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TECHNICAL REPORT NO. 15

**BANK AND CHANNEL EROSION PROBLEMS AT  
TWENTY MILE CREEK, MISSISSIPPI**

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OCT 19 1989  
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September 1989

Committee on Channel Stabilization  
**CORPS OF ENGINEERS, US ARMY**

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## REPORTS OF COMMITTEE ON CHANNEL STABILIZATION

Technical Report	Title	Date
1	Symposium on Channel Stabilization Problems	
	Volume 1	Sep 1963
	Volume 2	May 1964
	Volume 3	Jun 1965
	Volume 4	Feb 1966
2	Review of Research on Channel Stabilization of the Mississippi River, 1931-1962	Sep 1963
3	Effect of Water Temperature on Discharge and Bed Configuration, Mississippi River at Red River Landing, La.	Aug 1966
4	Channel Stabilization Publications Available in Corps of Engineers Offices	Nov 1966
5	A Procedure for Computation of the Total River Sand Discharge and Detailed Distribution, Bed to Surface	Nov 1968
6	Water-Temperature Effects on Stage-Discharge Relations in Large Alluvial Rivers	Sep 1969
7	State of Knowledge of Channel Stabilization in Major Alluvial Rivers	Oct 1969
8	Channel Stabilization, Interoceanic Sea-Level Canal, Lower Atrato River Portion, Route 25, Colombia, South America	Oct 1969
9	Sedimentation Aspects, Project for Navigation and Flood Control, Lower Colorado River, Texas	May 1972
10	Chena River Lakes Project, Alaska, Problems Relating to Channel Development, Erosion, and Bank and Levee Protection	Mar 1973
11	Jackson Hole Flood Control Project	Mar 1974
12	Mississippi River and Tributaries Project, Problems Relating to Changes in Hydraulic Capacity of the Mississippi River	Aug 1974
13	Columbia-Cowlitz-Toutle Rivers, Washington, Restoration Subsequent to Mt. St. Helens Eruption	Sep 1985
14	Arizona Canal Diversion Channel, Selection of Roughness Coefficients for Designing the Concrete-Lined Channel	Sep 1985
15	Bank and Channel Erosion Problems at Twenty Mile Creek, Mississippi	Sep 1989

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Preface

Establishment of the Committee on Channel Stabilization in April 1962 was confirmed by Engineer Regulation 15-2-1, dated 1 November 1962, and re-authorized by ER 15-2-1, dated 25 June 1971 and 30 April 1980. As stated in ER 15-2-1, the objectives of the Committee, with respect to channel stabilization, are:

- a. To review and evaluate pertinent information and disseminate the results thereof.
- b. To determine the need for and recommend a program of research; and to accomplish advisory technical review of research when requested.
- c. To determine basic principles and design guidance.
- d. To provide, at the request of field offices, advice on design and operational problems.

This report consists of a study of bank and channel erosion problems at Twenty Mile Creek, Mississippi, prepared by the US Army Engineer District, Mobile, in 1981, outlining the problem and proposed remedial measures and Committee comments on the report.

Copies of this and other reports of the Committee on Channel Stabilization can be obtained from the US Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, Mississippi 39180-6199.



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BANK AND CHANNEL EROSION PROBLEMS AT  
TWENTY MILE CREEK, MISSISSIPPI

Introduction

1. General. Preparation of this report was directed by the Office of the Chief of Engineers in DAEN-CWB-E second indorsement dated 28 October 1980 to SAMPD-F letter of 15 February 1980 entitled "Reconsideration of Proposed Program for Resolving Bank and Channel Erosion Problems on Twenty Mile Creek, Prentiss, Lee, and Itawamba Counties, Mississippi." This report ~~was also~~ <sup>is</sup> proposed in the Twenty Mile Creek Plan of Work submitted to the US Army Engineer Division, South Atlantic (SAD), on 29 May 1981.

2. Severe erosion is evident in the upper reaches of Twenty Mile Creek. Congress has responded to the urgent requests for assistance from landowners by providing the authority to rectify the erosion problems and has provided funds for a "pilot" phase of streambank stabilization. It is anticipated that additional funding will be provided when a plan for more complete rectification is finalized. The funding provided by Congress was to construct "...two grade control structures with adjacent stabilization work, including planting willows..." (H.R. 96-934). This report presents the plan of action, design drawings, and costs associated with the pilot phase of the problem rectification. The report is to secure approval for the preparation of plans and specifications.

The Project

3. Background. Twenty Mile Creek is one of 22 streams entering the Tombigbee River that were authorized for modification in the interest of flood control by the Flood Control Act approved 3 July 1958 (P.L. 85-500). Twenty Mile was included in the first increment of work performed under that authority along with similar modifications on Big Browns, Mantachie, and Donovan Creeks. Work on the four streams was completed between December 1965 and November 1970 with the modification of Twenty Mile Creek in Itawamba and Lee Counties, Mississippi, being completed in December 1966. In January 1967, the completed project on Twenty Mile Creek was turned over to the local sponsor, Tombigbee River Valley Water Management District (TRVWMD), for operation and maintenance in accordance with the authorizing act.

4. Construction of flood-control work was confined to those limits shown for the individual streams in the project document (H.D. 167/34). On Twenty Mile Creek, the authorized project limits extended from the mouth of the creek in Itawamba County for about 61,700 ft (11.7 miles) to the Chappelville-Pratts Road Bridge crossing in Lee County (Plate 1). P.L. 96-304 modified the project to provide "for the design and construction of grade stabilization structures along Twenty Mile Creek, in Lee, Itawamba and Prentiss Counties, Mississippi, between mile 11.7 and mile 22.0" (Plate 2).

