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A Guide to the George Palmiter River Restoration Techniques

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A GUIDE TO THE GEORGE PALMITER RIVER RESTORATION TECHNIQUES

Contributing Report
U.S. Army Engineer
Institute for Water Resources
Policy Study 81-0560

Prepared by

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PREFACE

This guide was prepared by the Institute of Environmental Sciences, Miami University, Oxford, Ohio, for the U.S. Army Engineer Institute for Water Resources, Fort Belvoir, Virginia 22060, under Contract No. DACW 72-79-C-0043.

The Institute for Water Resources has an assigned mission to study and identify new planning methodologies related to the development and management of the Nation's water resources. The purpose of this study was to explore an interesting alternative to traditional methods for reducing flooding and erosion. This alternative method, which was developed and practiced by George Palmiter in northwestern Ohio, North Carolina, and Tennessee, appeared to deserve a close examination since it had strong local support and appeared effective while at the same time being inexpensive and ecologically sensible. Further, it does not require heavy equipment. However, the method is labor intensive, does not provide high levels of flood protection, and must be performed periodically in an area in order to maintain effectiveness. Although the Palmiter Techniques cannot solve all flooding and erosion problems, they are useful in situations where they are applicable.

The co-investigators of the project of which this guide is a product, were Dr. A. Dwight Baldwin, Jr., and Dr. Gene E. Willeke. P.E. technical assistance was provided by: Charles E. Carroll, Administrator of CETA Programs, Williams County, Ohio; and George Palmiter, the Ohio State University, Department of Agricultural Engineering; and the St. Charles Area River Management Society, Inc. Production assistance was provided by Ruth E. McLeod and Don Shuler. The guide was written by C. Neil Herbkersman. The slide and tape programs that accompany the guide were narrated by William Utter and produced by Thomas A. Collins and C. Neil Herbkersman with assistance from Joe Bockelman, Deb Parn, Kathy Penikas and Scott Voorhees.

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How to use this information package

This information package, entitled The George Palmiter River Restoration Techniques, is designed to help you understand and apply Mr. Palmiter's techniques on common river problems. The package consists of three components:*

* this training manual;
* three tape/slide programs; and
* a videotape.

This training manual closely parallels the tape/slide programs and explains in detail the Palmiter techniques. The three chapters are of the same titles as the tape/slide programs and provide supplementary information on the topics covered.

The three slide programs are synchronized to a cassette tape. If used with a slide projector and a slide-synch tape recorder, use the side of the cassette tape labeled AUTOMATIC ADVANCE. The cassette will automatically advance the slides with inaudible (1000 Hz) cue tones. If used with a slide projector and a regular tape recorder, use the side of the cassette labeled MANUAL ADVANCE. It will use audible "beep" tones to cue the operator to advance the slide.

"Let the River Do the Work," the first slide program, is an overview of the Palmiter techniques. One set of slides and two different cassettes are included with this program. The first cassette is for use in training sessions and the second for use during public meetings.

"The Palmiter Techniques of River Restoration," the second slide program, explains in detail the six steps involved in actually using the Palmiter techniques on a river. (As in Program 1, one set of slides and two cassettes are included with this program.)

*Copies of the three tape/slide programs and videotape may be purchased separately or as a set for the cost of their reproduction by agreement of the U.S. Army Corps of Engineers, and are available through the Institute of Environmental Sciences, Miami University, Oxford, Ohio 45056 (ATTN: Dr. Gene Willeke).

"How to Manage a Palmiter River Restoration Project," the third slide program, describes the management duties required to successfully conduct a project using Palmiter's techniques. One set of slides and only one cassette tape for training sessions are included with Program 3.

The final audiovisual component of this information package is a videotape entitled "Working with the Flow: The Palmiter River Restoration Techniques." This videotape describes how Mr. Palmiter corrects bank erosion problems on small streams. This program can be used either for training sessions or in public meetings.

CHAPTER 1

LET THE RIVER DO THE WORK

This information package outlines the river restoration techniques of Mr. George Palmiter of Montpelier, Ohio. Mr. Palmiter developed his techniques through experimentation over many years while attempting to make rivers near his home navigable for canoes and small boats. The rivers had become choked with fallen trees and log jams after severe wind storms. By cutting log jams, floating logs and other materials into eroded banks and observing the results, Palmiter synthesized and refined his techniques.

The Palmiter techniques require a minimum of equipment, relying more upon human labor. A central theme is "let the river do the work." The river provides most of the needed raw materials in log jams and nearby trees and shrubs. Human labor, hand tools and, occasionally, a tractor or mule are used to cut and move the jams. Logs and other debris are then placed at strategic points in the river channel. The strategically placed materials direct the existing currents away from eroded banks or into sand and gravel bars which need to be removed because they are blocking the channel. The new flow pattern resembles what would happen without human intervention and is therefore relatively permanent. Furthermore, the techniques employ an overall river management approach rather than simply controlling erosion. Using this type of approach, the symptoms are not just treated, the problems are eliminated.

This first chapter describes why river restoration is needed, provides a brief overview of traditional restoration methods, highlights characteristics of a healthy waterway and provides an overview of the Palmiter techniques. This chapter is designed to be used with the first tape/slide program of the same title. One set of slides and two different cassettes are included for this program. The first cassette is for use in training sessions and the second for use during public meetings.

Why do we need to restore rivers?

Some of the problems which require river restoration techniques include: fallen trees and log jams; eroded banks; sand and gravel bars; and excessive plant growth in the main channel. Each of these problems is likely to occur in the natural evolution of a waterway. For example, a tree can fall into a river during a storm. This alters the natural flow characteristics and floating logs and other debris can easily get caught, causing a jam. The current is then forced around the log jam against a nearby bank, causing erosion. In addition, sediments can easily become deposited near the log jam where the current velocity is reduced, creating a bar. In smaller streams and drainage ditches, a common problem is the excessive growth of aquatic plants such as cattails, reeds and grasses. If the small waterway is not shaded by trees, these plants grow into the main channel and can choke the water's flow.

COMMON RIVER PROBLEMS

* Bank erosion
* Obstructions such as
  Fallen trees,
  Log jams and
  Sand and gravel bars
* Excessive plant growth in the main channel

Clearly, these problems can have profound effects on the waterway, causing more frequent and prolonged flooding, loss of farmland and loss of

recreational opportunities such as canoeing. Moreover, these effects can cause monetary damage in urban as well as agricultural areas. River restoration projects are planned to minimize or eliminate any future damage.

What are some of the traditional river restoration methods?

Some of the traditional methods include: channelization, clearing and snagging and river training works. To briefly summarize these methods:

> Channelization involves dredging sediments from the river's channel and straightening the river. Trees are cleared from one or both banks and a levee is generally built on the bank from dredged materials.
>
> Clearing and snagging involves cutting and digging obstructions (fallen trees, jams, bars, etc.) from the main channel. The material is removed from the immediate flood plain.
>
> River training works involves placing objects on the edge of the river or in the main channel to direct current flow, for example, away from eroded banks. Jetties, groins, automobile bodies and wire mesh deflectors are placed in the river to "train" the current into a desired direction.

