ECHOTA BEND
BANK STABILIZATION PROJECT:
IMPLEMENTATION REPORT

FY 92 104(B)(3)

Russell C. Dutnell, P.E.
Environmental Engineer
Oklahoma Conservation Commission

September 19, 1997

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1.0 INTRODUCTION

Echota Bend is located on the Illinois River northeast of Tahlequah, Oklahoma about one mile north of U.S. Highway 62 in the northwest quarter of Section 24, Township 17 North, Range 22 East, Cherokee County (Figure 1). Echota Bend is an unstable bend of the Illinois River characterized by a 15 to 20 foot high eroding bank. Aerial photography indicates that the bank migrated approximately 500 feet down valley between 1938 and 1990. The banks have continued to erode at a rate of approximately 10 feet a year since that time. It has been roughly estimated that approximately 200,000 yd^3 of material has been lost from this site since 1938.

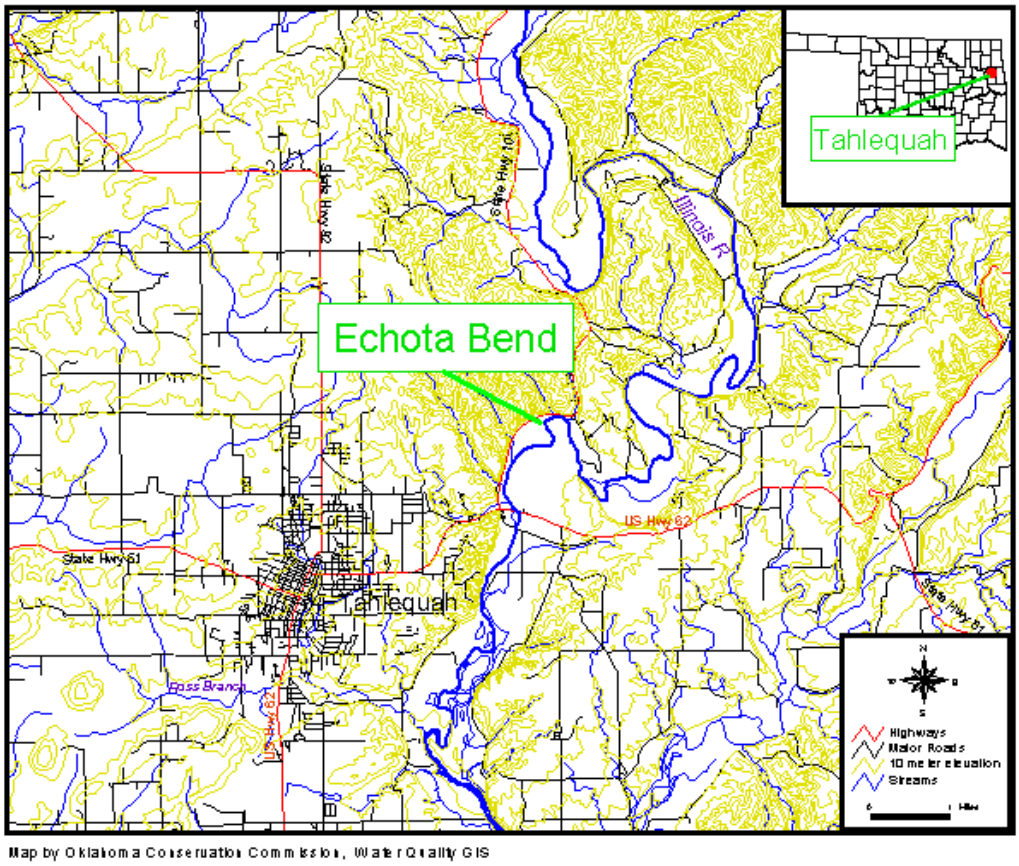


Figure 1: Echota Bend project location.

Figure 2 shows an aerial photograph of the site taken shortly before implementation of the project (February, 1997). It can be seen that the channel splits into two branches at the bend. The flow at the time the picture was taken was significantly above base flow, but not at bankfull (See Appendix A for definition). At base flow the channel would have been confined to the inner (left) branch. The outer (right) branch would be cut off at the upper end with backwater on the lower end. Figures 3 and 4 show the site from ground level looking downstream and upstream, respectively. These pictures were also taken shortly before implementation during a period of relatively high flow.

The Oklahoma Conservation Commission (OCC) and the Oklahoma Scenic Rivers Commission (OSRC) proposed that a riparian corridor restoration project be undertaken to prevent further erosion. Rather than using traditional "hard control" methods such as rip-rap or gabion baskets, which are generally ineffective, unsightly, and extremely costly, OCC and OSRC proposed to incorporate the principles of fluvial geomorphology into a design that would consider the natural tendencies of the river and work with the river rather than against it. In addition, stability would be provided in such a way as to maintain the scenic beauty of the river. OCC applied for and received an FY 92 104(b)(3) wetlands grant from EPA to provide funding for the project.

