. This assumption could be negated by additional channel modifications or the occurrence of unusually large, destructive flooding that could alter ongoing widening processes.

As with channel-bed elevations, the channel widths used in equation 2 were obtained from surveys and inspections made by the Mississippi State Highway Department, the U.S. Army Corps of Engineers, and the U.S. Geological Survey (table 3). Some changes in width may not be absolutely indicative of actual change. The bankfull widths were derived from surveys made by different agencies and may not reflect exactly the same location(s). Thus, there are inherent uncertainties in the interpretation of these data.

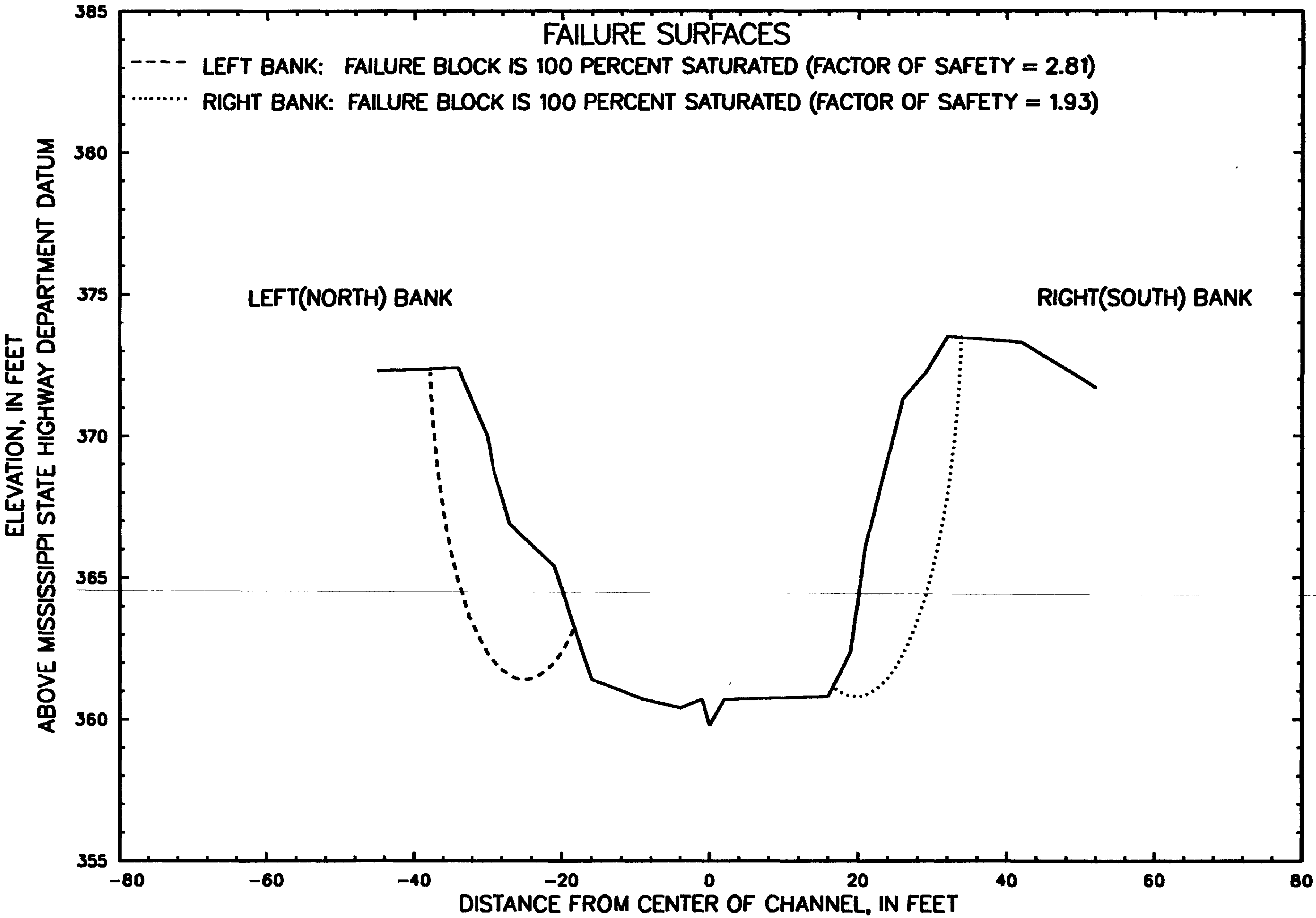

Figure 3.--Cross section showing critical failure surfaces for channel banks on Osborne Creek about 50 feet downstream from the proposed U.S. Highway 45 relocation near Wheeler, Mississippi.

Table 3.--*Bankfull channel width and widening on Osborne Creek at existing U.S. Highway 45 near Wheeler, Mississippi*

Year	Bankfull channel width (feet)	Total widening since 1953 (feet)
1936	33	0
1938	40	7
1954	50	17
1980	57	24
1988	66	33

Channel-widening processes at existing U.S. Highway 45 appear to be representative of processes about 0.9 mi upstream at the proposed relocation. The 1988 channel widths at both the existing U.S. Highway 45 and the proposed highway relocation were about 66 ft.

Available channel-width data from 1936 to 1988 indicate that the Osborne Creek channel widened about 33 ft at existing U.S. Highway 45. Two possible scenarios were analyzed at this site using the channel-width data to project near-future widening. For the first scenario (fig. 4), a log-linear regression of all available channel widths with respective times was used to define a channel-widening relation ($W = 33.0t^{+0.156}$, where t is time, in years since 1936). The second scenario was based on the assumption that the May 1983 flood altered the ongoing widening process that began in 1936. Therefore, log-linear regression of channel width with time was used to define a channel-widening relation from 1936 to 1983 ($W_1 = 33.5t_1^{+0.139}$, where t_1 is time, in years since 1936) and from 1983 to 1988 ($W_2 = 57.0t_2^{+0.0818}$, where t_2 is time, in years since 1983). The first and second scenarios projected 0 and 9 ft, respectively, of further widening by the year 2010 at existing U.S. Highway 45.

