

Figure 80—A small block plane is useful for finish work on wood structures.

Draw knives have either straight or concave steel blades that are 12 to 15 inches long with a wooden handle at each end. The draw knife is pulled toward the worker. The straight draw knife does not put as much of the edge against the wood as the concave knife, making the concave knife more efficient and more popular (figure 81).



Figure 81—Straight and concave draw knives.

## Bark Spuds

Bark spuds are better suited for removing the bark from thick-barked or deeply furrowed logs and logs with many knots or large knots. Normally, logs are most easily peeled when the tree is still green, but this characteristic varies by tree species. Bark spuds are from 18 inches to 6 feet long. All have a steel head that is 2 to 3 inches wide and 3 to 5 inches long, sharpened on the end and both sides. The wooden handle is 15 inches to 5½ feet long (figure 82).



Figure 82—A bark spud works well when peeling green logs.

## Tools For Drilling Holes in Wood Bits

Bits are used to drill holes in wood for bolts and for pilot holes for nails and screws. Some of the types of bits available are twist bits, chisel bits, augers, and ship augers.

Twist bits are intended for use on steel, but the smaller bits can be used for drilling pilot holes in wood for nails and screws (see appendix D for appropriate pilot hole sizes). Chisel bits resemble a chisel with a point in the center. Chisel bits tend to tear up the wood around the hole on the top and bottom surfaces of the wood, but they are readily available in diameters of 1/16-inch increments. Augers resemble a widely threaded screw with a sharp end and sharp edges. Augers do not tear up the wood like chisel bits do. A normal auger bit is 6 inches long and readily available in 1/4- to 1½-inch diameters, in 1/8-inch increments, less readily in 1/16-inch increments. With a 6-inch-long auger, it is difficult to get the holes to line up when two 3-inch ledgers are on each side of a 6 by 6 pile. Ship augers help in this situation because they are longer. Ship augers are 15, 17, 18, 23, and 29 inches long and are indispensable when working with timbers and logs.

Old auger bits were made with a four-sided shaft to fit into a manually powered brace or drill. A six-sided shaft is designed for use in a power drill and will spin uselessly when used in a manually powered brace or drill. Today, most bits are made for power drills. When selecting a bit from a maintenance shop, check to see that the shaft of the bit matches the brace or drill to be used at the work site (figure 83).



## Construction Tools

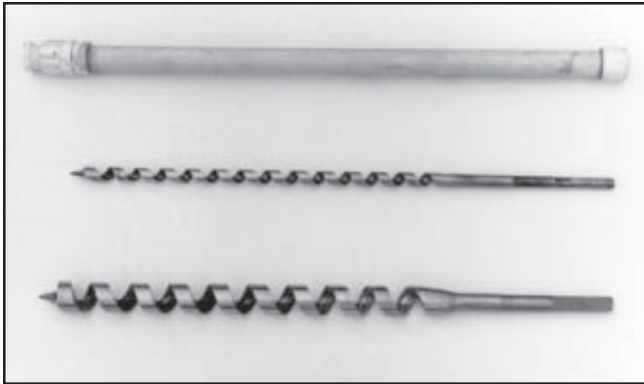


Figure 83—Ship augers are longer than normal 6-inch augers.

### Braces

Braces and bits are the traditional tools for drilling holes in wood. The brace, a handtool suitable for wilderness use, is extremely slow. Old braces require an auger bit with a four-sided shaft (figure 84).

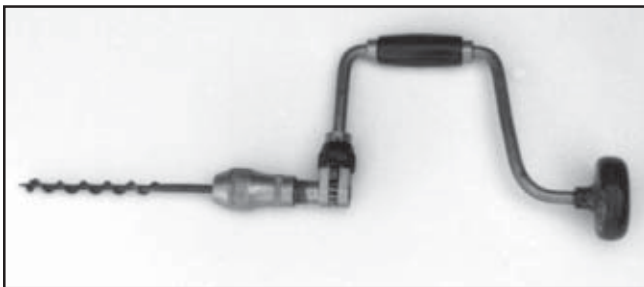


Figure 84—A traditional brace and bit.

Some braces are made with a ratchet, which is helpful when working in close situations where the brace cannot be turned a full circle. People have a tendency to lean on the brace to speed up drilling. This practice bends inexpensive braces. Buy a good brace or don't lean on it. Keep the bits sharp.

### Battery-Powered Drills

Small battery-powered drills are useful for drilling holes  $\frac{1}{16}$  inch to  $\frac{3}{8}$  inch in diameter. Some heavy-duty drills can drill holes up

to 1 inch in diameter. Battery-powered drills may be practical for backcountry use where only a few holes are to be drilled, where the crew returns to the shop after work, or where a generator or photovoltaic power source is available.