5. Problems in the Twenty Mile Creek project area were realized shortly after the project was completed. In April 1967, after only 4 months of project operation, the US Army Engineer District, Mobile (SAM), received a letter from the project sponsor, TRVWMD, that cited two complaints about caving and erosion of channel banks along the project. An inspection of the affected area made in April 1967 by SAM personnel verified that a problem existed. Subsequent to the April 1967 letter, many other complaints relative to bank erosion have been received by TRVWMD. In addition, complaints have been received about flooding and associated sedimentation on cultivated lands due to flooding. Considerable correspondence and verbal requests for investigation and assistance have been received from TRVWMD.

6. During 1977, a program was recommended to higher authority under which all completed projects on the streams in the basin would be investigated to determine the necessary remedial requirements. The study would have had as its objective the identification of causes, effects, remedies, and responsibilities and appropriate actions for both the Corps of Engineers and TRVWMD to undertake to assure the future integrity of the project.

7. Twenty Mile Creek was selected for study since it is typical of the completed tributary projects. A discussion between the Division Engineer (SAD) and the Mobile District Engineer led to the preparation of a letter report that described the overall problem. That letter report was prepared and submitted on 22 February 1979 and recommended construction of two "pilot" grade-control structures, one of which would be within the project limits and the other located upstream of the project limits to arrest the continuing extension of the erosion problem. It was recommended that both structures be constructed under the authority provided by Section 32 of the Water Resources Development Act of 1974. OCE's 3d Indorsement to the report stated that the problem should be investigated under the outstanding survey report authority rather than

under the Section 32 program. Congressional and local interests were informed of that decision.

8. In response to an inquiry by Congressman Whitten, he was informed on 16 November 1979 that efforts were under way to resolve the Twenty Mile Creek problem. Subsequently, Mr. Whitten's staff inquired with regard to what can be done expeditiously to alleviate the head cutting and erosion problems. When this matter was discussed with SADPD, it was suggested that the District retrace the previous decision to conduct the studies under survey authority. It was the District's contention that the only existing authority under which immediate reaction could be provided would be Section 32 since the problem is outside of the project limits and the request for reconsideration was prepared on that basis and submitted 15 February 1980. SAD's 1st Indorsement to the retrace (14 March 1980) requested reconsideration for authorization of the needed work under Section 32 or as a correctable design deficiency. SAM was contacted at various times to discuss OCE's drafts of legislation that would authorize the needed work.

9. Subsequently, the Congress authorized the modifications to Twenty Mile Creek project in P.L. 96-304 which negated the necessity for a response to the retrace. This legislation provided the authority for the "pilot" bank stabilization measures presented in this report and discussed in the Twenty Mile Creek "Plan of Work" submitted to SAD on 29 May 1981.

10. Original project designs. The original project designs used for construction plans on the tributaries were typical of that period. In each case, lowering of flood stages was accomplished by channel excavation, snagging, and clearing. The design flows and frequencies for the channel sizes were selected by maximizing the project economics on each stream.

11. Design adequacy. The Twenty Mile Creek modified channel was designed to contain a flood having a 0.33-year frequency of exceedance based on the maximization studies. Channel dimensions and the invert slope were designed to accommodate flows of that frequency. Whereas it was expected that some erosion and deposition would take place due to the work, as reflected in the annual maintenance cost estimated for the project, it is apparent that no allowance was made in the design for the prevention of the severe erosion and deposition problems which have occurred. Furthermore, the erosion and deposition that followed project completion were left essentially unchecked except for maintenance excavation in the downstream reaches by TRVWMD.

Provisions were not made at the upstream end of the project to restore hydraulic and sediment transport characteristics to natural conditions.

### Effects of the Project

12. Changes in land use. With the relief from flooding afforded by the project, land that has previously been either marginally suited or totally unavailable for cultivation was brought into production. The actual amount of land brought under cultivation is not known without a detailed analysis and consultations with local US Soil Conservation Service (SCS) and Agricultural Stabilization and Conservation Service (ASCS) personnel within the three affected counties. These changes in land use within the Twenty Mile Creek floodplain have contributed to the amount of sediment entering the stream. The Twenty Mile Creek watershed is characterized by easily erodible soils. As these soils are cultivated and exposed to rainfall, the runoff contains more sediment than would be the case if it were pastureland or timberland. Consequently, the sediment load to the creek is increased. Another contributing factor to the sediment load is the recent conversion of large amounts of pastureland to cultivation. This change resulted from a severely depressed beef cattle market about 6 years ago that forced many farmers to turn to other, more profitable agricultural practices; the planting of soybeans was the most popular alternative. This further cultivation in an area of moderate to high topographic relief contributes additional sediment runoff.

13. Stream conditions. Construction of the project through the excavation of a wider, and in instances deeper, channel with the removal of brush, trees, and snags has contributed to the alteration of flow conditions in the stream. Under the original construction work, the thalweg of the stream was lowered from the mouth to a point 9.1 miles upstream by channel excavation (Plate 1). The project also involved clearing and snagging along the natural channel for 2.6 additional miles upstream from the excavated section. The combination of these changes lowered the water-surface elevation immediately following completion of the project in the 11.7-mile reach, while maintaining essentially the natural grade upstream of the project. Under project conditions, the increased hydraulic gradient of the modified channel resulted in a steeper water-surface slope with increased water velocities. The greatest changes in velocity occurred in the transition area between the upstream limits

of the project and the natural channel. The increased velocities and increased slope added to the sediment-carrying capabilities of the stream. Because of this changed condition, soil was eroded by the flow from the banks and bottom of the stream. This unstable condition was extended upstream about 10 miles, primarily by the process termed "head cutting."