The possible aggradation period from 1962 to 1983 could not have significantly affected the channel-widening process. Aggradation totaled only about 1 ft and did not significantly reduce the bank heights. With no significant reduction in bank heights, the aggradation had no significant effect on reducing the rate of channel widening.

Estimates of near-future (10 to 20 years) widening can also be obtained by projecting the streambank slough-line angle on a plotted cross section (Simon and Hupp, 1986a). Projection of this slough-line angle on the banks was used where conditions were stable and vegetation was well established. On banks where a slough line had not developed, a temporary angle of stability was estimated by averaging the angle of internal friction of the bank material and the existing bank angle, a technique developed by Spangler and Handy (1973). By extending slough line and temporary angles of stability onto a channel cross section just upstream of existing U.S. Highway 45, 4 to 6 ft of near-future widening was projected. At the proposed relocation, about 7 to 18 ft of near-future widening was projected. The width with time relations, as previously presented, suggest it may take much longer than 20 years to approach 18 ft.

In summary, channel-widening processes at existing U.S. Highway 45 appear to be representative of processes at the proposed relocation. Two scenarios of a power function of bankfull channel width with time were used in conjunction with projecting streambank slough-line angles and temporary angles of stability. About 10 ft of additional widening could reasonably be expected through the year 2010 at existing U.S. Highway 45 and at the proposed relocation.

SUMMARY

The channel of Osborne Creek at existing U.S. Highway 45 near Wheeler, Mississippi, has degraded about 8 ft and widened about 33 ft since 1936. About 1 to 2 ft of further degradation and about 10 ft of additional widening could reasonably be expected through the year 2010 on Osborne Creek in the vicinity of existing U.S. Highway 45 and the proposed relocation. These projections are based on the assumption that no additional channel modifications and no unusually large and destructive flooding will occur by the year 2010.