This report presents a summary of the project including design, permitting requirements, implementation, and project cost. Discussions on lessons learned, project publicity, future educational plans and recommendations on future monitoring are also presented.

Figure 2: Aerial photograph of Echota Bend (February, 1997).

Figure 3: Echota Bend looking downstream before construction (March, 1997).

Figure 4: Echota Bend looking upstream before construction (March, 1997).

2.0 BACKGROUND

The techniques employed in this project were developed by Dave Rosgen (1996), continuing and expanding upon work performed by L.B. Leopold (1964, 1994), M.G. Wolman (1954), and many others. The techniques involve assessing the fluvial geomorphology in the system, determining the "stream type" of the river, and physically modifying the channel geometry to a stable configuration. These techniques, though tried and proven elsewhere in the country, have never been attempted in Oklahoma.

The benefits of these techniques are numerous. Erosion rates are reduced resulting in a reduction of sediment load to rivers and downstream reservoirs. Valuable riparian areas are protected and often enhanced. Aquatic habitat is restored and water quality is often improved. These techniques are also more aesthetically pleasing than traditional methods in that natural, often native, materials are utilized. This encourages the establishment of native vegetation, thereby restoring the natural conditions of the stream bank.

A final benefit of employing these techniques in this project is educational. As more engineers and resource conservationists are exposed to these methods they will gain more acceptance and use, and will one day replace the traditional methods that utilize mostly hard control with little or no consideration of the stream's natural tendencies.

Determining the proper configuration of a stream is not a cookbook procedure that can be done from a desk. Rather it requires going to the field, getting in the stream, making observations and taking measurements. OCC personnel with the assistance of personnel from OSRC and the Oklahoma Department of Environmental Quality (DEQ) spent several days on the Illinois River surveying cross-sections and longitudinal profiles. Measurements were taken above and below the project area and at the U.S.G.S. gauge station approximately two miles downstream of the project area. An extensive survey of the project area was conducted to determine the existing morphology. This information was then processed along with hydraulic information obtained from the U.S.G.S. to determine the natural configuration of the river.

A summary of Rosgen's classification system, the stream classification for Echota Bend, and the channel modification design were included in a previous report titled "Proposed Design for the Stabilization of Echota Bend in Cherokee County, Oklahoma". That report is included in Appendix A where the reader is referred for additional information.

3.0 DESIGN

After the data was collected and analyzed to determine the natural configuration of the river, the proposed channel dimensions were determined and design drawings were prepared. Details of the design employed in this project, including the plans, were also included in the previous report titled "Proposed Design for the Stabilization of Echota Bend in Cherokee County, Oklahoma". That report is included in Appendix A where the reader is referred for additional information on the design.

4.0 PERMIT REQUIREMENTS

Implementation of stream bank stabilization projects typically necessitate obtaining permits. The permits required for this project included an Oklahoma water quality (401) certification from the Oklahoma Department of Environmental Quality and a 404 permit from the U.S. Army Corps of Engineers. Copies of the report, "Proposed Design for the Stabilization of Echota Bend in Cherokee County, Oklahoma", along with the requisite paper work were sent to the respective agencies and the permits were issued some time thereafter.

5.0 IMPLEMENTATION

Although the project would not have been possible without planning and preparation, implementation would ultimately determine the success or failure of the project. The implementation phase of the project consisted of three components; construction, planting, and miscellaneous tasks. Each of these components will be addressed below.

Construction

Implementation of the project required moving large amounts of material including dirt, trees and rocks. The most cost effective means of doing this would have been to lease big modern machinery and to hire skilled operators to run it. Unfortunately, this was not an option for this project since operators, skilled or unskilled, were unknown to OCC. Equipment was therefore hired at an hourly rate with operators provided.

Several contractors were contacted and bid requests were sent for the equipment needed. Bids were received on all of the equipment needed except for a trackhoe with a live thumb, which seem to be rare in the region. Fortunately, the week before construction was to begin, a track hoe with a live thumb was observed doing work along I-44 near Tulsa. It happened to be available so it was hired for the project. In the end, equipment was obtained from four separate contractors; Patton Construction, Sooner Emergency Services, Tonto Construction and Yocham Trucking. The equipment used for the project and the contractors that provided them are listed below.