### Gasoline-Powered Drills

Many trail crews use gasoline-powered drills. These tools can drill holes up to 1 inch in diameter and weigh from 10 to 12 pounds, plus fuel (figure 85).

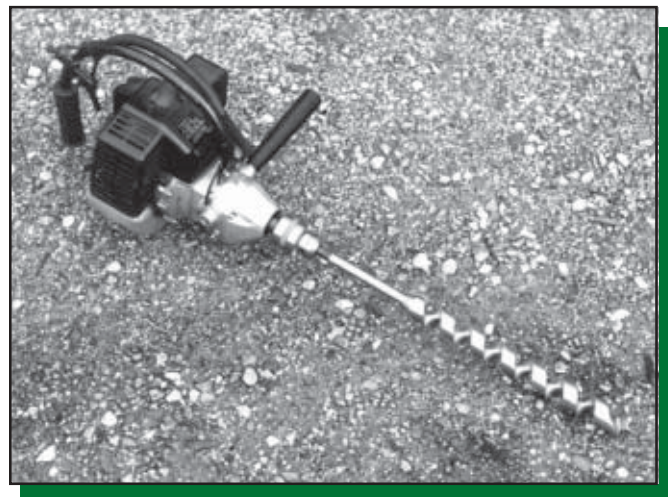


Figure 85—Gasoline-powered drills are great for backcountry work if regulations allow their use.

Only the more expensive heavy-duty drills, whether battery or gasoline powered, have a reverse gear. A bit can become stuck if it does not go all the way through the wood. To avoid getting a bit stuck, lift the drill up a few times while drilling each hole. If the bit does get stuck, disconnect the bit from the brace or drill and use a wrench to twist the bit backward.

If you have a generator at the work site, another alternative is to use a  $\frac{1}{2}$ -inch-diameter electric drill. Most of these drills have a reverse. An annoying drawback is stepping over a long extension cord and getting it tangled in brush and timbers. If the operator is standing in water, electric shock is a possibility. Generators are heavy and require fuel. Although some generators have wheels, most are awkward to transport to wetland sites.



## Clamps

A pair of large jaw clamps can speed the installation of two ledger bents. The clamps should have at least a 12-inch opening. These clamps are used for making furniture and may be all steel or part steel and part plastic. Both ledgers are placed roughly in position and clamped loosely to each pile. The height of each ledger is adjusted, the clamps are tightened, and the bolt holes are drilled (figure 86).

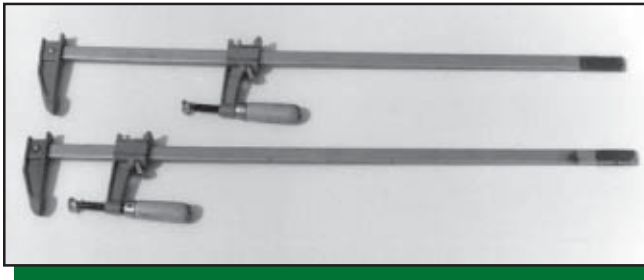


Figure 86—Large jaw clamps.

## Wrenches

At least one wrench is needed to securely fasten carriage bolts and lag screws. Two wrenches are needed to fasten machine bolts and all-thread rod. Specialty wrenches or screwdrivers are needed to install vandal-proof screws. Closed-end and open-end wrenches, and a set of socket wrenches, may all be needed. Tying one end of a cord to the wrench and the other end to your belt may help keep the wrench from getting lost in the water or mud.

## Chisels

Wood chisels are needed for wetland trail structures. The blade may be  $\frac{1}{4}$  to  $2\frac{1}{2}$  inches wide. Wood chisels are typically made with short handles, which often contribute to scraped knuckles. It is worthwhile to repair or replace the handles of old, long-handled chisels.

For a small amount of close work, the wood chisel can be hit or pushed with the palm of the hand. If this technique is impractical, use a wooden mallet. Hitting a wood chisel with a steel

hammer will damage the chisel's handle. A good wood chisel should not be used close to nails, screws, or bolts. The cutting edge should be kept sharp.

The socket slick, an oversized chisel, is a difficult tool to find. However, if considerable notching or other accurate work is required, obtaining a slick will be worth the extra effort and expense. The blade is  $3\frac{3}{8}$  inches wide with an 18-inch wooden handle. The slick weighs 3 pounds. A 2-inch-wide chisel weighs just 10 ounces. The advantages of the slick are its wide blade and long handle. The slick can remove wood twice as quickly as a wide chisel. The long handle keeps the hands farther from the wood being cut (figure 87).



Figure 87—Socket slicks can be hard to find.