14. Effects on tributaries. In the upper portion of the project, water-surface levels have been reduced below those predicted. This is a result of the cross-sectional area of the stream having been increased by erosion and accompanying channel degradation after completion of the project. Because of the creek's increased capacity and changed slope and velocity, secondary erosion problems have been created along its tributaries. These problems include head cutting and bank sloughing.

#### Problem Identification

15. Basic problem. The three basic problems identified in connection with the Twenty Mile Creek project have been discussed in previous paragraphs of this report within the context of causative or project-produced impacts. Briefly, the identified problems are as follows:

a. Erosion. This problem is occurring within the project limits (above mile 5.5) and is progressing upstream along the creek and its tributaries through the process of head cutting.

b. Bank sloughing. This problem is attendant with and related to the channel erosion problem.

c. Sediment deposition. This problem is confined to the lower 5.5 miles of the project and is caused by the high level of transported sediments entering the low-velocity stream area near the mouth of the creek.

16. Related problems. There are additional related problems which were identified that are either a part of, or a direct result of, the basic problems listed above. They are as follows:

a. Loss of functional utility of the lower reach of the project in providing flood control without continual maintenance by the local sponsor.

b. Loss of floodplain soils from erosion due to clearing and changes in land use.

c. Endangering of bridges and loss of farm acreage due to bank sloughing.

d. Increase in the scope, complexity, and cost of maintenance work required to assure the continuation of the project in an "as-designated" status.

#### Plan of Action

17. Previous work. The most expeditious method for providing protection under the pilot plan involved the planting and establishing of "willows" and similar fast-growing vegetation (maidencane) along selected areas of the project. Contacts were made with the SCS for the acquisition of 1,500 plantings of reed grass. Willow trees were available in areas near the project. The willow planting was delayed by protest from the low bidder whose bid was excessive, but the work was readvertised with new bids opened 6 January 1981. Planting commenced in February 1981 and was completed in March 1981. The plantings were made in the vicinity of the proposed grade-control structures shown in Plate 2.

18. Description of proposed structures. Based on the previous studies which led to the letter report of 22 February 1979, subsequent studies and surveys of Twenty Mile Creek, guidance from higher authority, and discussions with personnel from the SCS, it is believed that the resolution of the identified problems must begin with the installation of grade-control structures. Without some means to retard the head cutting or channel erosion first, there is little likelihood that streambank stabilization efforts can achieve more than limited or localized success. Therefore the primary focus of the "pilot" phase is to install two grade-control structures and evaluate their effectiveness. In conjunction with these grade-control structures, it is planned to install approximately 4,000 lin ft of bank stabilization structures in the form of concrete jacks and slotted board fence, similar to those used by the SCS (Plates 3 and 4).

19. The locations of all these structures were chosen to facilitate ease of access to the sites for construction and monitoring and also to place them in locations where maximum utility of the structures can be achieved.

20. Grade-control structure No. 1 (mile 11.7). This structure will be located just downstream from the Chappelville-Pratts Road Bridge, near the upper limit of the original flood-control project on Twenty Mile Creek. This location was chosen because of the ease of access for construction and

monitoring and because of severe erosion problems in this reach. The structure should also help alleviate the erosive forces that attack the bridge abutments and piers.

21. The structure will consist of riprap and grouted gabions with a steel sheet-pile weir section (Plates 5a and 5b). The bank protection will extend from top of bank down across the channel bottom and up to the opposite top of bank. The structure will be located about 50 ft downstream from the bridge and will extend downstream about 150 ft. The steel sheet-pile weir will be located about 100 ft downstream from the bridge and will be about 10 ft above the channel bottom. A small V-notch will be cut in the weir down to about 5 ft above the channel bottom to pass low flows, so the weir will impound about 5 ft of water initially until deposition occurs upstream of the structure. The weir structure is sufficiently low, however, to have no significant effect at bank-full flood stages.

22. The banks in this area are unstable with nearly vertical slopes resulting from active sloughing. The banks will be graded to 1V on 4H in the vicinity of the structure and protected with riprap. Willow and maidencane plantings have been made just upstream of the Chappelville-Pratts Bridge as a demonstration attempt to stabilize the eroding banks. Selected streambanks just upstream of the bridge will be used to place 1,000 lin ft of concrete jacks and 1,000 lin ft of slotted board fences, with exact locations to be chosen prior to completion of plans and specifications. These structures have been successfully used by the SCS in other creeks in the vicinity with similar erosion problems.

23. Grade-control structure No. 2 (mile 19.9). This grade-control structure will be located on an outcrop of erosion-resistant material about 3,500 ft downstream from the ICG RR crossing. This structure was located at this site because severe head cutting has not yet progressed beyond the outcrop material. Although some accelerated erosion is evident upstream from this area, it is felt that this is a critical area which needs priority attention in arresting the channel erosion. A very large scour hole has developed downstream from this structure location.