These techniques require heavy equipment (such as dredges and bulldozers), consume large amounts of energy and are expensive. Moreover, frequent maintenance work is required. Although the resulting waterway is free of hydraulic problems for a period of time, it does not possess many of the characteristics people desire in a healthy, more natural river.

What are some of the characteristics of a healthy waterway?

There are many aspects of an environmentally healthy waterway. Some of the most important are outlined below.

The most important characteristic is the absence of major obstructions such as fallen trees, log jams and sand and gravel bars. These obstructions slow down and deflect the current flow. In addition, there is no excessive growth of aquatic plants in the main channel to reduce current flow.

The banks of a health waterway are lined with a substantial canopy of trees and shrubs. They provide shade for the river. Shade is vital in preventing the excessive growth of aquatic plants in the main channel. Furthermore, shade helps keep the water cool, an important factor in maintaining a population of fish and other aquatic wildlife. In addition to providing shade, the trees also have extensive root systems which stabilize and strengthen the bank and inhibit erosion. Likewise, the trees help prevent sediment from entering the channel after a rain. Clearly, a substantial canopy of trees along a waterway provides many important benefits.

A HEALTHY WATERWAY

* Absence of major obstructions
* No excessive plant growth in the main channel
* Banks are lined with trees and shrubs
* Absence of excessive erosion
* Smooth, gentle bends
* Abundant and diverse food and habitats for wildlife

Another important characteristic of a healthy waterway is the absence of excessive bank erosion. Also, there should be smooth, gentle bends. Finally, the waterway should offer abundant and diverse food and habitats for wildlife.

Thus, the goal of river restoration work should be to restore good flow characteristics while maintaining diverse wildlife habitats. Although the traditional restoration methods do increase hydraulic capacity, they do not necessarily result in a waterway which can be classified as environmentally healthy.

What are the Palmiter techniques?

The Palmiter techniques can be divided into two major areas: the actual on-the-river work and the behind-the-scenes management duties. A description of the practical, on-the-job aspects of these two areas can be found in

the next two chapters of this manual. The remaining section of this chapter describes the six steps of the Palmiter techniques.

THE PALMITER TECHNIQUES

1. Remove Log Jams
2. Protect Eroded Banks
3. Remove Sand and Gravel Bars
4. Revegetation
5. Remove Potential Obstructions
6. Maintenance

The six steps of the Palmiter techniques are listed to the left. Although they are listed in a particular order, work does not necessarily have to proceed in this order for all river restoration projects. An understanding of the river problems will help determine the order of the six steps in any river project.

1. Remove Log Jams

Fallen trees and log jams alter the flow characteristics and slow the current to a point where sediments are deposited because the current can no longer move the sand and gravel. Jams may also divert the current into one of the banks, causing erosion. By removing fallen trees and jams, the unimpeded current can erode away nearby sand and gravel bars and bank erosion is minimized. Much or all of the material cut from the log jams is used to protect eroding banks.

2. Protect Eroded Banks

Erosion typically is caused by rapid currents which undercut the bank. This occurs where the current is diverted around an obstruction like a log jam or a sand and gravel bar, or against the outside bank of a river bend. If the erosion is caused by an obstruction, the obstruction must first be removed before the erosion can be stopped.

Palmiter's approach to protecting eroded banks involves placing and securing a tree top or other brushy material on the river bank upstream from the erosion site. This brush pile changes the current flow, creating two beneficial effects. First, the main current is diverted out into the main channel away from the eroded bank. Secondly, the current is decreased in the brush pile and immediately downstream, allowing sediments to be deposited in these places.

Generally, the diverted current flow will again touch the bank downstream. A second brush pile is anchored there, and so on throughout an entire problem area. Several well-placed brush piles will divert the current toward the center of the channel and may actually begin erosion of any sand and gravel bar on the opposite bank of the river. Furthermore, sediments will continue to build in the brush piles.

3. Remove Sand and Gravel Bars

Sand and gravel bars occur for a variety of reasons wherever the current velocity is decreased. They form most frequently, however, just downstream from log jams and fallen trees. They can also occur as bars (commonly called point bars) on the inside bank of river bends opposite eroded banks. If the jam or fallen tree is removed, the bar will usually be eroded away by the uninhibited current flow. Likewise, point bars are often eroded away by the current flow created when brush piles are used to protect eroded banks. But if these two techniques fail to remove the bar, further work will be needed.

This work requires the placement of current deflectors and the digging of pilot channels. Current deflectors are large brush piles of tree tops which are anchored far into the river channel. They divert the current into

the bar, thereby undercutting it. Small but deep pilot channels, or trenches, are also dug, usually by hand, through the bar. Water entering the pilot channel will erode the bar. Eventually, a substantial portion of the current will pass through the pilot channel.

4. Revegetation

This fourth step involves reestablishing vegetation in two places: in the newly-deposited sediments in the brush piles and along the bank where there is no vegetation. Revegetation is a very important component of the Palmiter techniques. First, the planted vegetation will grow roots to stabilize and secure sediment and banks. This encourages further sedimentation in the brush piles. Second, the vegetation will grow leafy branches which provide shade for the river. The shade is very important in preventing the growth of aquatic plants in the main channel. Additionally, the shade helps keep the water cool, an important factor in maintaining fish and aquatic wildlife populations.

5. Removing potential obstructions

Potential obstructions are those trees which are in imminent danger of falling into a waterway. These are either standing dead trees or trees which are severely leaning over the channel. The trees can have the tops or branches which lean over the channel removed. In the last resort, these trees must be completely cut down. Standing dead and mature harvestable trees may be cut and used for lumber or firewood. These trees are cut leaving the root structures and a short stump intact. The root structures are important in stabilizing banks and protecting them from erosion and new growth may occur from the old stump.

The goal of removing potential obstructions is to prevent these trees from falling into the river and becoming an obstruction in the future, while

at the same time leaving a good, strong stand of trees and shrubs along the bank for bank stabilization and shade. Trees that aren't in danger of falling into the river need not be removed and may have valuable wildlife benefits.

6. Maintenance

The final step of the Palmiter techniques is maintenance. After a stretch of a river has been restored, periodic reexaminations are necessary. This is to assure that past work was adequate to alleviate channel problems. The reexamination is also necessary to determine if any new work is needed. Reexaminations are particularly important after periods of high water when the erosive force of the waterway is greatest.

By correctly using the six steps of the Palmiter techniques, a work crew can have many beneficial effects on a waterway. The next chapter will discuss how to actually implement these steps on a river. The final chapter of this manual describes how to manage a river restoration project using the Palmiter techniques.

CHAPTER 2

THE PALMITER TECHNIQUES OF RIVER RESTORATION

This chapter describes how to actually correct common river problems. Included in this chapter is information on what power equipment is needed to move trees and logs. Next, there is a detailed description of the six steps and the chapter concludes with some safety considerations. This chapter is intended for use with the second tape/slide program of the same title. One set of slides and two different cassettes are included with this program. The first cassette is for use in training sessions and the second for use during public meetings.