## Mallets

Mallets are made with plastic, wooden, leather, or rubber heads. Mallets with plastic or wooden heads should be used for hitting wood chisels.

## Hammers

### Claw Hammers

A carpenter's claw hammer is helpful for nailing log culverts, bog bridges, boardwalks, and geotextile fabric. A 28-ounce framing hammer is better than the lighter models, although the heavy hammer may be awkward for workers who are unaccustomed to it.



## *Sledge Hammers*

A variety of different weight sledge hammers should be available at the work site. A 4-pound sledge is good for starting drift pins and spikes. A 6- or 8-pound hammer is better for driving them. The 8-pound hammer is better suited for moving heavy timbers and logs fractions of an inch when they are almost in place. Surveyors sledge hammers have shorter handles. They are better for driving long pieces of steel because they provide better control.

## *Crowbars*

A crowbar is indispensable for building trails in rocky terrain. For most wetland trail work, the crowbar is used to move fallen trees and logs out of the way and to align piles, logs, and timbers. A crowbar, also called a rock bar or pry bar, is much stronger than a hollow-pipe tamping bar. The two are often confused.

## *Tools for Digging Holes* *Shovels and Posthole Diggers*

The sharp-pointed shovel can be used for digging a narrow deep hole, but a posthole digger or manual auger is more efficient. The posthole digger with its clamshell-like blades is most common, but it is slow and awkward to use. The auger is more expensive, but more efficient.

## *Augers*

The auger blade consists of two pieces of immovable curved steel set at opposing angles to each other. The wooden handle is turned in a horizontal plane while the blades drill a hole in the ground. In most soils an auger is more efficient than a posthole digger (figure 88).



Figure 88—A hand auger.

## *Gasoline-Powered Augers*

Gasoline-powered augers are available. These can usually be rented from local equipment rental companies. A one-person auger weighs 18 to 140 pounds. A two-person auger weighs 35 to 75 pounds. These augers are easily moved to a site. The heavier one-person augers have an engine mounted on wheels that is separate from the auger. Power augers usually make fast work of drilling holes in almost any soil. Problems occur when the auger runs into a boulder, a large root, or soil containing 4- to 6-inch pieces of gravel. The bit will stop, and the torque of the engine may cause back injury.

## *Wheelbarrows*

Wheelbarrows are an underrated and often forgotten piece of equipment for trail work. A wheelbarrow is a necessity for moving fill for most turnpike construction and can be helpful for moving tools, materials, and supplies. For big jobs, two wheelbarrows are handy. One can be loaded while the other is being dumped.

Steel and fiberglass are the most common materials for the body. Steel is heavier and stronger, but fiberglass is cheaper and more easily repaired.

Wheelbarrows commonly available at most local building supply stores do not withstand the rigors of trail work. Contractors wheelbarrows are made with stronger steel, and the handles are made of heavier, better quality wood. Although more expensive, a contractors wheelbarrow will far outlast the flimsy backyard variety. Contractors wheelbarrows can also be rented.





## Construction Tools

The solid-body wheelbarrow is the type that comes to mind when we think of wheelbarrows, but the gardeners wheelbarrow also has a place in trail construction. This wheelbarrow, without sides, is easier to use when loading large stones, short timbers and logs, and bags and boxes of materials. Gardeners wheelbarrows are more expensive than contractors wheelbarrows and are difficult to find. Most have steel wheels. Pneumatic rubber tires are better for trail work. The frame of a standard wheelbarrow can easily be converted to a gardeners wheelbarrow. Temporary flat-tire repair sealants, sold in aerosol cans, help prevent pneumatic tires from going flat. Motorized carriers could greatly ease the burden of moving materials, where their use is allowed.

## Compactors

Compactors should be used when placing fill for turnpike and for backfill around end-bearing piles. Several companies make a vibratory tamper type of compactor that is suitable for compacting small areas of fill. These companies also make vibratory plates, which are better suited for larger areas, such as turnpike and accessible surfaces. Vibratory tampers have an area 8 inches square that contacts the ground. Vibratory plates have an area 15 inches square that contacts the ground (figures 89 and 90).

A third type of compactor is an attachment to the Pionjar rock drill. It can be used for compacting backfill in narrow spaces around end-bearing piles, fenceposts, and signposts.