24. The grade-control structure will be similar to structure No. 1 except that a 5-ft-high stone or gabion weir will be used instead of a sheet-pile weir and the banks will be graded to 1V on 3H in the vicinity of the structure (Plates 6a and 6b). Willow and maidencane plantings have been made

just downstream from this location to evaluate their effects near the scour hole. Concrete jacks and slotted board fences will also be constructed within 1/2 mile downstream of this grade-control structure, with the exact locations to be chosen prior to completion of plans and specifications.

25. Real estate requirements. There are two considerations to evaluate in arriving at a course of action for real estate acquisition. It is necessary only to: (a) acquire enough land to construct, maintain, and monitor the structures, or (b) should a partial real estate solution be an integral part of the pilot stabilization project?

26. As noted previously, the ultimate solution for the erosion problems being experienced along the Twenty Mile Creek water course will probably involve an extended period of time. The continued erosion of the landowners' property within the 10.3-mile segment extending upstream of the original project limits (P.L. 96-304) is, however, a very sensitive issue in the area. It has been the subject of repeated congressional interest, and the Corps has received extensive exposure of an adverse nature in the local media. It is believed that the property owners, who claim to have lost in excess of 500 acres to erosive action along the creek, will not be fully appreciative of the extended period of time required by the Corps to complete its analysis and formulate an effective and feasible physical solution to the erosion problem. Some of the property owners have retained counsel, and it would be a reasonable expectation that early litigation will ensue unless some timely measures are administratively initiated by the Government to address the owners' continued loss of property.

27. While definitive proposals for corrective action of any physical nature must await completion of the plan of study presented herein, it is considered a certainty that the final plan will involve a combination of grade stabilization structures and bank protective work in the nature of slope moderation, grassing, and riprap placement. Since these operations may for the most part involve the acquisition of additional land interests throughout the 10.3-mile reach addressed in P.L. 96-304, it would seem advisable that such acquisition proceed at an early date to ameliorate the concerns of those property owners where the erosion is now prevalent. We would envision a Channel Improvement Easement (EP 405-1-2) over an area measured perpendicular from the center line of the creek a sufficient distance to provide about 100 ft landward of the top of the existing bank. This area is considered

sufficient to accommodate the installation of grade stabilization structures as well as any bank sloping which would be necessary incident to grassing, placement of riprap, or the accomplishment of some other form of physical protection.

28. A cursory appraisal, based on land values developed for the nearby Tennessee-Tombigbee Project, would indicate that the cost of an easement involving a 100-ft strip of land on each side of the creek for the entire reach under study (an area of about 280 acres) would approximate \$280,000. Maximum acquisition costs for the estimated 100 ownerships that would be affected is about \$200,000. We recognize that some of the property owners will raise the issue of compensation for lands already lost to bank erosion. In this eventuality, it is felt that the Corps' position would be one of immunity from such damages under Section 702c of the Flood Control Act of 1928 coupled with the obligation of the project sponsor to provide all land interests on the initially authorized segment of project as well as to indemnify and save harmless the Government from any claims for damages arising out of the construction of the initial phase of the project. The 10.3 miles of the project authorized by P.L. 96-304, however, does not provide for a local sponsor; and it is considered that all real estate interests required for the authorized work is a Federal responsibility and the acquisition as proposed herein would be within the purview of this legislation.

29. If only enough land is acquired for the structural implementation of the pilot program, only about 3 acres must be acquired at an estimated cost of \$28,000 including acquisition costs.

30. It appears that sufficient funds are currently available not only to implement the structural pilot plan but also to acquire real estate easements sufficient for the monitoring period. The extent of real estate acquisition would be determined, based on availability of funds, and presented in a subsequent real estate report. For the purposes of this report and in developing projected costs, however, the real estate costs are limited to the requirements for the structural implementation only.

31. Environmental compliance. An environmental assessment and Section 404(b)(1) evaluation will be conducted for the proposed activity. The proposed action will be coordinated with Federal, State, and local agencies and the public by way of a Section 404 public notice. State of Mississippi water quality certification will be obtained prior to initiation of the work.

32. SCS involvement. The Mobile District has always had a good working relation with the SCS in Mississippi. Congressman Whitten had suggested that the District meet with the SCS and discuss the Twenty Mile Creek problem and compare various streambank protection methods used by each agency. During August 1980, representatives from Mobile met in Tupelo, Mississippi, with the SCS and also toured nearby projects where the SCS had employed various bank stabilization methods. The SCS representatives agreed that the most pressing need was for some grade-control structures to retard head cutting on Twenty Mile Creek, complemented by the use of other methods such as concrete jacks and slotted board fences for bank stabilization. The Corps concurs in this approach and this is essentially the plan of action.

33. The SCS has requested that they be kept informed of our activities on Twenty Mile Creek and the Mobile District will endeavor to do this. Since the SCS has much experience with the installation of the concrete jacks and slotted board fences, they will be consulted before installation of these structures is finalized.

34. Cultural resources. Coordination with the Mississippi Historic Preservation Officer revealed the presence of two known archeological sites in the project area which may be affected by construction of the proposed structures. Prior to finalization of plans and specifications, a cultural resources survey will be conducted to determine whether the recorded archeological sites or other significant cultural resources will be affected by this action. The report of this survey will be coordinated with the State Historic Preservation Officer.

#### Cost Estimates and Construction Schedule

35. Cost of structures. The cost estimates for the structures are shown in the following table. The costs for the concrete jacks and slotted board fence are for 2,000 lin ft of bank protection for each type of structure. All unit costs are based on July 1981 price levels.