THE PALMITER TECHNIQUES

1. Remove Log Jams
2. Protect Eroded Banks
3. Remove Sand and Gravel Bars
4. Revegetation
5. Remove Potential Obstructions
6. Maintenance

Although the six steps are discussed in a sequence, this particular order may not be important for all river restoration projects. It is best to let the physical and biological characteristics of the river dictate the order in which these tasks will be undertaken in a given project area. Begin working on the most severe problem. But be sure to eliminate the problem itself, don't just treat the symptoms. With good preliminary surveys (this aspect will be discussed in Chapter 3), the sequence of work at each site should

become clear. Usually, almost all work is completed at one site before moving to the next; but the exact sequence will vary from one river project to another.

Power Equipment Needs

Although the Palmiter techniques stress human labor, some power equipment is generally needed, Typically, the power equipment is a tractor, but occasionally a large, four-wheel drive tractor, a high lift or a backhoe may be needed if the logs are very large. The equipment is used to move logs, to pull stumps back onto the bank and to place current deflectors. The equipment is not used to dredge the channel.

In certain areas it may be difficult to get a tractor close to the river bank; two solutions to this problem have been devised. First, a team of mules or horses can be used. They have great pulling power, especially when using the mechanical advantage of a block and tackle. Likewise, the team can get in between the trees much more easily than a tractor.

A second solution, which works best on a large river with a low flow velocity, is the construction of a raft. The St. Charles River Management Society, Ltd., of St. Charles, Michigan, has built a 28' x 12' raft which has been used quite successfully. The raft is constructed of telephone poles and is equipped with a crane and a power winch. The winch is powered by a 10 h.p. gasoline engine with an 80:1 gear reduction. The raft is driven by a 35 h.p. outboard engine, weighs 4 tons, and has 1500 lb. of flotation material under it. Additionally, the raft has a bumper used as a ram on its prow. The raft has been used with much success on the large volume, low velocity Bad River in Michigan.

When using the raft, first the log jams are cut apart, then the crane and winch move the materials. The raft is a floating work platform which transports people and equipment to the work site and is also a source of power in remote locations. A similar raft could prove helpful on other rivers similar to the Bad.

For more information on this type of raft, contact:

St. Charles River Management Society, Ltd.
125 East Belle
St. Charles, Michigan 48655

Having obtained a suitable source of power, it can now be put to work on a river. Typically, the first step of the Palmiter techniques is to remove log jams and fallen trees.

Step 1: Remove Log Jams

Before actually cutting apart a jam, it is first necessary to determine where the logs and other materials will be taken and used. If the material will be used to construct brush piles to protect eroded banks, cut the logs into larger sizes. But if the logs will be removed from the immediate flood plain, they can be cut into smaller, more manageable sizes.

A chain or bow saw is used to cut the logs. Hand saws are used whenever it is unsafe to use a power saw. For cutting submerged logs, chain saws do not work. But there are several ways to cut these logs. Pull the log out of the water with a tractor, then cut it with a chain saw; or the logs can be cut underwater with a hand saw or with a reciprocating power saw. (A Wright Saw has been used successfully.)

When cutting log jams in swift currents, work from the downstream side. The swift current could sweep and trap a person under the log jam if a worker fell into the water upstream.

Once the log jam and fallen trees are cut, bring in the power equipment to move the larger logs. It is advisable to move each log only once; so advance planning is necessary to know where the logs should be put to use. There are several uses for larger logs. First, they can be used to protect eroded banks. (This operation will be described in the next section.) The logs can also be used to construct current deflectors to remove sand and gravel bars. (This operation will be discussed in Step 3: Remove Sand and Gravel Bars.) Finally, the logs can be completely removed from the immediate banks of the river. They can be stacked for use as firewood or lumber or left as shelter for wildlife. If the logs cannot be removed from the immediate banks, they should be stacked up and then securely cabled to nearby trees. This will prevent the logs from becoming future jams.

Smaller branches and twigs need not be removed from the river channel. The river will carry this debris away in high water and deposit it in the flood plain where it will decompose.

If a log jam has an uprooted and leaning stump that is in danger of falling into the channel, it should be removed. Caution must be used when working on these leaning stumps since they are unstable and could fall over, injuring workers. So one or more safety cables should be securely attached to the leaning stump and then to nearby trees. The safety cables can be made tight with hand winches. Once the cables are in place and secure, crews can work around the stump in greater safety.

Often it is necessary to pull these stumps back out of the channel and onto the bank. This can be accomplished by attaching a strong cable to the stump. Then, using a large tractor, pull the stump back toward the bank. The mechanical advantage of a block and tackle is usually helpful in moving these heavy leaning stumps.

Once the jam has been cut apart and the logs removed, and once the leaning stumps are pulled back onto the bank, the next step is to protect the eroded banks.

Step 2: Protect Eroded Banks

Whenever a swift current strikes a bank, it can undercut the bank, causing erosion. If the swift current is diverted into the bank by an obstruction (such as a log jam), that obstruction will have to be removed. Then remedial action can be taken to protect the eroded banks.

Palmiter's approach to this remedial action takes the form of securing a tree top or other brush on the edge of the river, upstream from the eroded area. The size of the brush pile is proportional to the size of the waterway.

The materials for the brush pile can come from several sources along the river. A primary source is the logs and other material from jams and fallen trees. Likewise, materials can come from the removal of potential obstructions, such as the tops of trees which lean over the channel. Finally, material for constructing brush piles can come from nearby trees and shrubs which are cut and hauled to the river. If the project occurs within a city, a good source of material can be the trees cut along city streets by maintenance crews. Arrangements can be made with the city administration to have maintenance crews haul these materials to a river restoration project. This diverts these trees from burial in the local landfill and also helps the river project by providing an easily-obtainable source of material for constructing brush piles.

Construction of the brush piles is relatively easy. Place a large, bushy tree top or group of logs and branches at the correct point along the bank upstream from the erosion problem. (The exact placement of the brush

piles will be described in more detail in just a moment.) Place the materials at the normal water level, butt end upstream.

Pile a few heavy logs or rocks on top, then anchor the pile in place. Using cable, wire or rope, tightly secure the pile to a nearby tree. If there is no tree nearby, drive steel fence posts, large wood stakes or posts into the bank and secure the brush pile to them. Another type of stake can be made from a live cutting from a nearby tree. (A description of this technique can be found in Step 4: Revegetation.) Pound these cuttings into the bank and secure the brush piles to them.

You do not need to cover the entire eroded area with brush. A few well-placed brush piles can protect a large eroded area. To determine the position of the first brush pile on an eroded bank, first walk down river, then look back upstream toward the eroded area. Look for the point where the current first touches and undercuts the bank. Anchor the first brush pile there.

Once this brush pile is securely in place, it will deflect the current out into the main channel. In many cases, however, the current will again touch and undercut the bank downstream. Place a second brush pile at this point and continue this process throughout the entire eroded area.

If it is difficult to follow the current into the bank, throw material that floats and is easy to see into the river upstream from the eroded area. (Cork, corn cobs, wood, or other floating material will do the job.) This material will float downstream with the main current and will touch the bank where the first brush pile is needed. Once the first brush pile is in place, repeat this procedure to see where the second and subsequent piles should be placed. A non-toxic colored dye may also be used for this purpose. Rhodamine or a similar commercial fluorescent dye will be satisfactory.