CAT 320L Trackhoe (Patton)
CAT 936E Loader (Patton)
CAT 960F Loader (Patton)
CAT D6H Dozer (Patton)
CAT D8 Dozer (Patton)
120 G Road grader (Patton)
John Deer 590D Trackhoe with live thumb (Sooner)
John Deer 892 D-LC Trackhoe with dead thumb (Tonto)
John Deer 544E Loader (Tonto)
Cat D7 Dozer (Yocham)

In addition, Rusty McKee from Chimney Rock, Colorado was contracted to assist with the project. Rusty is an equipment operator who has been working with Dave Rosgen for almost 15 years. Because this was the first project of this nature implemented in the state, it was thought that Rusty's experience would be invaluable to the success of the project. This proved to be the case as Rusty is both an excellent operator and instructor. His ability to communicate with the other operators was vital to the success of the project.

Construction was initiated on (Cinco de Mayo) May 5, 1997. Working from 7:00 AM to 8:00 PM each day, construction was completed ten days later on May 14, 1997. Approximately 25,000 yd^3 of material was moved, 19 loads of rock were shipped in, and 17 root wad revetments and 2 rock veins (bendway weirs) were installed. The channel was rerouted, an oxbow lake was constructed and the high bank was sloped back. Figures 5 - 12 show construction in progress.

Figure 13 shows an aerial photograph of the site during construction. The temporary diversion, the existing channel and the design channel can all be seen in the photograph. Several of the root wad revetments and stockpiled material may also be observed.

Figure 5: Completion of channel diversion.

Figure 6: Clearing and shaping of new channel.

Figure 7: Unloading of rock (1 of 19 loads at $300/load).

Figure 8: Installation of root wad revetment.

Figure 9: Installation of root wad revetment.

Figure 10: Installation of rock vein (bendway weir).

Figure 11: Construction of oxbow lake.

Figure 12: Sloping of high bank.

Figure 13: Aerial photograph of project during construction.

Planting

An equally important component of implementation was the planting and transplanting of vegetation. Some of this work was done in conjunction with construction and some was done separately. First, large willows used in conjunction with the root wad revetments were transplanted from approximately 10 miles upstream. A track hoe dug them up and put them on a flat bed trailer and in a dump truck (both provided by OSRC). The willows were then transported to the site, removed with the track hoe with the live thumb and placed in loaders. The loaders transported them to ditches dug by a track hoe for temporary storage. The track hoe with the thumb would then pick them out of the ditch for final placement as needed. Figures 14 - 17 illustrate this process.

Figure 14: Removal of willows from flatbed with trackhoe.

Figure 15: Transferring willow into front end loader.

Figure 16: Temporary willow storage area.

Figure 17: Planting of willow with trackhoe.

Additional trees were acquired through donations provided by three different local nurseries. The nurseries providing trees for the project included Park Hill, Green Leaf and Midwestern. Trees, in 2 and 5 gallon buckets, were transported to the site and planted by personnel from OSRC and CCCD. Some of this work was performed as construction was ongoing, but much of it was done after construction was completed. Table 1 provides a list of the trees provided by each nursery as well as a cost estimate for the trees. Figures 18, 19 and 20 show the installation of the trees.

Sod from on top of the high cut bank was moved to the top of the newly constructed channel using a loader. With a little practice the loader operator was able to scrape up a portion of sod (approximately 6 - 9" thick) without doubling it over. He was then able to transport it to the top of the newly constructed channel and shake it out so that it laid flat in the desired position.

In addition, grass seed was spread on the newly constructed floodplain (separating the channel from the oxbow lake) and on the sloped bank. This was performed repeatedly over the few weeks following completion of construction to assure good growth.

Table 1: List of trees donated for planting at Echota Bend.

Green Leaf Nursery (wholesale values)				
	248	Weeping willow	$13.75	$3,410.00
	174	Cottonwood	$13.75	$2,392.50
	222	Red Maple	$16.00	$3,552.00
	75	Silver Maple	$14.50	$1,087.50
	89	Sycamore	$14.85	$1,321.65
	20	Redbud	$14.85	$297.00
	828	**TOTAL**		**$12,060.65**
Midwestern Nursery (depreciated costs)				
	15	Oak	$5.00	$75.00
	15	Red Maple	$5.00	$75.00
	25	River Birch	$5.00	$125.00
	120	Sycamore	$5.00	$600.00
	25	Silver Maple	$5.00	$125.00
	10	Flowering Magnolia	$5.00	$50.00
	210	**TOTAL**		**$1,050.00**
Park Hill Nursery (depreciated costs)				
	1611	Willow	$4.00	**$6,444.00**
Grand Total				
	2649	**Trees**		**$19,554.65**

Figure 18: Willow planting by hand.

Figure 19: Willow planting with backhoe.

Figure 20: Maple planting with tractor and auger.