36. Construction schedule. It is anticipated that plans and specifications will be completed by 30 September 1981. Completion of the environmental compliance, acquisition of real estate, and coordination with State and Federal agencies should all be finalized by 15 October 1981. Advertisement of the construction contract is scheduled for 31 October with contract award on

Table of Costs

<u>Description of Work</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Cost</u>	<u>Total Cost</u>
<u>Grade-Control Structure at Mile 11.7</u>				
Earth Excavation/Fill	12,000	cu yd	3.50	\$ 42,000
Riprap Stone	2,400	cu yd	44.00	105,600
Bedding Material	1,525	cu yd	10.00	15,250
Grouted Gabions	1,015	cu yd	80.00	81,200
Filter Cloth	6,100	sq yd	4.00	24,400
Steel Sheet Pile (PZ27)	100	tons	1,100.00	110,000
Water Control: Ditch and Dike	1,000	cu yd	2.00	2,000
Sand Bag Dike	2,000	bags	4.50	9,000
Pumping	200	hours	21.00	4,200
Subtotal				\$393,650
<u>Grade-Control Structure at Mile 19.9</u>				
Earth Excavation/Fill	8,300	cu yd	3.50	29,050
Riprap Stone	2,000	cu yd	44.00	88,000
Bedding Material	800	cu yd	10.00	8,000
Filter Cloth	3,200	sq yd	4.00	12,800
Water Control: Ditch and Dike	500	cu yd	2.00	1,000
Sand Bag Dike	1,000	bags	4.50	4,500
Pumping	100	hours	21.00	2,100
Subtotal				\$145,450
<u>Bank Stabilization Structures Mile 11.7</u>				
Install Concrete Jacks	1,000	lin ft	55.00	55,000
Install Slotted Board Fence	1,000	lin ft	85.00	85,000
Subtotal				\$140,000
<u>Bank Stabilization Structures Mile 19.9</u>				
Install Concrete Jacks	1,000	lin ft	55.00	55,000
Install Slotted Board Fence	1,000	lin ft	85.00	85,000
Subtotal				\$140,000
<u>Real Estate Costs</u>				
Land and Acquisition				\$ 28,000
Total Costs				\$847,100
Contingencies at 15%				127,065
Total Construction Costs				<u>\$974,165</u>

30 December 1981. Construction should commence in the spring of 1982, after the high-water season has passed.

#### Conclusions and Recommendation

37. The problem. Based on the presently known extent, magnitude and probable continuation and worsening of the erosion, bank sloughing, and head cutting problems on Twenty Mile Creek and its tributaries, it is concluded that alleviation of those problems will involve a comprehensive approach and a solution is urgently needed. It can be concluded that allowing the stream to reestablish itself naturally would involve a continuation of the problems for an indeterminate period with a magnification of economic and environmental losses. At a minimum, the problem will produce further expressions of dissatisfaction and concern.

38. The selected plan. In view of the nature of the problem and its probable future, it is concluded that a solution appears likely through the implementation of a structural plan involving grade-control structures and bank and channel stabilization work. Prior to undertaking the full implementation of such a plan, an evaluation of the effectiveness of the proposed structures in controlling erosion, bank sloughing and head cutting will be carried out as suggested by the existing project authority.

39. Recommendation. It is recommended that the necessary work on Twenty Mile Creek, as described in this report, be approved for preparation of plans and specifications under the authority of P.L. 96-304, at a cost of approximately \$975,000.

#### Comments of Committee on Channel Stabilization

40. The District should recognize that the "pilot" project may not yield highly significant response relative to alleviating the problems in Twenty Mile Creek. Evaluation and analysis of the system to determine what the stream is doing are important. If the "pilot" project does not appear to be producing a desirable response, the District should proceed with plans, based on WES reports and experience from other projects, designed to alleviate the problems at the problem locations. The District should consider a number of small, inexpensive structures in lieu of a single large structure proposed to

control a long reach. The meandering process should receive careful attention. It is a long-term process and has the potential for excessive future additional damage. Bank stabilization alternatives should be assigned a high priority. Experiences of other Corps offices such as Missouri River Division, which have had extensive experience in grade control and bank stabilization design, should be utilized on a consulting basis in design activities. Coordination and discussion with pertinent agencies outside the Corps, SCS for example, should be continued.