One final way to deflect the current away from eroded banks involves locating a tree just upstream from the eroded area and on the same bank. This tree is cut halfway through on the side away from the river. The point of the saw cut acts as a hinge, since the tree is pushed over and bends at this point. The tree bends over until it falls into the river at approximately a 45° angle to the current flow. The top of the tree should fall far enough into the river so that it diverts the main current away from the eroded bank; but the top of the tree should not completely block the channel.

The brush piles and hinged trees begin protecting the banks quickly. In rivers which move heavy loads of sediment, silt and sand soon build up along the once eroded bank and the problem is well on its way to correcting itself. Once the erosion problem is arrested, the next step is the removal of sand and gravel bars.

Step 3: Remove Sand and Gravel Bars

Sand and gravel bars form when the velocity of the current decreases to a point where sediments can no longer be moved by the water. There are many causes of these bars, but frequently they occur near log jams and fallen trees. If these types of obstructions are removed, the river will usually erode the bar away. In addition, point bars of sand and gravel often occur on the inside corner of sharp bends in a river--on the opposite bank from sites of erosion. Placing a brush pile or a hinged tree to protect the eroded bank will usually divert the current far enough into the main channel to remove the point bar. But if the bar is not removed by these two actions, then further work is needed. This work takes three forms: removal of certain vegetation on the bar, digging small pilot channels through the bar and constructing current deflectors.

If there are tall trees growing in the bar, they should be removed. Using a large tractor and a block and tackle, if necessary, remove the tree and as much of the root structures as is possible. (The extensive root systems of large trees hold the sand and gravel in place in the bar.) If the tree is too large to pull out, cut it down at ground level. Smaller shrubs need not be removed at first since their root systems are usually shallow. But if these shrubs prevent the bar from being eroded, they will also have to be removed; either pull them out or cut them off at ground level.

For the second type of remedial work, dig one or more deep, but narrow, trenches or pilot channels through the bar. These pilot channels are dug with hand tools. Make the channels at such an angle that a rapid current is diverted into the trench. This rapid current is needed to erode the bar. If the bar is large, several pilot channels may have to be dug. Furthermore, it is often helpful to use a rake to clear any large stones or leaf debris from the channel on all sides of the bar. This action increases the current flow along the edges of the bar and promotes erosion.

A final form of remedial work used to help the river remove sand and gravel bars involves constructing one or more current deflectors. The current deflector, a brush pile or hinged tree, is secured on the edge of the river at a point upstream from the bar. The current deflector is positioned out in the main channel in such a way to diver the current into the bar. Soon the current begins to erode the bar. If it is a large bar, several current deflectors may be needed to divert the current into it at several points.

The brush pile or hinged tree is constructed and anchored in the same manner as was discussed in the previous section; but usually, it must be made of much larger and heavier logs. This is because the current deflectors must

must sometimes completely cross the channel and are therefore subjected to greater amounts of force from the current.

It is important to realize that sand and gravel bars are deposited over a long period of time and contain many tons of material; so a long period of time may be needed for the river to remove the bar. Several periods of high water may be necessary. In addition, more shrubs and roots may have to be removed, more and deeper pilot channels may have to be dug and the current deflectors may have to be adjusted. So, in summary, the removal of bars requires remedial work, several periods of high water, reexaminations, maintenance, and, above all, patience. But, if used properly, the Palmiter techniques will allow the river to remove the bars. Once the log jams are removed, the eroded banks are protected and the sand and gravel bars are being removed, work crews can now move their attention onto the banks of the river. A program of revegetation can be started.

Step 4: Revegetation

Revegetation involves planting cuttings and rooted seedlings of fast-growing, water-tolerant trees. The trees are planted in the brush piles and along the banks where there are no trees and shrubs. These newly-planted trees will grow roots to help secure and stabilize the brush piles and banks. In addition, the trees will sprout leafy branches to provide shade for the river. Shade is important for inhibiting the excessive growth of aquatic plants in the main channel and in keeping the water cool.

It is best to plant these trees in the spring, before the new growing season begins and after the last hard frosts in northern states. Late March and April are excellent months. In southern states, where the growing season is longer, these times can be extended back into the winter months.

Making cuttings is easily done. Fast-growing, water-tolerant trees such as willow, can usually be found along the banks. A limb from such a tree is used. Figure 1, on page 21, provides a list of the kinds of trees which can be used to make cuttings.

The limbs used to make cuttings should be from one to three inches in diameter and have many branches coming off of them. If the cuttings are to be used in brush piles, they should be from five to seven feet long. This is long enough for the cutting to be pushed through the brush pile and from six to 12 inches into the sediments below with about three feet extending above the brush pile. At the bottom of the cutting, trim the side branches, leaving two or three short stubs intact. All of the side branches are removed for the next several feet. At the top, trim the side branches again, leaving two or three short stubs intact. Next, plant the cuttings by pushing them through the brush pile and far enough into the sediments to bury the short branches at the bottom. Cuttings should be planted about one foot apart throughout the brush piles.

Cuttings are also planted along the banks. They are made in the same way, but need to be only about two or three feet long. To plant these shorter cuttings on the banks, dig a hole with a small hand auger or dynamite drill. Then push the cutting into the hole and compress the soil around it.

If the cutting is used as a stake for securing brush piles, it is made in the same manner and it should be from three to four feet long. This cutting is pounded into the bank with a sledge hammer.

Small, rooted seedlings can also be planted higher up on the banks where there are no trees or shrubs. They are planted in small holes dug with an auger and the soil is compressed around the plant. (See Figure 1, on page

TREES FOR PLANTING AS CUTTINGS[1]

1. Black Willow (*Silax nigra*)
2. Cottonwood (*Populus deltoides*)

TREES FOR PLANTING AS SEEDLINGS ON BANKS[2]

1. Black Willow (*Silax nigra*)
2. Cottonwood (*Populus deltoides*)
3. Sycamore (*Platanus occidentalis*)
4. Red Maple (*Acer rubrum*)
5. Silver Maple (*Acer saccharinum*)
6. Pin Oak (*Quercus palustris*)
7. Red Oak (*Quercus borealis*)
8. Box Elder (*Acer negrundo*)
9. Black Ash (*Fraxinus niger*)

[1]NOTE: These trees are fast growing, water tolerant and easily reproduce through cuttings. These two species represent trees which have worked well in stabilizing brush piles in northern states like Ohio. Consult a botanist in your location for appropriate species for your climate.

[2]NOTE: These trees are water tolerant and grow rapidly. They are ideally suited for use in northern states like Ohio. Consult a botanist in your location for appropriate species for your climate.

Figure 1. Tree Species Used during Revegetation

21, for a list of the kinds of fast-growing, water-tolerant trees which can be planted as seedlings.)

The ultimate goal of revegetation is to reestablish woody plant growth along the banks of the river. Revegetation of the brush piles and banks is one of two steps of the Palmiter techniques which concerns the management of the woodlands along the river. Removing potential obstructions is another woodland management practice.

Step 5: Remove Potential Obstructions

Potential obstructions are those trees along the river banks that are in danger of falling into the river. This is because they are dead or are severely leaning over the channel. Likewise, mature trees along the bank may be harvested for timber or firewood.