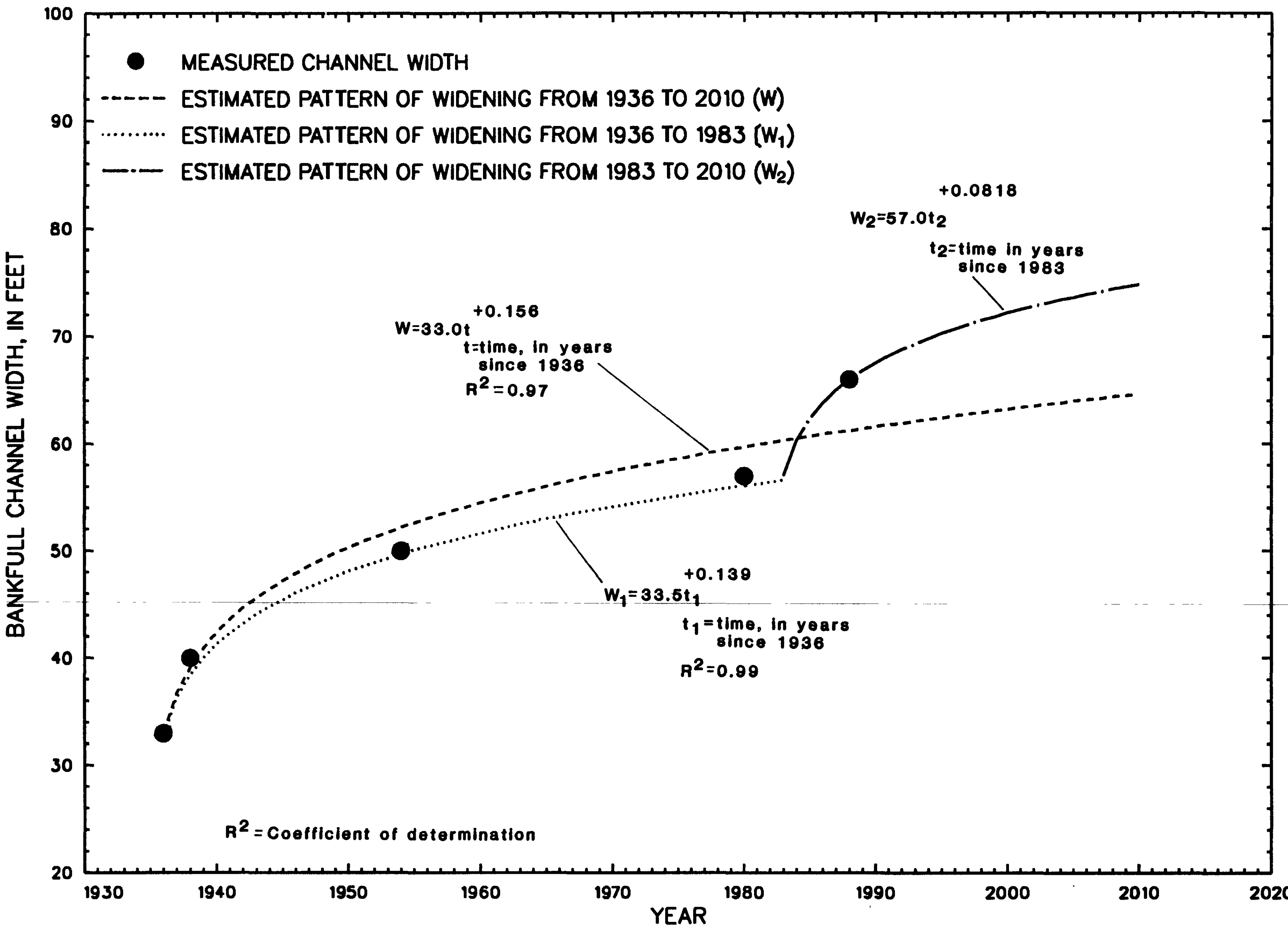

Figure 4.--Estimated patterns of channel widening on Osborne Creek at existing U.S. Highway 45 near Wheeler, Mississippi.

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