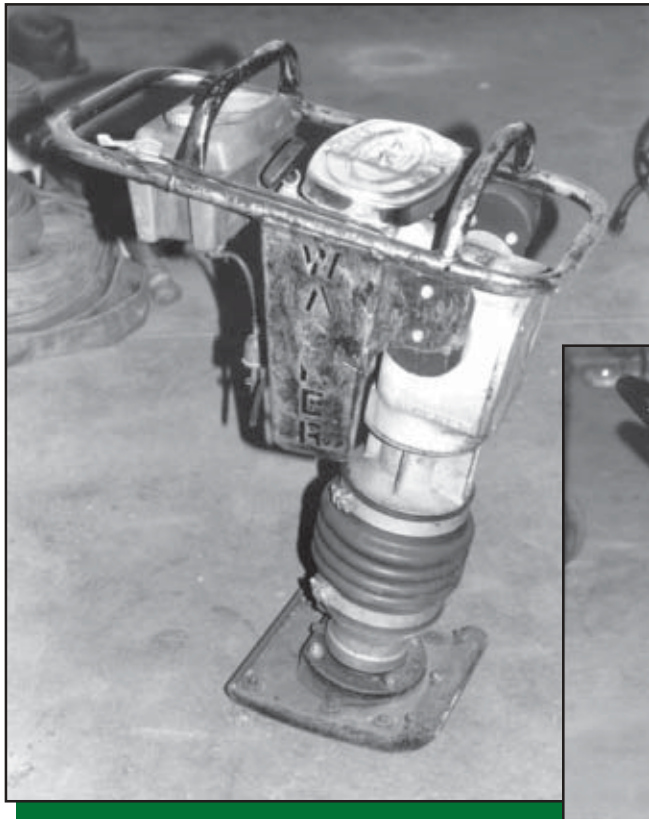


Figure 89—A vibratory tamper.

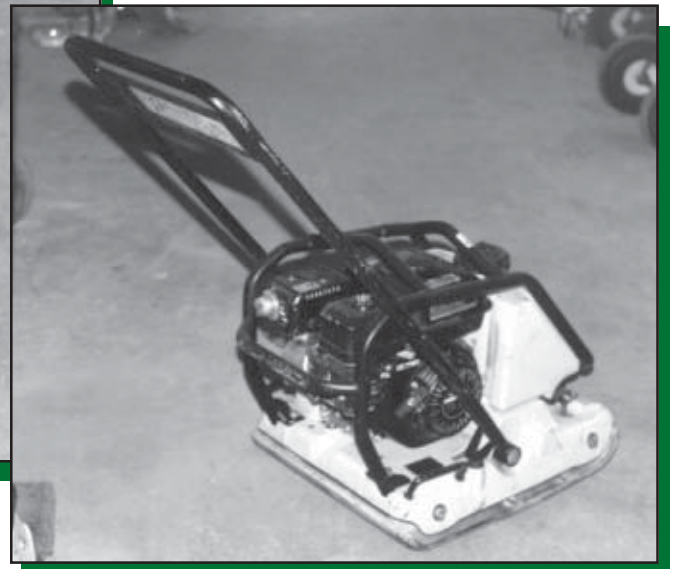


Figure 90—Vibratory plate compactor.



# Practicing the Craft

## Working With Logs

You learn some time- and labor-saving procedures after working with logs a few times. Here are some tricks that can make your work easier.

### Felling

Trees needed for log construction should be felled during the growing season, mid-April to early September in most regions. The bark is easier to remove from trees cut during this season.

Ideally, fell trees uphill from the construction site, and out of sight of trail users. Select straight trees free of obvious defects. Often defects are not noticeable until the tree is down, but outward signs of rot, fungus growth, and insect attack indicate a tree to be avoided. Special training and agency certification are required for fallers, a very hazardous occupation.

### Bucking and Seasoning

After felling, the tree is bucked, or cut, into log lengths. The logs can be peeled, which will reduce their weight and permit them to dry out, or *season*. Leaving the bark on the logs will protect the surfaces when the logs are moved, especially if the logs are dragged. Whether the logs are peeled or not, they should be stacked off the ground on two or three stringers of low-quality logs. Stickers should be used between layers of usable logs to allow uniform seasoning. Stickers can be 2 by 4s or small-diameter logs placed across a layer of logs at the ends and midpoints of a layer (figure 91).



Figure 91—Stickers placed between layers of logs help the logs dry faster and reduce rotting.

## Moving Logs

Logs are heavy. Footing is uneven and often slippery. Accidents can happen easily, and the emergency room is far away. When logs are carried by hand, the tendency is to pick up the logs and carry them on the shoulder or at the waist. If workers holding the log slip, the log will come down on them. The result can be a serious injury to the ribs, hip, ankle, or foot.

To avoid or reduce the severity of this type of injury, use two or more log carriers. Log carriers are large steel tongs mounted in the center of a 2- to 3-inch-diameter wooden handle that is 4 feet long. Two workers can use one log carrier to drag a log. At least two carriers are needed to lift a log, one carrier at each end. Each carrier requires one worker on each side of the log.