Potential obstructions should first be tagged. Two colors of tags may be helpful. For example, orange tags could be used for trees which must be completely removed; yellow tags can be put on those which need only the tops or branches which lean over the channel removed. Once the trees are tagged, they can be cut any time. In most northern states, a good time to cut them is winter when the river is frozen over and other river work is difficult.

On trees that are going to be completely removed, leave the stump intact. The roots will help stabilize and protect the banks from erosion. In trees where only the top or branches must be removed, a person must climb up and cut them. The safety of these workers is very important. They must be thoroughly trained and the proper safety equipment and climbing techniques must be used at all times.

The trees, logs and branches which are cut down must not be left to become future log jams. This material can be used to make brush piles to

protect eroded banks. Bushy tree tops are excellent for this purpose. The material can also be used to make current deflectors to erode sand and gravel bars. Any trees and logs which are left over can also be removed from the immediate flood plain and stacked for wildlife protection or for use as firewood.

One river project in Michigan solicited the help of local residents in removing standing dead trees. On certain days, residents were allowed to come to the river bank and cut down these trees and take them home for firewood. The residents were closely supervised and were required to take the entire tree with them.

Removal of these potential obstructions is an important aspect in the overall proper management of the river woodland. But the woodlands should not be completely removed because they provide many benefits in stabilizing and maintaining the river and its aquatic ecosystem. Furthermore, only those standing dead trees which are in danger of falling into a river should be removed since these trees provide excellent habitats for many forms of wildlife.

When the potential obstructions are finally removed, the river work is not yet completed. There is almost always a need to perform maintenance on past work.

Step 6: Maintenance

The final step of the Palmiter techniques of river restoration is maintenance. The maintenance requirements are usually not substantial, but past work should be inspected to make sure that it was adequate in solving the actual problems. If the original work was not adequate, remedial work will be necessary.

The initial inspection of past work should be done a few weeks to one month later, depending on the river. It is especially important to check on

work done to remove sand and gravel bars. An excellent time to conduct an inspection is after one or more periods of high water, since the erosive forces are greater and more deposition of sediments can occur. If the past work was not adequate, determine what remedial work is necessary during the inspection, then bring back work crews and correct the problems.

To recap, the Palmiter techniques of river restoration consist of six steps:

1. Remove Log Jams
2. Protect Eroded Banks
3. Remove Sand and Gravel Bars
4. Revegetation
5. Remove Potential Obstructions
6. Maintenance

These six steps have been developed over many years of experimentation and testing. They are effective in correcting many common river problems on a variety of rivers.

Safety Considerations

In conducting any river restoration work, safety must always be considered. Each worker must have a hard hat, goggles and a life jacket and they must use them while on the job. Moreover, the workers should be trained in how to work safely on the job. Crews should have training in first aid and a properly equipped first aid kit should accompany each work crew.

In addition, there are some additional safety precautions that must be considered. These are in the areas of canoe usage, power saw operation, climbing trees, undercut log jams and hypothermia.

Work crews will probably use canoes or small boats to travel to and from a work site. Workers must be trained in the safe handling of these craft. Likewise, it is often necessary to use a power saw while in a canoe. This can

be dangerous. Canoes are unstable, especially when using a power saw. To make them more stable, lash two canoes together with sturdy poles and rope. Also, place several small logs in the canoe opposite the person who is using the saw. These measures will help make the canoe more stable.

Power saw operators must understand the capabilities and limitations of this tool. Proper training is essential. One aspect of particular importance is the need for a "clear zone" around each operator. No other worker should be within ten feet of a person using a power saw.

Another potentially dangerous aspect of river restoration is climbing and topping trees. Training is essential to assure the safety of the climber. Likewise, the proper safety equipment should always be correctly used and maintained.

Another major concern in rivers, especially in areas of swift current, is undercut log jams and rocks. In these situations, the current is rapidly swept under the jam or rock. A person can easily be swept with the current and become pinned under water. Caution must be exercised in these situations. When removing log jams which are undercut, always work from the downstream side.

One final safety consideration is a particular problem in northern states--hypothermia. A person who falls into the icy waters of winter can easily go into shock when his/her body temperature rapidly drops. Extra caution must be used around water in winter. Again, proper first aid techniques should be taught to crew members on how to avoid hypothermia and how to rescue a person who has fallen into cold water.

With a good understanding of why the Palmiter techniques work and how to actually implement them, work crews can go a long way to correcting common,

irritating river problems. Yet there is one final area which must be considered when carrying out a river restoration project. That final area is the subject of the last chapter of this technical training manual: How to Manage a Palmiter River Restoration Project.

CHAPTER 3

HOW TO MANAGE A PALMITER RIVER RESTORATION PROJECT

You're ready to go. You understand the Palmiter techniques and feel confident you can apply the six steps on a nearby river which has some problems. But before doing that, there are four management duties that must be considered. These duties are important in assuring the success of a river project. This chapter will describe how to:

* survey the river problems;
* plan the work;
* supervise and document the work; and
* maintain good public relations.

With an effective management effort and a good understanding of how to apply the Palmiter techniques, a river restoration project will be much more successful. But the management duties and paper work should not be allowed to overshadow the goal of the river project: to correct common river problems in a manner that does not impair the river ecosystem. This chapter is intended for use with the third slide program, which is of the same title.

Survey the River Problem

A river survey is a vital first step in any river project. During the river survey, one can determine the magnitude and the types of problems in the project area. Likewise, the river survey is important in determining what

resources are going to be needed to correct the problems and the remedial work that is necessary.

Ideally, the survey begins with a helicopter flight over the project with map in hand. If a helicopter is not available, a small, single engine airplane is a good second choice. It is best to conduct this aerial survey when the leaves are off the trees. At that time, it is easier to see problem areas and access routes and match them up on a county drainage map or large-scale topographic map. Ordinarily, the map scale should be 1:24,000 for ease of use. This is the scale of a USGS seven-and-a-half minute quadrangle sheet.

If an aerial survey is not possible, investigate the project area on the ground. In fact, a ground survey is needed even after a flight over the project has been accomplished. If a land survey is conducted after an aerial survey, one need inspect only the problem areas--not the entire river. The land survey can be done on foot or in a canoe or a light boat. Generally, Mr. Palmiter begins his survey at the upstream side of the project area. He then proceeds downstream. Sometimes it may be necessary to conduct a survey both on foot and in a canoe, depending on the number and severity of the problems and the length of the project area.

While surveying the river project on land, valuable data can be collected. To collect these data, one needs to have a county drainage of seven-and-a-half minute topographic map, a small, portable tape recorder, graph paper and a camera.

The maps are used to pinpoint problem areas. Once a problem area has been identified, label it; for example, as site "A," etc.

Then describe the problems of site "A" into a small, portable tape recorder. Likewise, outline what remedial work is required and where log jam

material should be taken. Also, describe the resources needed; for example, personnel and power equipment. Finally, estimate the length of time needed at site "A."

Next, sketch roughly to scale a map of site "A" on graph paper. Draw the problems, possible access routes and where remedial work such as brush piles or current deflectors are needed. To help simplify this task, map legend symbols can be found in Figure 2 on page 30.