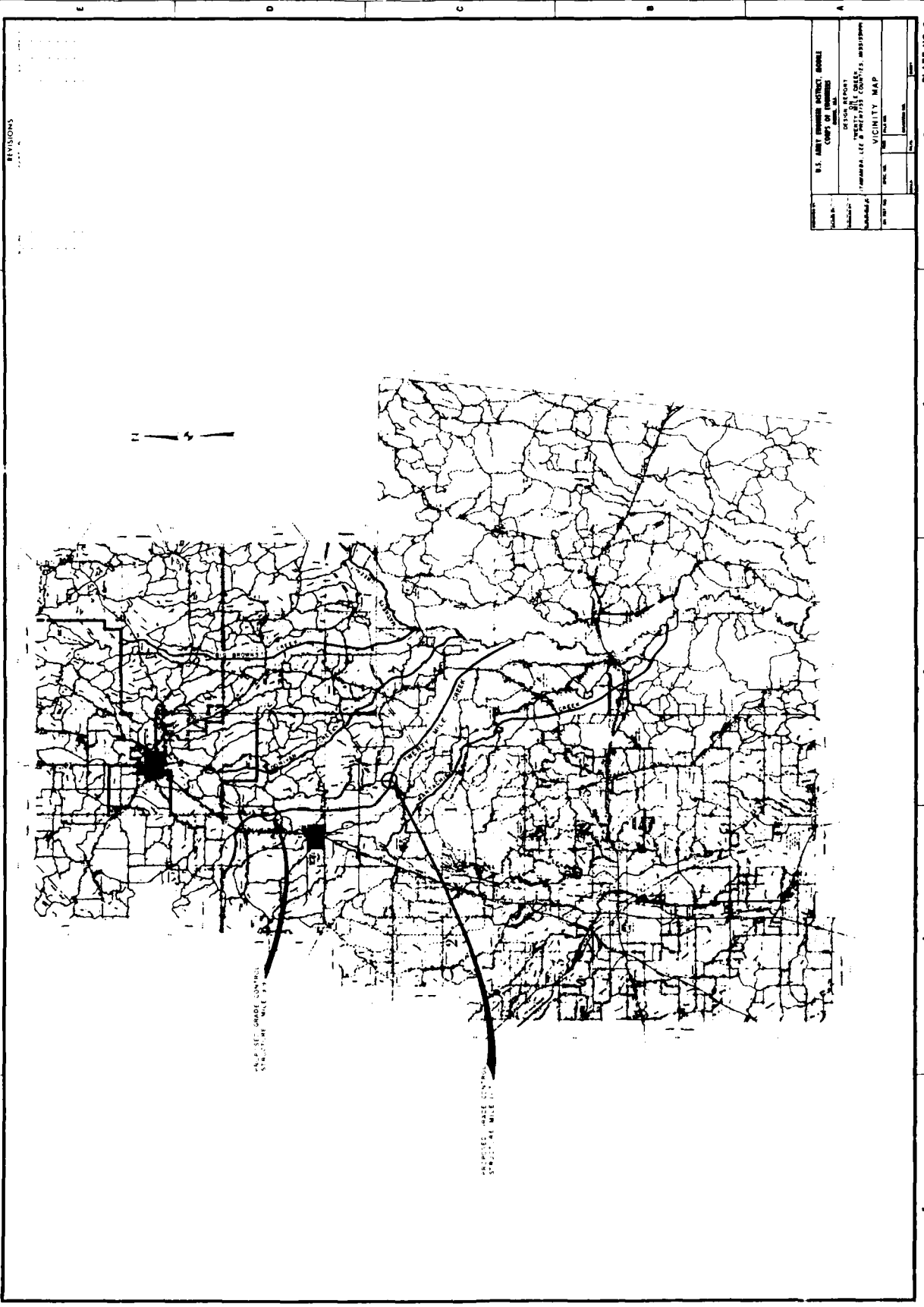
41. Documentation of the problems, solutions tried, solutions successful, and future changes in the project is important and should receive careful attention. The types of problems on Twenty Mile Creek are common to many small flood-control projects all over the country; therefore information on this project could be very beneficial in other projects.



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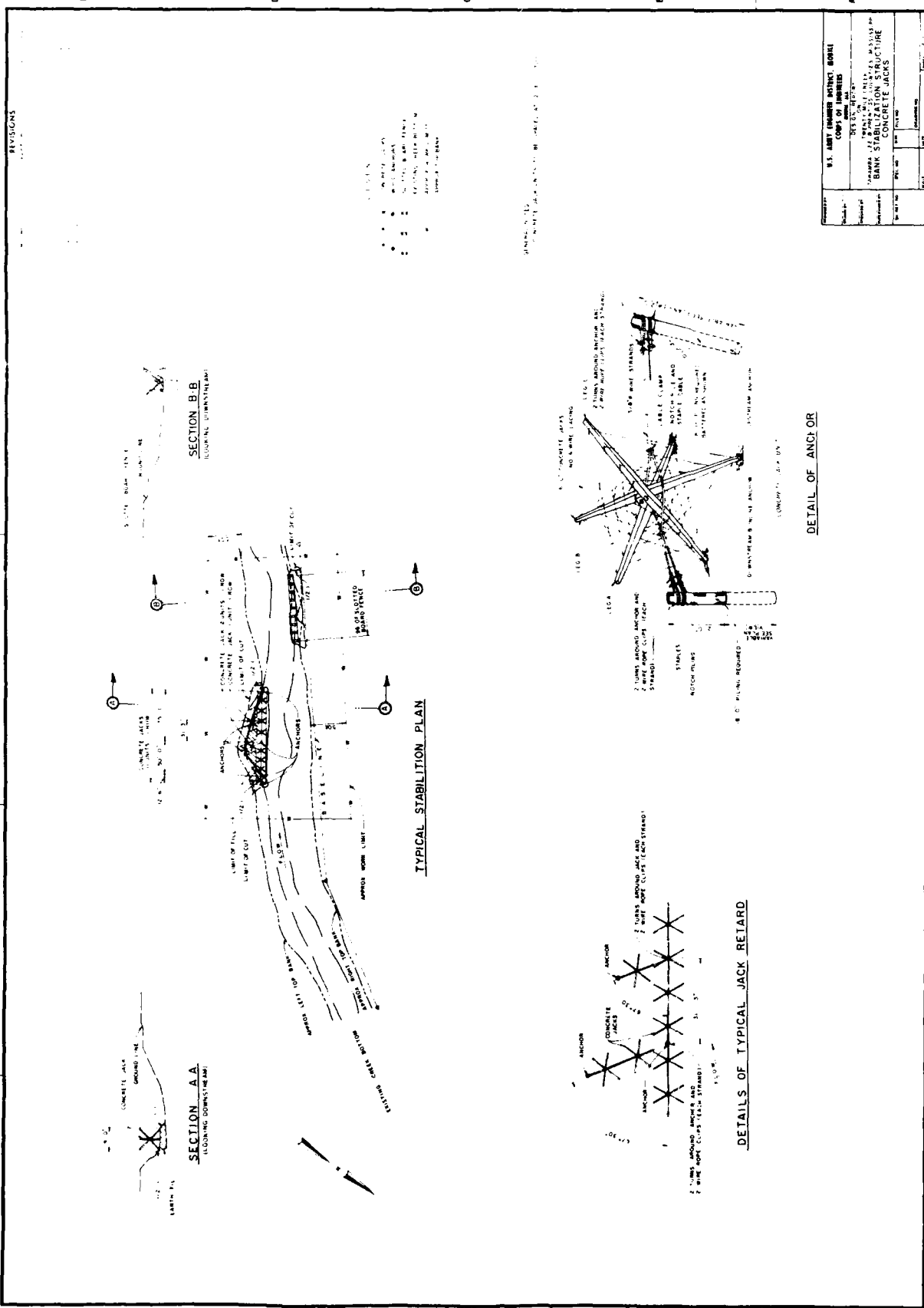
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REVISIONS