Log carriers are awkward to pack, heavy, and serve only one purpose. The teeth of log carriers indent the wood half an inch or so on each side of the log. The indentations mar the appearance of the log and provide a place for rot to begin.

A cheaper and lighter method for moving a log is to use rope slings and the removable handles of mattocks or adzes (or small-diameter logs that are 3 to 4 feet long). The slings are made by taking 6 feet of 1,000-pound-test nylon rope and tying a fisherman's knot, double fisherman's knot, or a grapevine knot at the ends, forming a loop.

Roll the log onto the slings and slip the handles over the log and through the loops of the slings. With one worker on each end of the handles (four workers total), lift the log off the ground. The log should be about ankle high. If anyone slips and drops the log, the most serious injury will be to the ankle or foot, and the log will not have fallen far enough to develop much force (figure 92).

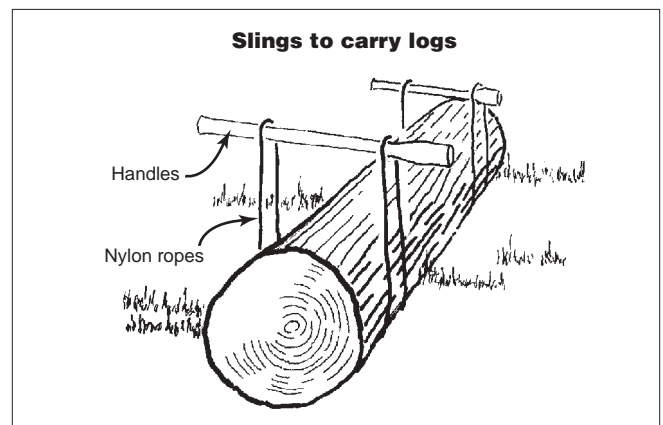


Figure 92—Slings are a good way to move logs and timbers, bundles of steel bars, wheelbarrows that must be carried over soft ground, or bags of cement carried on plywood.



## Peeling

Peeling is a tedious process. There is little reason to peel the bark off a log if you plan to hew or plane it, unless the bark is dirty and likely to dull your cutting tools. Pine, fir, and other evergreen trees may develop pitch pockets just under the bark. On freshly cut trees, pitch may be runny rather than thick or sticky. The cutting edge of a drawknife is never more than an arm's length from a worker's face, and the drawknife is pulled toward the worker's body. Cutting into a pitch pocket splatters pitch on the worker. A drop of pitch in an eye results in the same burning effect as a drop of turpentine. Wear safety glasses or goggles when peeling logs of most evergreen species.

## Squaring a Log

It is not easy to cut a uniform plane surface on a log. That difficulty plus the desirability of using treated timbers for longevity is the reason less work is being done with native logs on site. However, if you are determined to use logs because of their availability and their rustic appearance, here is how to do so. The first step is to place the log on nearly level ground and roll it over to determine which face is easiest to work with. Avoid areas with many knots or large knots. The crook of the log, if any, should be in the direction that will cause the least problem when the construction is completed. Roll the log until the best face is up and in a roughly horizontal position (figure 93).

Determine the width of the plane surface that is needed. Put a carpenter's or mason's level in a horizontal position against the end of the log. Use a measuring tape or framing square to measure the distance between the solid wood and the inside of the bark at the edge of the level. By trial and error, move the level up or down until its upper edge is level and on a line that measures the dimension needed. Draw a line across the end of the log on the edge of the level. Without moving the log, use the same process to draw a line across the other end.

Drive a nail into the bark where each horizontal line meets the bark. Stretch a chalkline or stringline between the two nails on one side of the log. If the bark is thin or has been removed, a chalkline can be used and snapped, leaving a chalk mark to work to. A chalkline will not leave an accurate or discernible mark on thick, deeply furrowed bark or on a log with an inch or more of crook. In this situation, drive nails to hold the string every 2 feet or so along the line of the string. Repeat the process on the other side of the log.