Finally, use the camera to take photographs of site "A" from several different angles. Use black-and-white film if the photos are to be used in reports and as a work plan (see page 43). Color slide film should be used if you want to show the problem areas to large groups of people.

Collect these same data at each problem site along the river project area. Once the entire project area has been surveyed, the data that were collected are used to plan the work.

Plan the Work

During the planning phase of a river project, the data collected are used to draft two documents. The documents are a work map and a work plan.

The work map diagrams the entire project area. The exact form of the work map usually varies from one project to another. It can be as complex or as simple as is needed to convey the information. If a very accurate and detailed map is needed, a surveying crew should tour the river problems and then draw the map. At the other extreme, if a fairly simple work map is needed, redrawing field sketches is sufficient.

One work map can cover the entire project area or it can consist of a series of close-up maps at each problem site. Keep in mind that the purpose of the work map is to diagram the present situation and to show proposed

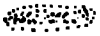
•	Tree to be removed
Ø	Tree to be topped
═══	Fallen tree to be removed
S	Leaning stump needs to be pulled back on bank
||||||	Excessive plant growth in main channel
	Erosion
	Sand and gravel bar
XXXXXX	Log jam
	Construct brush pile on bank
XXXXXX	Construct current deflector in channel or construct hinged tree
	Dig pilot channel
oooooo	Cable material securely
	Plant cuttings and seedlings
	Pile extra materials here
X	Remedial action was completed, problem solved. Place a red "X" over the problem.

Figure 2. Map Legend Symbols.

remedial work. To show such detail, a scale of one inch to two hundred feet works well. An example of a work map can be found in Appendix A on page 40.

Once the work map is completed, next draft a work plan to describe the remedial work which was sketched on the map. Like the work map, the work plan can be as complex or as simple as is needed to convey the information. But usually the work plan consists of four sections which:

1. describe the work;
2. outline resources;
3. schedule work;
4. itemize budget.

The first section gives a brief description of the types of work to be completed at each site or by groups of sites which are close together. At each site(s), describe the types of work to be done and where logs and branches can be put to best use. Also, note where power equipment, such as a tractor, is needed. An example of such a description is included in Appendix B, page 42. Furthermore, black-and-white prints of problem sites can also be used as simple yet effective visualizations of work needed at each site. Using a colored felt tip marking pen, simply sketch on each print what remedial work should be accomplished at each site. Work crews can even carry these prints to problem sites in the field and easily see what work should be done. (NOTE: It would be helpful to dry mount the photos on cardboard and then laminate them in plastic to assure durability.)

The second section of the work plan outlines the resources required to do the river restoration. Typical resources include personnel, equipment, supplies and time. A good estimate of these resources is needed to help write a work schedule and a budget.

Personnel are the first resource to consider. Personnel requirements depend upon the length of the river to be treated, the types of problems which exist as well as budget constraints. Typically, a work crew will consist of between five and ten laborers and a foreman. Several work crews may be needed, depending upon the project. Likewise, one or more supervisors may be needed to oversee the entire project.

The laborers do not need to have any special skills but several training sessions should be mandatory. At the very least, training sessions should overview the Palmiter techniques, cover the safe use of chain saws and canoes and demonstrate how to climb trees. Furthermore, laborers should be taught how to administer first aid and how to rescue a person who falls into the water in cold weather. Foremen should have a good practical working knowledge of the areas just mentioned. Also, they should be familiar with the Palmiter techniques and how to move heavy logs and trees with a minimum of power equipment. The supervisor(s) should have the same knowledge as the foremen plus an understanding of how to effectively manage a river project.

The first two slide programs of this series can be used for a training session to overview the Palmiter techniques. All personnel would benefit from these two slide programs. The third slide program of this series was designed for use by supervisors. Use the cassettes labeled "For Training Sessions" for this training. Likewise, both the foreman and supervisor will benefit from reading this manual.

The second type of resource to be considered when writing the work plan is equipment. The equipment needs are quite simple: hand tools, canoes, chain saws, log chains, a block and tackle and so on. A more complete list can be found in Appendix C on page 45.

Another type of resource to include in the work plan is consumable supplies. Typical supplies include gasoline, chain oil, wire, rope, first aid supplies and so on. A more complete list can be found in Appendix D on page 48.

Time is the final resource component that should be considered in the work plan. It is the most difficult resource to determine and there are no rules of thumb for estimation. The practical working experience of the foreman and supervisors is the best reference.

Now that the work plan has a description of the project and an outline of the required resources, the next section is a work schedule. This schedule shows what tasks will be performed during what months. It is advisable for crews to begin with the worst problems, then move on to the less severe areas. But be sure to include alternate plans for periods of high water or other times when work on a river is unsafe or impractical, such as when the river is choked with ice. Clearly, some of the Palmiter techniques are best done at certain times of the year. A sample work schedule for one calendar year can be found in Figure 3 on page 34.

Keep in mind that the work schedule is not intended to list day-to-day activities. This is best determined when actually in field work. At that time, one- and five-day weather forecasts may be of considerable help.

The final section of the work plan is the budget. The budget itemizes the expenses for personnel, equipment, supplies, travel as well as any benefits and overhead charges. Average costs on some recent projects range from one to three thousand dollars per mile of river. Clearly, these costs vary with the size of the river and the magnitude of the problems. Sample budgets can be found in Appendix E on page 50.

WINTER

Survey river problems for future work
Evaluate past year's work
Remove potential obstructions
Training
Write work map and work plan

SPRING

High Water	Normal Water
Remove potential obstructions	Remove log jams
Training	Protect eroded banks
Maintain equipment	Remove sand and gravel bars
	Revegetation

SUMMER

High Water	Normal Water
Tag potential obstructions	Remove log jams
Training	Protect eroded banks
Maintain equipment	Remove sand and gravel bars
After high water--survey past work	

FALL

High Water	Normal Water
Tag and remove potential obstructions	Remove log jams
Training	Protect eroded banks
Maintain equipment	Remove sand and gravel bars
After high water--survey past work	

Figure 3. Work Schedule

Now that the river problems have been surveyed and the work has been planned in a work map and work plan, actual work on the river can begin. But the management duties are not over. Supervision of the project and documentation of the work should take place.

Supervise and Document the Work

There are a number of normal tasks required to keep a river restoration project running smoothly. These tasks involve purchasing equipment, keeping the project on schedule, authorizing payment of invoices and so on. In addition, it will be necessary to inspect current and past work on the river. This is to assure that it was adequate and is actually eliminating the river problems. These follow-up inspections are best conducted after one or more periods of high water, for it is at these times that the most dramatic changes occur.

It is also advisable to conduct an inspection of the entire length of the river project during the winter months after one working season. This can be done from the air or on land. The purpose is to evaluate the past work and to make future plans if more work is needed.

In addition to supervising the work, it is important to document all facets of the work as it is taking place. For example, daily log sheets of work completed and photography are just two methods of documentation.

The daily log sheets are filled out by the foremen to describe what personnel, equipment, supplies and length of time were required at each work site. The information obtained is important not only for evaluating current progress, but is also helpful in future planning. An example of a daily log sheet can be found in Figure 4 on page 36.