Miscellaneous Tasks

In every project there are miscellaneous tasks that need to be accomplished to complete the project and this project was no exception. A fence along the high bank had to be removed and re-installed upon completion of the work, a drive way and parking lot, where equipment was parked, had to be reworked, and an OSRC sign had to be moved. This work was all accomplished by personnel from OSRC. Also, an access road from the east had to be improved to allow equipment in and out of the project site. This work was performed by personnel and equipment from Patton Construction.

Figures 21 - 24 show the project two weeks after completion of construction. The project was not 100% complete at the time as some of the trees listed above were planted after these pictures were taken.

Figure 21: Completed project looking downstream.

Figure 22: Completed project looking upstream.

Figure 23: Completed project looking at oxbow lake.

Figure 24: Aerial view of completed project (prior to maple planting).

6.0 PROJECT COST

A majority of the cost incurred in completing this project was associated with construction. Table 2 presents a breakdown of the equipment costs incurred to complete the project. The contractor, the hourly rate, the hours used, and total cost is provided for each piece of equipment, as is the total equipment cost for the project. Equipment transportation costs, which varied from $100 - $500 per piece of equipment, and fuel costs for the Cat D7 dozer are not included.

The cost of the rock used in the project was also a significant expense. Nineteen semi-truck loads of 3 to 4 foot diameter rocks were used at a cost of approximately $300 per load, $200 of which was for transportation. The total cost of the rock used in the project was therefore approximately $5700. Another significant expense was the cost of contracting Rusty McKee to assist on the project. The total cost for Rusty's services including, transportation, lodging and per diem at the state rate was $6675.

The total cost of construction with all costs figured in, including charges incurred in an attempt to initiate construction in March, was $85,108.99. Some additional personnel charges were incurred by OCC for planning, design and supervision during construction and by OSRC and CCCD for planting. Nevertheless, the total cost of the project represents a substantial savings over the estimated $250,000 cost of rip-rapping the entire bank.

Table 2: Equipment costs for Echota Bend construction (w/ operators).

Description	Company	Cost/hr	Hours	Total
CAT 320L Trackhoe	Patton	$ 90.00	82	$ 7,380.00
CAT 936E Loader	Patton	$ 65.00	107	$ 6,955.00
CAT 960F Loader	Patton	$ 80.00	61	$ 4,880.00
CAT D6H Dozer	Patton	$ 85.00	109	$ 9,265.00
CAT D8 Dozer	Patton	$ 120.00	65	$ 7,800.00
120 G Road grader	Patton	$ 85.00	2	$ 170.00
John Deer 590D Trackhoe with live thumb	Sooner	$ 125.00	100	$ 12,500.00
John Deer 892 D-LC Trackhoe with dead thumb	Tonto	$ 100.00	104	$ 10,400.00
John Deer 544E Loader	Tonto	$ 60.00	84	$ 5,040.00
Cat D7 Dozer	Yocham	$ 75.00	73	$ 5,475.00
Total				**$ 69,865.00**

7.0 LESSONS LEARNED

As with any venture into unexplored territory much was learned from this project. If the project were being initiated today a few aspects would be done differently resulting in a better, less expensive project. The first change would have been in the design. Only two rock veins were employed because large rocks aren't common to the river channel and it was thought that the rock veins would look unnatural. Root wads, on the other hand, are common along the river so wood was employed for most of the revetment. However, upon completion of the project the rock veins appeared to be functioning well and did not look unnatural, so that if the project were being designed today, three or four veins would be incorporated.

As for construction, a several things could have been done differently that potentially could have reduced the cost of the project to $60,000 - $70,000. First, there could have been better organization during construction. The crews working on the project typically contract an entire job and are directed by their foreman. As stated earlier, crews from four different companies were employed under direction from Rusty McKee and Russell Dutnell. This may have led to some confusion and somewhat inefficient use of equipment. A meeting should have been held each morning to discuss what was to be accomplished that day and solicit input from all participants as to how to best accomplish the objective. This may have reduced the total time to complete the project by a day or two, as the right people would have been running the right equipment. Additional confusion came as a result of the fact that this type of project was new to the operators. Despite being provided copies of the plans beforehand, the operators really didn't understand what was being accomplished until construction was almost complete.

The manner in which the final diversion was accomplished also extended the duration of the project. The final diversion was completed just before dark on day 7 so that the increased turbidity caused by the diversion would pass under a downstream bridge at night. Unfortunately, this resulted in the channel being left too narrow and in the wrong position so that the flow was pinched against the point bar over night. This resulted in a large volume of material being washed into the already shaped thalweg of the channel. Cleaning and reshaping the thalweg extended the duration

of the project a day to a day and a half. Nevertheless, the project was very successful and the experience gained from this project will be applied to future projects. The cost of future projects should be reduced with better organization, more experienced operators, and better planning of work sequencing.