After scoring parallel cuts down to the chalkline with a chain saw or ax, use an adz to remove the wood from the top of the log down to the chalklines. Use small-diameter logs, 2 by 4s,

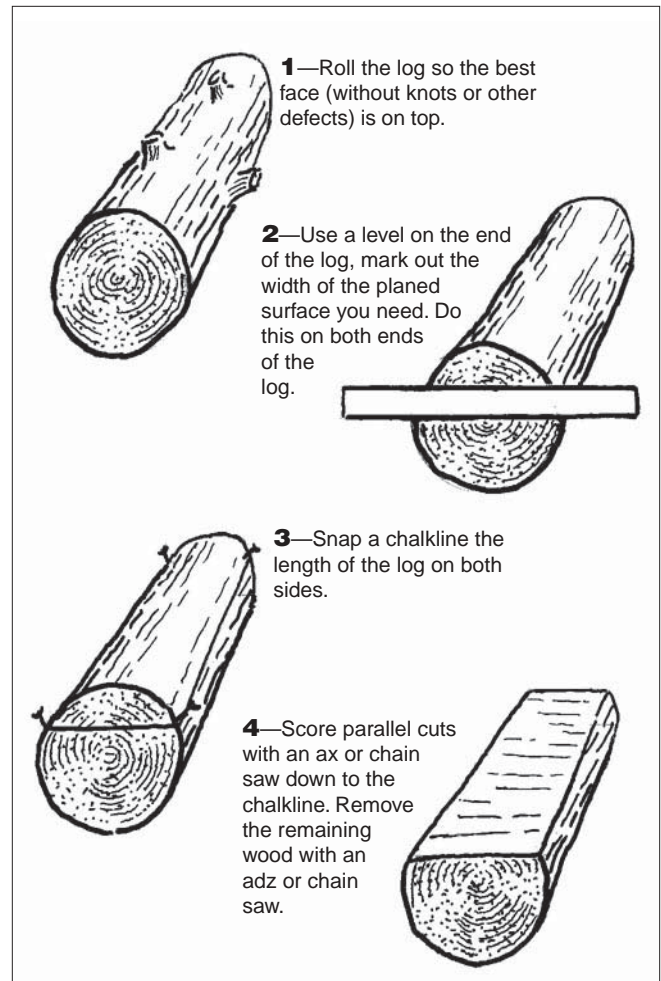


Figure 93—Steps to square a log.

or log dogs to hold small logs in place while doing the adz work. To control how much wood is removed, cut with the grain of the wood. This technique reduces the likelihood of breaking out deep chips of wood. The direction of the grain will be obvious after the first few cuts.

A chain saw will do the work much faster. A helper is needed to make sure the sawyer doesn't cut below the chalkline on the far side of the log (which the sawyer cannot see). Otherwise, you will end up with a wavy surface. If the wavy surface is used as a tread, it will cause hikers to slip and fall when the tread is wet or frosty.

If you are not using a chain saw, the technique described above is practical only on small logs. The adz is considered a finishing tool for surfaces that have already been hewed to size. If a lot of wood must be removed and power equipment is not available,





## Practicing the Craft

hewing with a broad ax is more common and more efficient. The process starts out much like that described for adz work, but instead of horizontal cuts, broad ax cuts are made vertically, for the length of the log along the chalkline. This technique is spelled out in more detail in *An Ax to Grind: A Practical Ax Manual* (9923-2823-MTDC).

Check the surface with a straightedge, a framing square, or a long level. Check across the log and also along its length. Mark any high spots and remove them. It is easier to detect high spots by kneeling on the side of the straightedge in shadow and looking between the straightedge and the wood (figure 94).

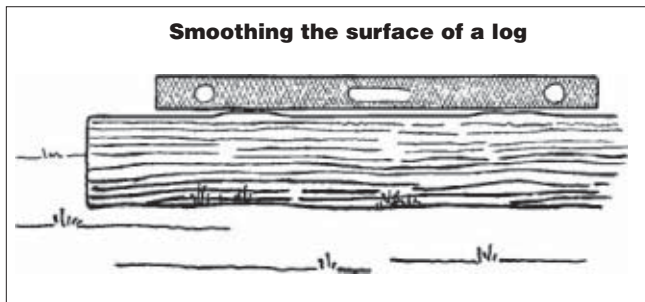


Figure 94—Use a long level to find high spots that need to be removed.

After the first surface is complete, a second surface can be marked and cut. If the second surface is perpendicular to the first, a framing square can be used to mark the ends of the log. Repeat the marking procedure with the chalkline or stringline and nails. The log can be rolled over so that the second surface is horizontal and can be adzed, or the log can be left in place so the second surface can be shaped with a broad ax. This method is suitable for making log puncheon that must be two logs wide (figure 95).

If the second surface needs to be parallel to the first, place the log with its ends resting on two other logs with the first surface facing up and the log level (figure 96). Determine either the thickness of the log needed, or the width of the second surface needed. Using the level, mark a line along the log's edge parallel with the first surface. Roll the log until the first surface is facing down and repeat the chalkline or stringline procedure for the second surface. Use an adz or saw to level the second surface. This technique is suitable for situations where one surface must be level for a tread and the bottom at each end must rest on log or stone piers.