RIVER RESTORATION PROJECT

DAILY LOG SHEET

Crew Leader:_____ Date:_____

Work Crew:_____

_____

_____

Time:_____Morning Arrival at Garage or Dock

_____Left Garage or Dock

_____Arrived at Work Site Map Section:_____

_____Lunch

_____Left Work Site

_____Arrived at Garage or Dock

_____Gear Secured, Left Garage or Dock

Supplies used:_____

_____

_____

Description of the Days Operations:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Figure 4. Daily Log Sheet

Photography after work is completed is helpful in evaluating the success of a project. The photos can be part of printed documents on the project or for use in maintaining good public relations.

Maintain Good Public Relations

Maintaining good public relations is the final management duty discussed in this chapter. Although it is listed last, public relations should be considered during every aspect of the project, from initial surveying to final work and evaluation. Clearly, the success of any river project depends in large part upon favorable public opinion.

Work crews will be standing on private owners' land and may have to drive across it to a work site. They will need land-owner permission to do this. Since the Palmiter techniques are rather new and unusual, public education may be helpful. For example, public meetings could be held to acquaint local residents with the project and the techniques. At these meetings, the first slide program of this series, "Let the River Do the Work," could be shown. A separate sound track on cassette tape labeled "For Public Presentations" is included for this slide program.

The videotape which is part of this information package is also an overview of the Palmiter techniques which could be used at a public meeting. If certain members of the public want more detailed information on the Palmiter techniques, the second slide program, "The Palmiter Techniques of River Restoration," can provide that information. Again, there is a separate sound track for program two for use at public presentations.

Three other public relations strategies have been hepful in past projects. The first is a tour of certain problem areas for the general public.

During this tour, you could show work in progress, future problem areas and past work completed.

The second strategy is to permit local residents to cut down standing dead trees. During weekends in the fall and winter, have local residents help remove the dead trees for use as fire wood. Clearly, the proper permission must be granted by land owners. With strict supervision, this strategy has worked well on past projects in gaining favorable public opinion.

The third public relations strategy is a final public meeting after the project is complete. An especially effective presentation at this meeting would be to show slides of river problems before and after work was done.

In summary, the four management duties of a Palmiter river restoration project are:

1. Survey the River Problems;
2. Plan the Work;
3. Supervise and Document the Work;
4. Maintain Good Public Relations.

They are an important aspect of any Palmiter river restoration project.

While the Palmiter techniques may not cure all the problems of a river, they can do a great deal to eliminate irritating and expensive river problems and local flooding. Moreover, the techniques correct the problems without disrupting the food supply or damaging the habitat of fish and wildlife. If properly applied and managed, the Palmiter techniques are an effective and inexpensive way to eliminate common river problems while maintaining a stable environment.

APPENDICES

A. A Section of a Work Map

B. A Section of a Work Plan

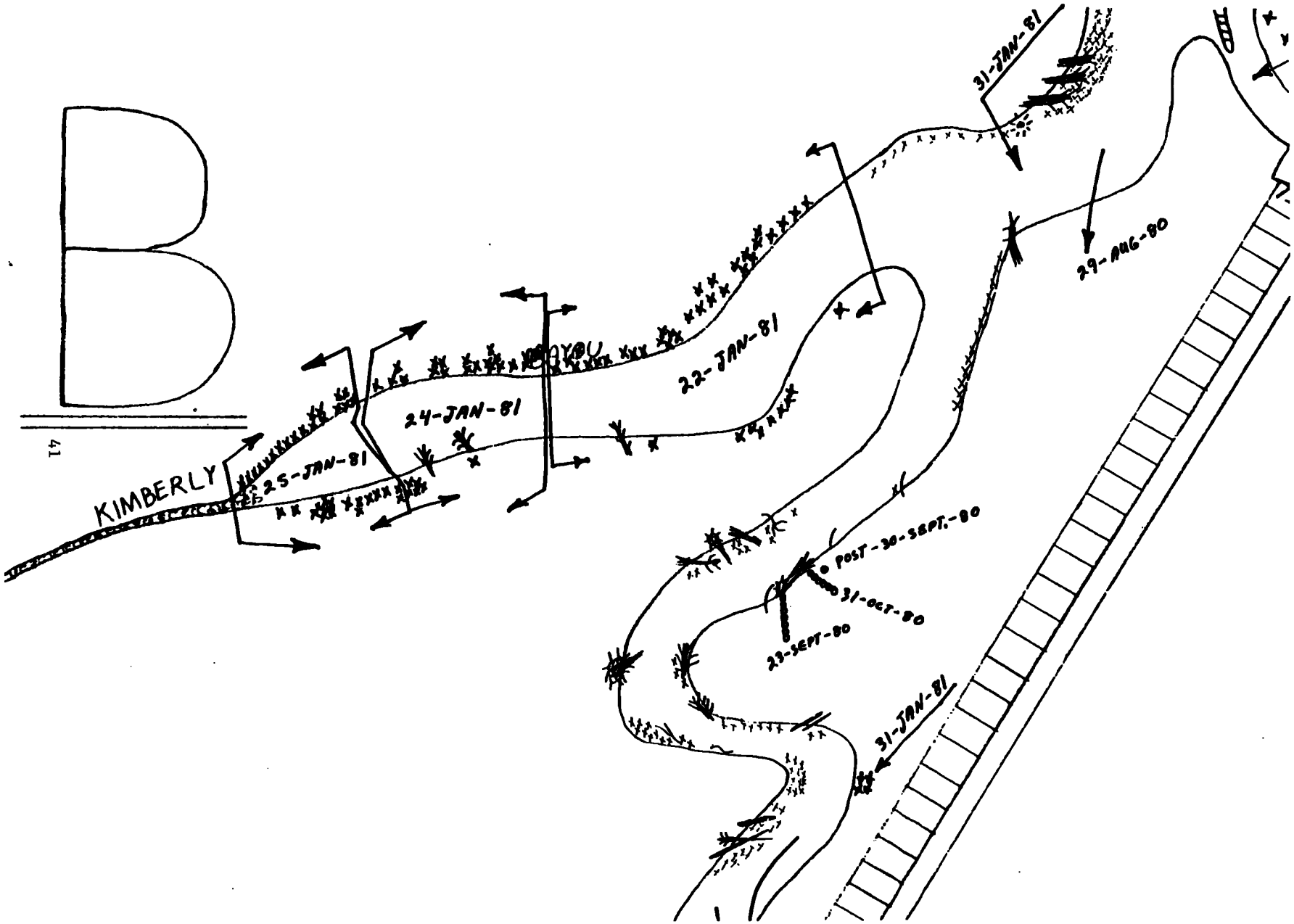
C. Equipment Needs for a Work Crew of Five People

D. Consumable Supplies

E. Sample Budgets from Several Past Projects

APPENDIX A

A SECTION OF A WORK MAP


B
KIMBERLY
25-JAN-81
24-JAN-81
22-JAN-81
31-JAN-81
29-AUG-80
POST-30-SEPT.-80
31-OCT-80
23-SEPT-80
31-JAN-81

APPENDIX B

A SECTION OF A WORK PLAN

BAD RIVER RESTORATION PROJECT

WORK PLAN*

MAP SECTION: C

Between Flood Gates and Wolf Creek (Straight Water Area)

Remove large fallen trees from south bank, then stack on same bank opposite confluence with Wolf Creek. Remove floating logs caught on north bank and cable there above the flood gates. Tag and remove numerous (approx. 50) standing dead trees along north bank and up Wolf Creek for 50 feet. At mouth of Wolf Creek, remove large sycamore and the small jam it causes. Cable with floating logs on north bank.