U.S. ARMY DISTRICT ENGINEER	
CORPS OF ENGINEERS	
DATE	DESIGN REPORT
PROJECT	MEMPHIS, TENNESSEE
MAP	VICINITY MAP
NO. 100	PLATE NO. 2

PLATE NO. 2



- 1/2" CONCRETE JACK
- 1/2" ANCHOR
- 1/2" ANCHOR BOLT
- 1/2" ANCHOR BOLT W/ WEDGE
- 1/2" ANCHOR BOLT W/ WEDGE & NUT
- 1/2" ANCHOR BOLT W/ WEDGE & NUT & WASHER
- 1/2" ANCHOR BOLT W/ WEDGE & NUT & WASHER & LOCKWASHER
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CHECKED BY: [unreadable]	
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DATE: [unreadable]	
PROJECT: [unreadable]	
SHEET NO. [unreadable]	
TOTAL SHEETS: [unreadable]	



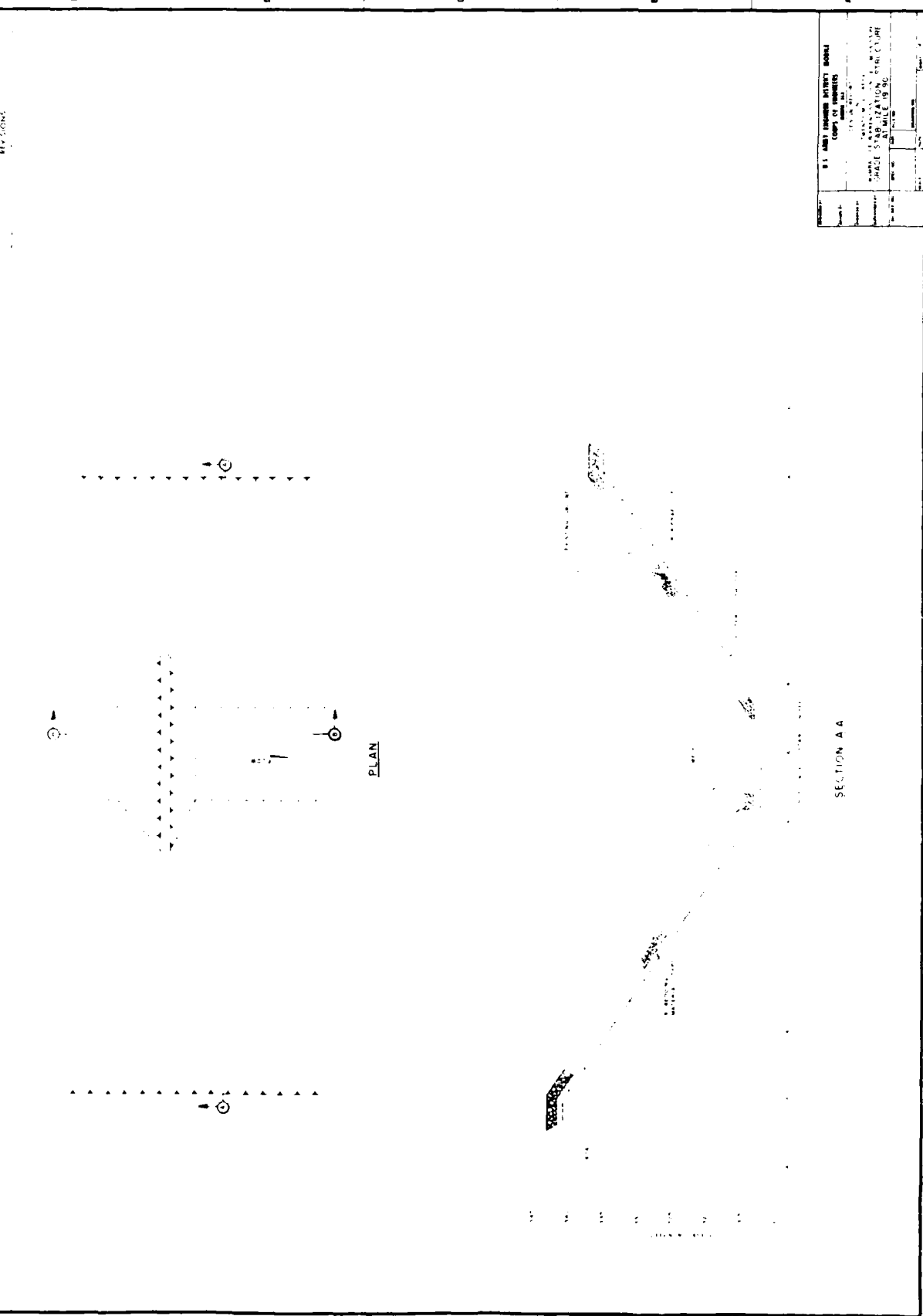




U.S. ARMY