8.0 PROJECT PUBLICITY AND FUTURE EDUCATIONAL PLANS

One of the primary goals of this project was to demonstrate that stream bank stabilization techniques utilizing a fluvial geomorphological approach can be effective and economical in controlling stream bank erosion. In order to accomplish this objective it is imperative that people be exposed to the techniques. Fortunately, this project received a lot of publicity during and shortly after construction. Articles on the project appeared in several newspapers including the Tahlequah Times Journal (May 17,1997), the Tahlequah Daily Press (May 8, 1997 and May 30, 1997) the Muskogee Daily Phoenix (May 8, 1997), the Tulsa World (May 13, 1997) and the Daily Oklahoman (May 13, 1997). A small clipping on the project was even included in the "Across the USA" section of USA Today (May 13, 1997).

Although the free exposure was beneficial, educational efforts must continue. OCC is therefore preparing a video tape of the Echota Bend construction process. A "Riparian Restoration" brochure is also being developed. It is hoped that both will be distributed throughout the state.

9.0 FUTURE MONITORING

Although the project seems to have been successful, the true test will be time. Will the design channel remain stable for 5 years, 10 years, or longer? Will the channel transport the water and sediment loads delivered by the watershed without changing plan, pattern or profile, and without agrading or degrading? Only time and monitoring will answer these questions. It is therefore proposed that surveying be conducted in the project channel, upstream, and downstream to monitor changes that may occur over time.

REFERENCES

Leopold, L.B., M.G. Wolman, and J.P. Miller, (1964), Fluvial Processes in Geomorphology, Freeman, San Francisco, CA.

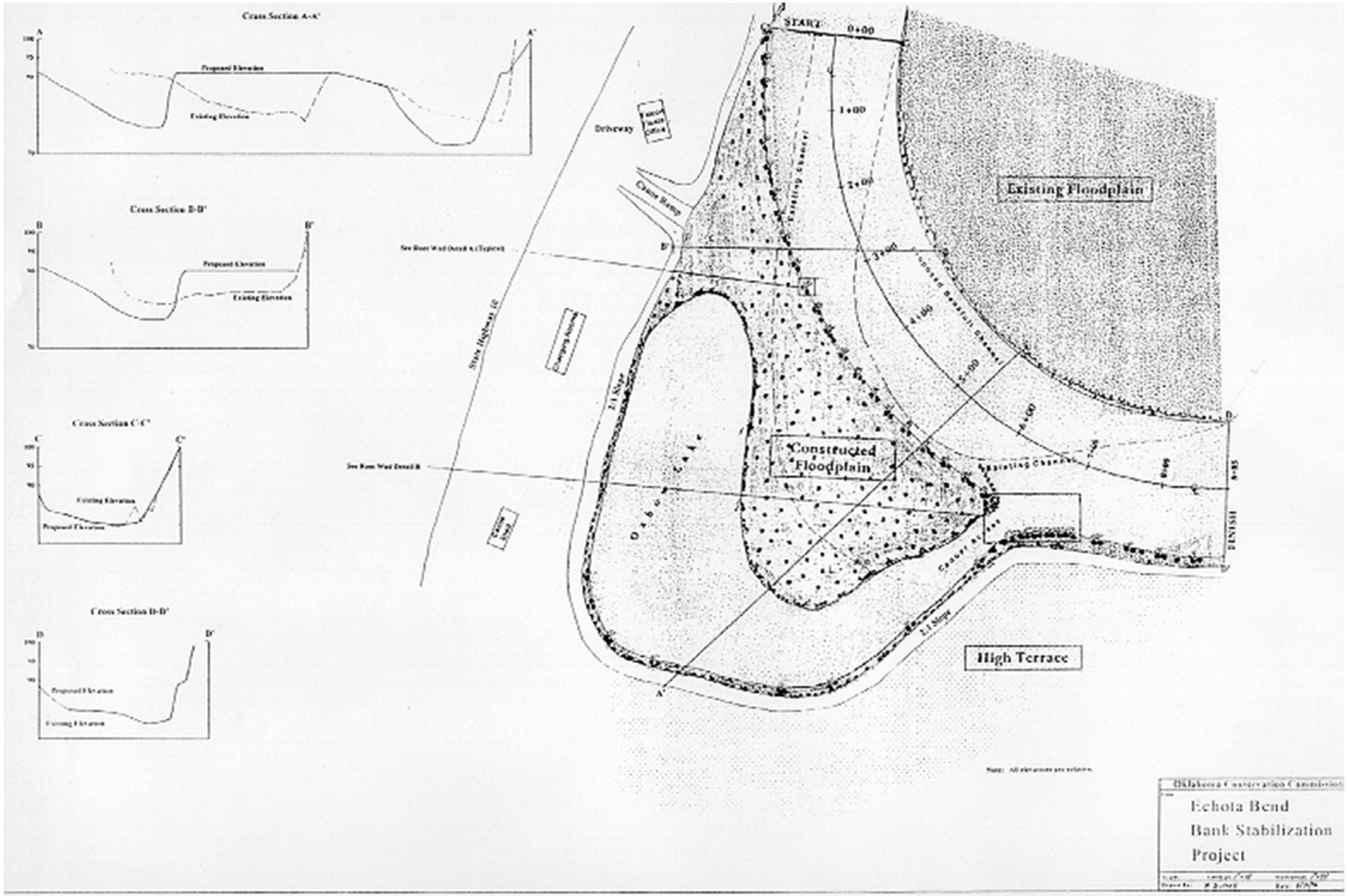
Leopold, L.B., (1994), A View of the River, Harvard University Press, Cambridge, MA.