Between Wolf Creek and Broken Dike Bayou

Tag and remove numerous (approx. 100) standing dead and leaning trees just down river from Wolf Creek and on the inside bank of the bend just upstream.

Remove fallen trees from outer bank of bend and cable as much as necessary in the eroded area near the end of the bend. Remove fallen trees and extensive log jam near Broken Dike Bayour. Then cable material on the bank behind the jam.

Between Broken Dike Bayou and Canada Bayou

Remove major jam of fallen trees and floating logs from north bank. Cable material on north bank opposite Broken Dike Bayou and further down river opposite lower end of the dike overflow. Tag and remove numerous (approx. 25) standing dead trees from north bank near siphon tube.

Between Canada Bayou and Shiawassee River at Tube Outlet

NORTH BANK: Remove numerous fallen trees and small jam from bank, then cable into eroded area. Stack and cable any excess material where necessary. Tag and remove numerous (approx. 50) standing dead and leaning trees, especially those near the outlet tube.

SOUTH BANK: Cable large tree opposite Canada Bayou to trees on bank. Remove fallen trees near the Shiawassee. Cable material securely

*NOTE: This work plan was adapted from work maps and daily work log sheets from the St. Charles River Management Society. Since no detailed work plan was located, this adaptation was written and included for use as a sample.

(the area floods frequently) to largest tree near the tube outlet. Tag and remove numerous (approx. 25) standing dead trees, especially those upstream from the confluence with the Shiawassee.

APPENDIX C

EQUIPMENT NEEDS FOR A CREW OF FIVE PEOPLE

EQUIPMENT NEEDS FOR A CREW OF FIVE PEOPLE

POWER EQUIPMENT (Not required daily and could be shared by several crews.)

1 - Tractor, large enough to remove logs from a jam
1 - Highlift, backhoe or four-wheel drive tractor, occasionally needed to pull large learning stumps back onto the bank
(optional) 1 - Team of horses or mules harnessed for pulling

TRANSPORTATION

1 - Truck van, for taking crews to work site; van should have a power winch on the front bumper
1 - Trailer which the van could pull; trailer is used to haul canoes, boats, cable and other equipment
3 - Canoes or flat-bottom boats for getting crews to remote work sites. Also need paddles, outboard motors and gas tanks.

SAWS

1 - 4' chain saw with chain guard and carrying case
5 - 10" chain saws with chain guards and carrying cases
1 - Set of wrenches and other tools for maintaining chain saws
3 - Bow saws
1 - Wright reciprocating power saw
1 - Set of clamps and files for sharpening saws

LOGGING TOOLS

1 - Large block and tackle, large enough to accept steel cable
1 - grappling hook
several - steel cables of various lengths and gauges with hook ends
several - log chains of different lengths and sizes with hook ends
several - clevises
several - clevis grab hooks
several - lengths and thicknesses of rope
several - hand winches
several - cable clamps
1 - cant hook
2 - sets of tree climbing equipment

HAND TOOLS

several - wedges
2 - splitting mauls
2 - axes
3 - rakes
3 - hoes

3 - shovels
3 - potato rakes
2 - hand augers, dynamite drills or planting hoes
2 - spud bars
3 - pitch forks
2 - pairs of lopping shears
3 - grubbing hoes
2 - machetes
3 - hatchets
3 - hammers
2 - sledge hammers

SAFETY EQUIPMENT

2 - fire extinguishers
5 - hard hats
5 - safety goggles
5 - ear protectors
5 - flotation jackets
1 - industrial first aid kit--one that floats and is waterproof
1 - snake bite kit
several - cans of insect repellant
several - blankets

COMMUNICATIONS

1 - two-way radio for truck van
several - walkie-talkies for use in canoes and at remote work sites

MISCELLANEOUS

2 - wet suits
several - waders
several - knee-high boots
5 - rain ponchos
1 - water cooler (5 gal.)
1 - ice chest
2 - gasoline cans (5 gal.)
1 - set of hand tools (screw drivers, pliers, etc.)

NOTE

Most river restoration work crews develop their own hand tools to suit their own needs. For example: slings made out of cable to haul floating debris; modified cant hook or grappling hook for lifting submerged logs and limbs; and "U"-shaped steel hooks for pulling cable around submerged logs. These types of locally-made hand tools for specific needs will not be described. Use your imagination to construct such tools.

APPENDIX D

CONSUMABLE SUPPLIES

CONSUMABLE SUPPLIES

gasoline for chain saws and vehicle

oil for mixing with gasoline in power saws

chain bar oil

first aid replacement supplies

insect repellant

chains for chain saws

saw blade for bow and Wright saws

rope, binder twine, wire, thin cable for securing brush piles

stakes--wooden and steel

colored plastic flagging of two colors

nails

APPENDIX E

SAMPLE BUDGETS FROM SEVERAL PAST PROJECTS

SAMPLE BUDGETS FROM SEVERAL PAST PROJECTS

Budget from the St. Charles River Management Society, Ltd.

Funds for this project were used to clear six miles of the high volume, low velocity Bad River in Michigan. A CETA grant was used to clear extensive log jams and fallen trees from the main channel. The logs and debris were cut, stacked on the bank and cabled in place to prevent them from becoming future log jams.

Wages (for 2305 person-hours)	$11,240
Benefits	2,208
Supplies and Equipment	2,003
Physicals	492
Total	$15,943
Total cost per mile cleared	$ 2,657

During the winter, closely supervised volunteers removed the stacked, cabled wood piles as well as marked standing dead trees. The volunteers donated the labor in return for free firewood. During the winter of 1981, for example, 470 pickup truck loads were removed from a two-mile stretch of the project area.

Budgets from Projects in Williams County, Ohio

Funds for this project were used to remove log jams and potential obstructions as well as protect banks from erosion. During August, 1975, to September, 1976, the County used a grant from the U. S. Department of the Interior through the Ohio Soil Conservation Service on the Tiffin and St. Joseph Rivers in northwestern Ohio. During the project, a total of 44 persons was hired with a maximum of 24 persons working at any given time and a minimum of eight during the winter. In all, 80 miles of the two rivers were cleared.

Wages (for 14,000 person-hours)	$64,000
Supplies, Equipment and Overhead	16,000
Total	$80,000
Total cost per mile cleared	$ 1,000

During a second project in Williams County, funds were used to employ all of the Palmiter techniques on the Tiffin and St. Joseph Rivers and their tributaries. During March, 1980, to April, 1981, a CETA grant was used to hire a total of ten persons. During the project, approximately 50 miles of the rivers and their tributaries were restored.

Wages	$46,350
Equipment and Supplies	2,000*
Administration and Overhead	5,150
Total	$53,500
Total cost per mile cleared (approximate)	$ 1,070

*Equipment and supplies were provided by the Williams County Highway Department.

*U.S. GOVERNMENT PRINTING OFFICE : 1985 00461-063/34321