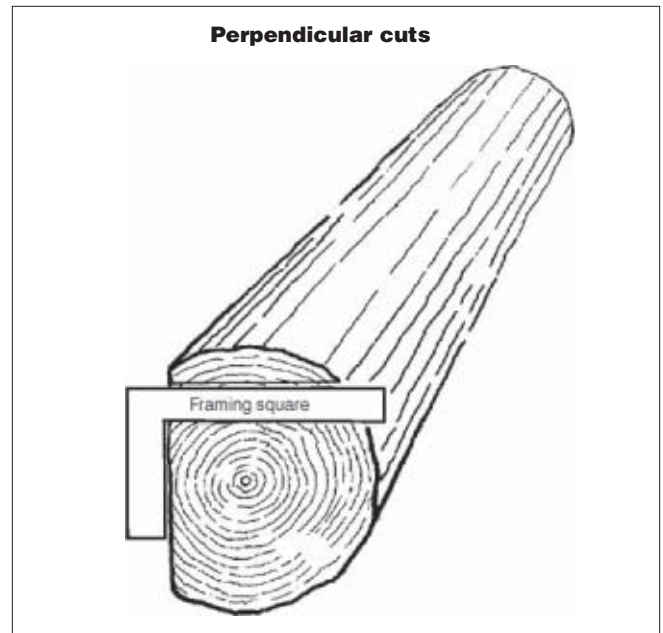


Figure 95—Use a framing square to mark a perpendicular cut.

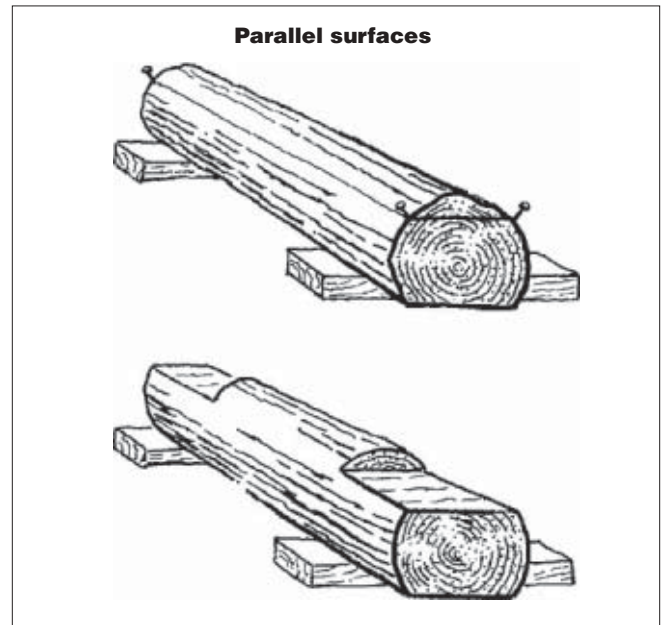


Figure 96—Use this procedure when a second flat surface must be parallel to the first.





## ***Cutting Planks With Chain Saw Mills***

Where chain saws are allowed, native logs are available, and distance or other factors preclude hauling in treated timbers, consider using an Alaskan sawmill (figure 97). This is about the only way to effectively channel the power of the saw to create uniform, square planks. Several sizes of mills are available. A basic mill costs less than \$200. You also need a powerful chain saw, one equipped with ripper teeth.

## ***Working With Timbers***

Rough-sawn timbers are splintery, and some species of wood are more prone to splinter than others. To avoid a handful of splinters, wear good-quality, heavy work gloves.

Timbers to be used in a horizontal plane, (ledgers, stringers, and culvert inverts) should be checked for camber, a slight bend in the length of a piece of wood. Although camber usually is slight—less than ½ inch per 10-foot length—it should be used to your advantage.

Camber can usually be determined by sighting along all the surfaces of the timber from one end. Sometimes a stringline held to each end of the timber helps to identify camber. Many timbers will not have any camber.

If camber is present, the convex face should be placed up and the concave face placed down, even if this contradicts the “green-side up” general rule of placing growth rings down to reduce cupping. Weight on a timber will cause the timber to deflect or sag. With the convex surface up, deflection will act to straighten the timber. If camber is ignored and the timber is installed with the concave surface up, it is already sagging. Additional weight will cause the timber to sag even more.



Figure 97—An Alaskan sawmill works great for creating planks from native logs. The mill requires a powerful chain saw (at least 3.8 cubic inches of displacement, more is better) and a special ripping chain.



## Working With Treated Wood

At a preservative treatment plant, freshly treated wood is stacked on areas of concrete where excess preservative drips from the stack and is collected and recycled. The treated wood is air dried, which works well in a dry climate. However, the wood is sometimes dry at the surface but wet below the surface when it is shipped. This wood will weigh more because of the moisture. You need to consider this factor when transporting the wood to remote locations. The high moisture content of newly treated wood will also cause tools to bind and tear the wood. This is not intended to deter you from using treated wood, but it is something you need to be aware of.