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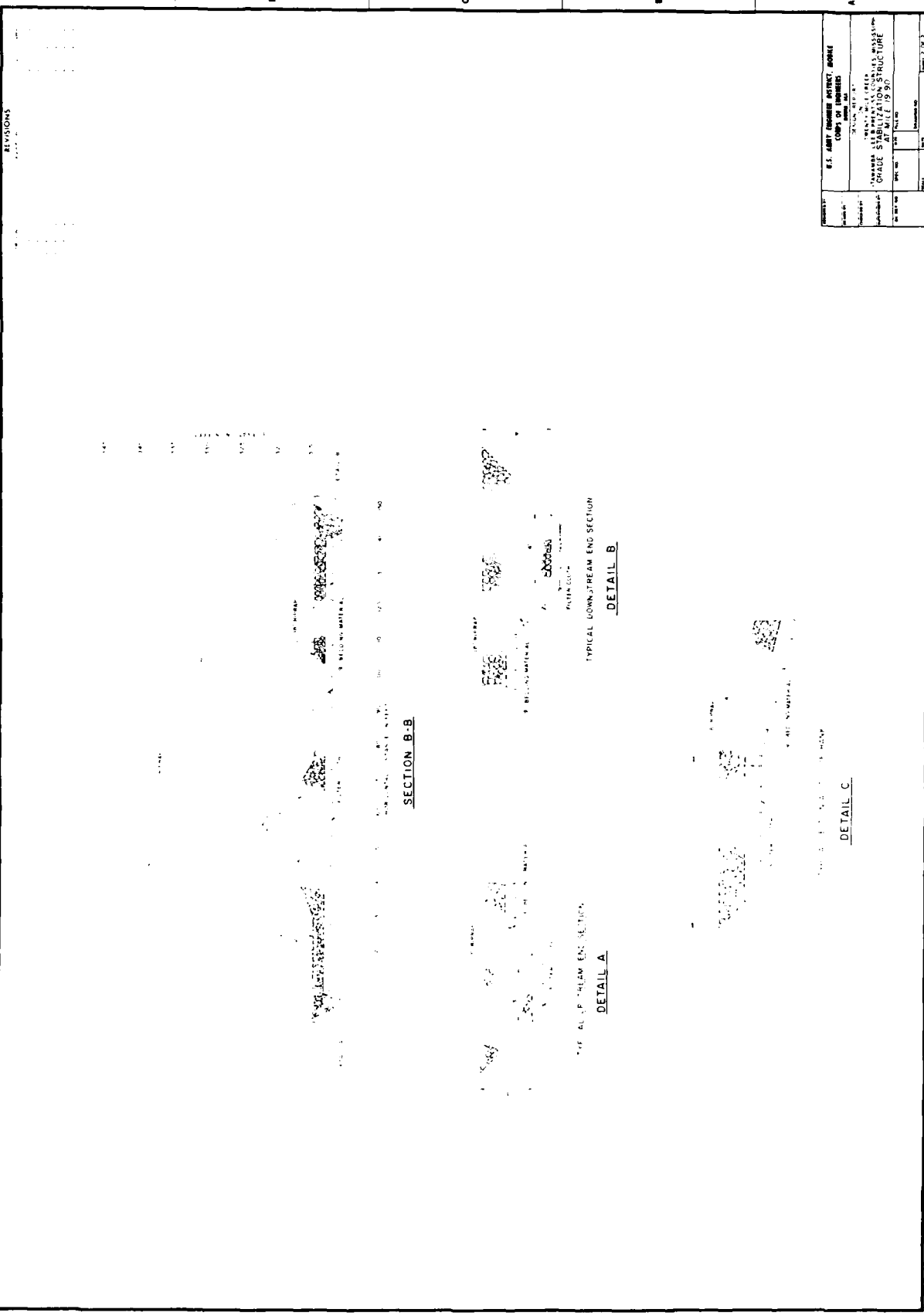
CORPS OF ENGINEERS



U.S. ARMY ENGINEERING DISTRICT BOARD	
CORPS OF ENGINEERS	
Project No.	100-100-100-100
Sheet No.	100-100-100-100
Scale	1/4" = 1'-0"
Author	100-100-100-100
Check	100-100-100-100
Approved	100-100-100-100
Date	100-100-100-100
ENGINEERING DISTRICT BOARD	
OFFICE OF THE DISTRICT ENGINEER	
WASHINGTON, D.C.	

PLATE NO. 5

PLATE 6a



REVISIONS

U.S. ARMY ENGINEER DISTRICT		CORPS OF ENGINEERS	
Project No.	Sheet No.	Scale	Plate No. 6
TITLE: TYPICAL DOWN-STREAM END SECTION GRADE STABILIZATION STRUCTURE DATE: 12 20 50			
Author	Checked	Designed	Drawn