Rosgen, Dave, (1996), Applied River Morphology, Wildland Hydrology, Pagosa Springs, CO.

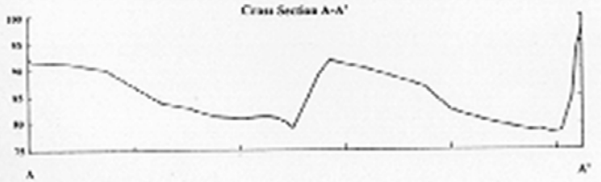
Wolman, M.G., (1954), A Method of Sampling Coarse River-bed Material, Transactions of American Geophysical Union, **35**, pp 951-956.

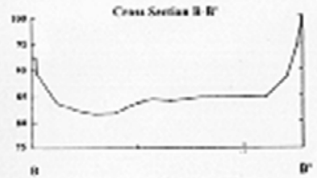
APPENDIX A

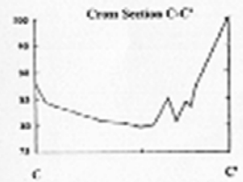
PROPOSED DESIGN FOR THE STABILIZATION OF ECHOTA BEND IN CHEROKEE COUNTY, OKLAHOMA AUGUST 30, 1996

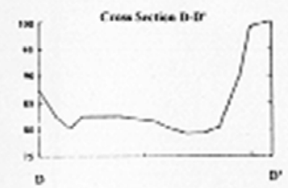


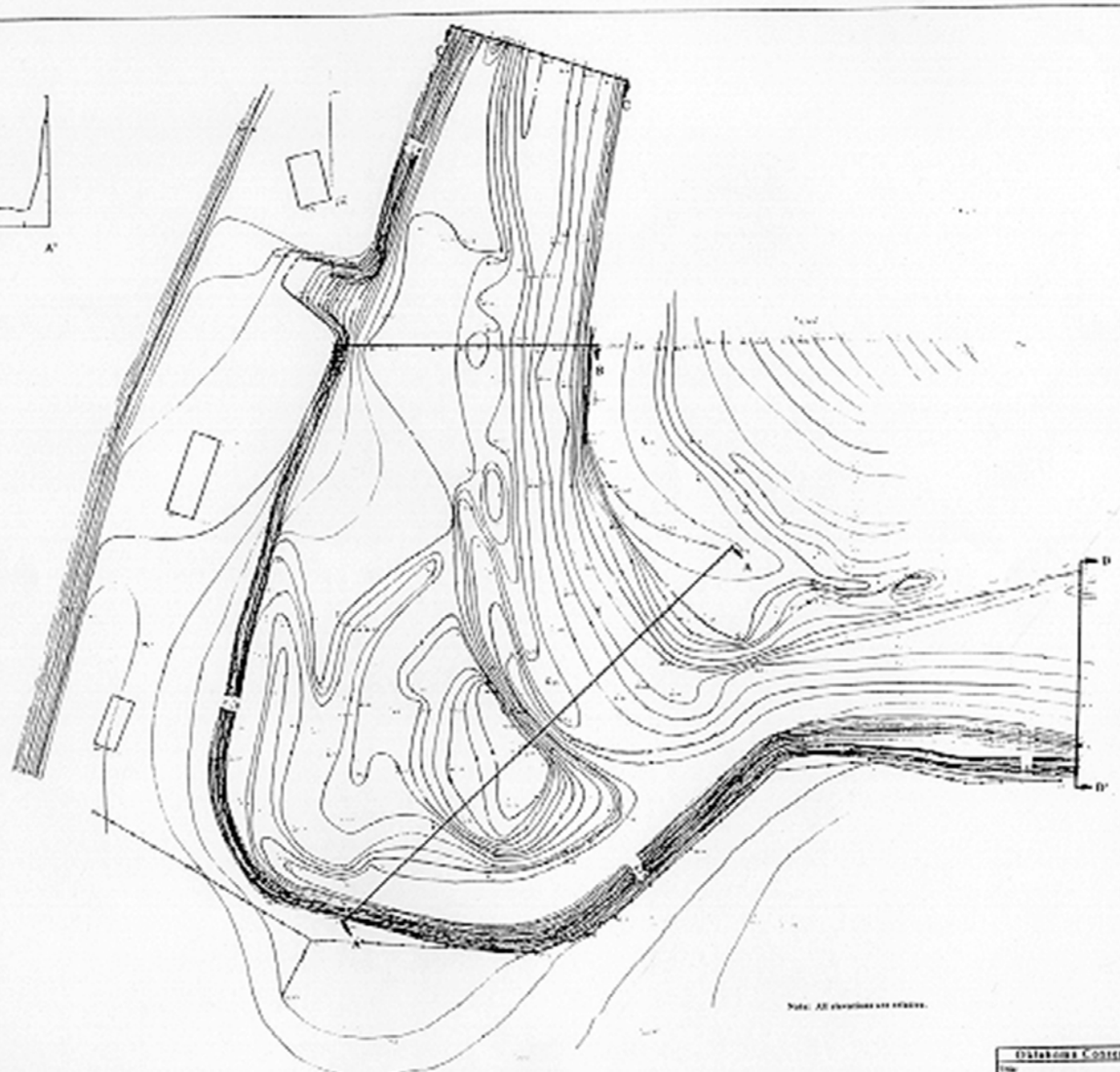
Cross Section A-A'
Proposed Elevation
Existing Elevation
Cross Section B-B'
Proposed Elevation
Existing Elevation
Cross Section C-C'
Existing Elevation
Proposed Elevation
Cross Section D-D'
Proposed Elevation
Existing Elevation
START