Treated wood may be kiln dried if that process is specified. Kiln drying to 19-percent humidity can be required. However, the minimum order for large plants may be a truckload. Most small local plants probably cannot do this at all. Kiln drying does cost more.

## Pinning Logs and Timbers

Driftpins (usually  $\frac{1}{2}$ -inch-diameter steel reinforcing bars) are used to pin logs and timbers. Some trail crews prefer to use driftpins cut from  $\frac{1}{2}$ -inch-inside-diameter galvanized steel pipe. The length of the driftpins will vary. When driftpins are used to anchor a log or timber to the ground, about 12 to 18 inches of the driftpin should be in the ground. If rock or boulders are encountered before the driftpin is driven its full length, it will have to be cut off with a hacksaw. When pinning one log or timber to another, the driftpins should be long enough to go through the upper piece and all the way through the lower piece, or at least 12 inches into it.

First, drill holes in the wood. Before driving the pins, dip the lower end of the driftpin in heavy automobile grease. The lubricant will make it easier to drive the driftpins, will protect the driftpin from the weather, and will provide a thin, protective film between the steel and the copper in treated wood. Driving the driftpins is much easier if you make a striking plate out of a short piece of pipe with a 2- to 3-inch round plate welded to one end.

The top of the driftpin should be countersunk (figure 98). Countersinking can be done neatly by placing a 4- to 6-inch piece of steel pipe around the driftpin and a 12-inch piece of a smaller diameter steel bar inside it. With the pipe resting on the log or timber and the smaller diameter steel bar resting on the driftpin, hit the steel bar with a sledge hammer until the top of the driftpin is below the surface of the wood. This depression can be filled with grease to protect the steel from rusting. Wipe any surplus lubricant off of the wood.

# Part 6 of 8

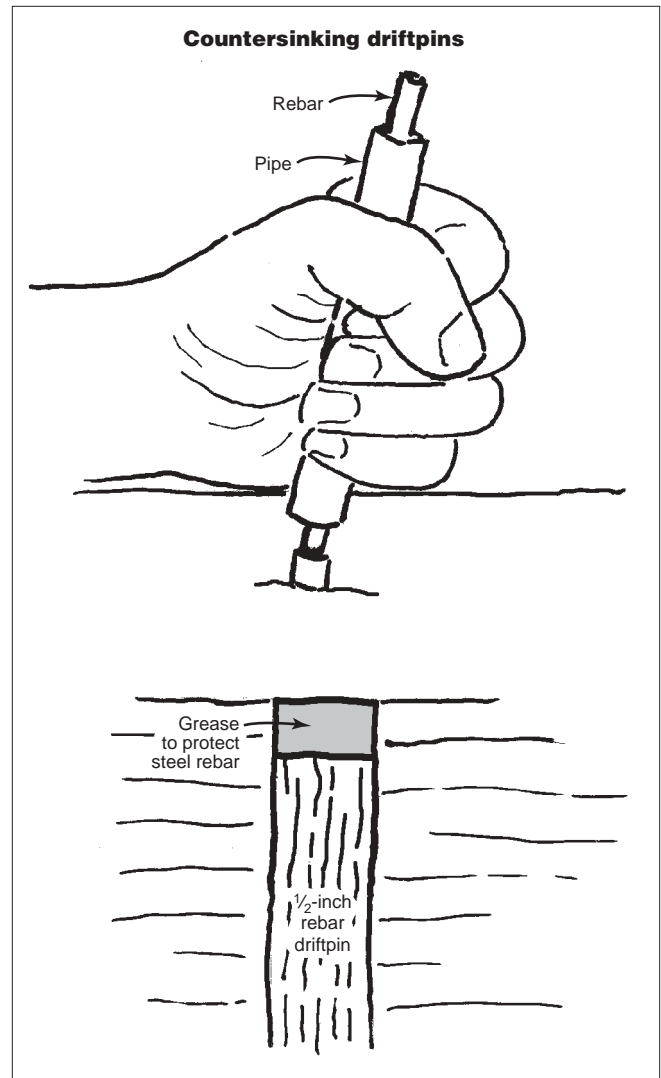


Figure 98—Countersinking the driftpin is a good practice easily accomplished by striking a short piece of rebar inside an even shorter pipe.

## Tread Surface Slippery Wooden Treads

We are frequently asked how to correct a slippery wooden tread. Often, the surface is not the source of the problem. The slippery surface usually is the result of overlooking factors such as trail grade, cross slope, or soil conditions.