0+00
1+00
2+00
3+00
4+00
5+00
8+85
FINISH
Driveway
Canoe Ramp
State Highway 10
Existing Floodplain
Constructed Floodplain
High Terrace
2:1 Slope
Existing Channel
Oxbow Lake
Note: All elevations are relative.
Oklahoma Conservation Commission
Echota Bend
Bank Stabilization
Project











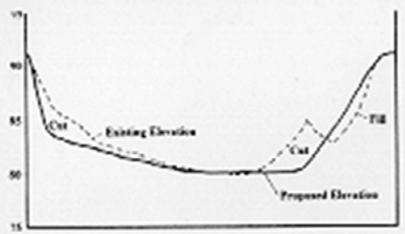
Oklahoma Conservation Commission

Title:

Echota Bend
Existing
Topography

Scale: Vertical: 1" = 5' Horizontal: 1" = 25'

Drawn By: [illegible] Date: 2/24/96



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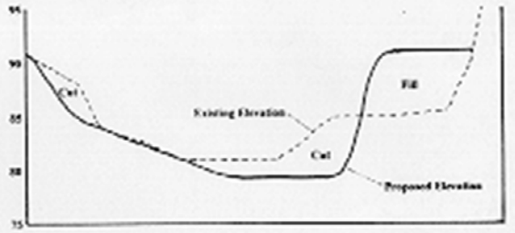

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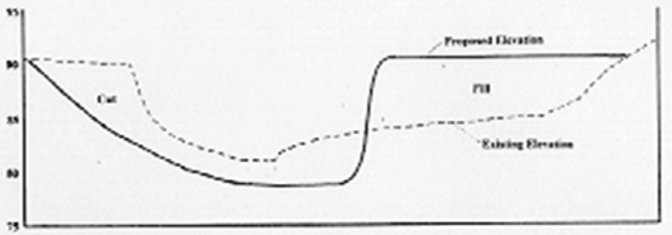

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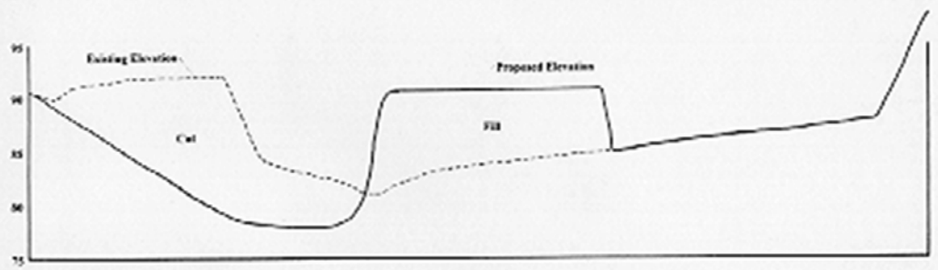

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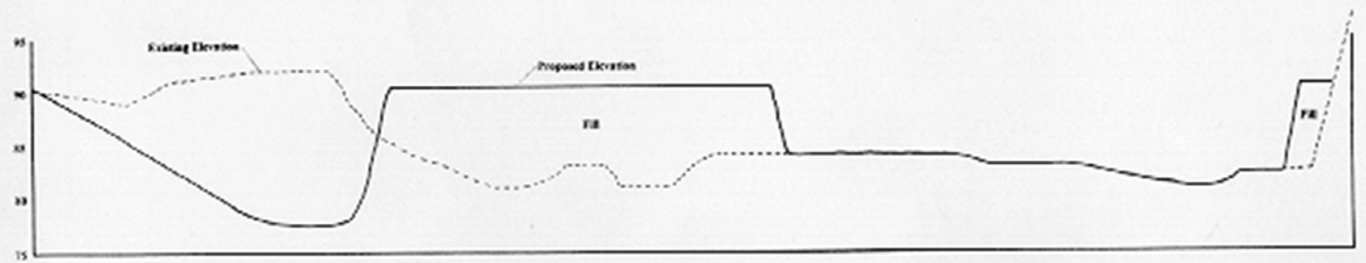

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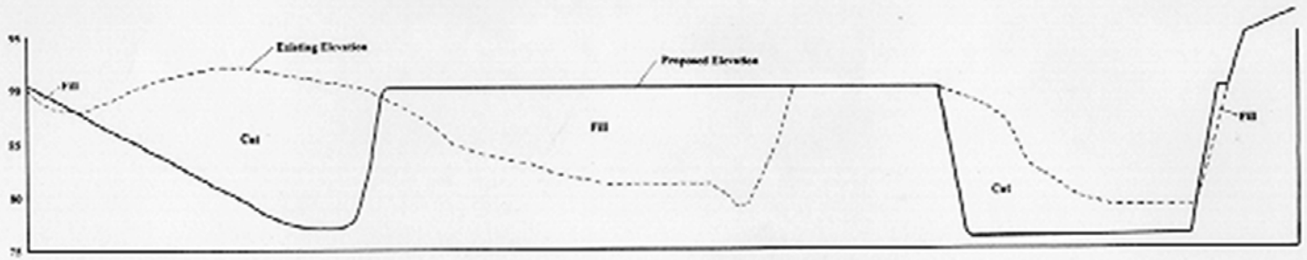
Oklahoma Conservation Commission

Echota Bend Cross Sections



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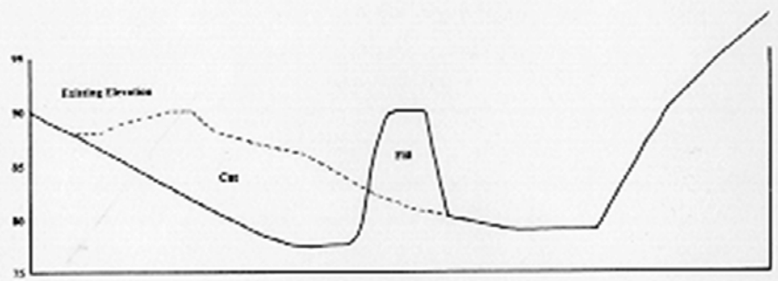

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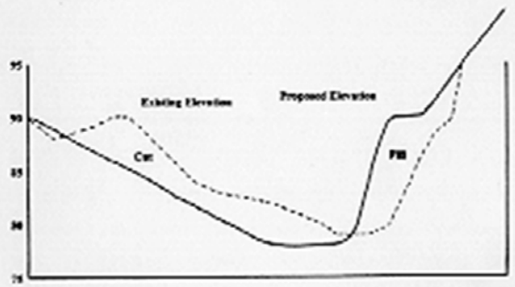

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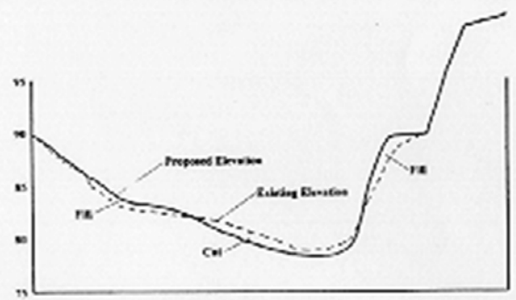

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Oklahoma Conservation Commission

Echota Bend Cross Sections