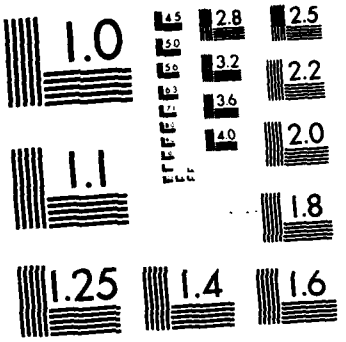
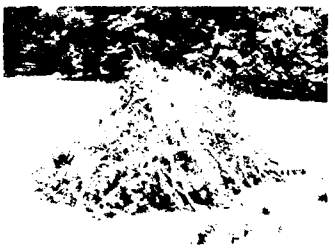
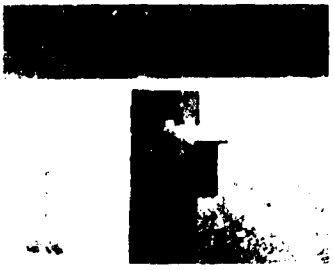
AD-A171 606 EEVIRONMENTAL IMPACT RESEARCH PROGRAM WOODEN FENCES 1/1
SECTION 524 US ARMY C (U) ARMY ENGINEER WATERWAYS
EXPERIMENT STATION VICKSBURG MS ENVIR
UNCLASSIFIED L E MARCY ET AL JUL 86 WES/TR/EL-86-20 F/G 13/2 NL



US Army Corps of Engineers





(12)

ENVIRONMENTAL IMPACT RESEARCH PROGRAM

TECHNICAL REPORT EL-86-20

WOODEN FENCES

Section 5.2.4, US ARMY CORPS OF ENGINEERS WILDLIFE RESOURCES MANAGEMENT MANUAL

by

Larry E. Marcy, Chester O. Martin

Environmental Laboratory

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
PO Box 631, Vicksburg, Mississippi 39180-0631

July 1986
Final Report

Approved For Public Release; Distribution Unlimited

Prepared for DEPARTMENT OF THE ARMY
US Army Corps of Engineers
Washington, DC 20314-1000
Under EIRP Work Unit 31631

Destroy this report when no longer needed. Do not return it to the originator.

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

The contents of this report are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or approval of the use of such commercial products.

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

AD-A171 606

REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704-0188
Exp Date Jun 30, 1986

1a REPORT SECURITY CLASSIFICATION Unclassified	1b RESTRICTIVE MARKINGS
2a SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.
2b DECLASSIFICATION/DOWNGRADING SCHEDULE	
4 PERFORMING ORGANIZATION REPORT NUMBER(S) Technical Report EL-86-20	5 MONITORING ORGANIZATION REPORT NUMBER(S)
6a NAME OF PERFORMING ORGANIZATION USAEWES Environmental Laboratory 6b OFFICE SYMBOL (If applicable)	7a NAME OF MONITORING ORGANIZATION
6c ADDRESS (City, State, and ZIP Code) PO Box 631 Vicksburg, MS 39180-0631	7b ADDRESS (City, State, and ZIP Code)
8a NAME OF FUNDING/SPONSORING ORGANIZATION US Army Corps of Engineers 8b OFFICE SYMBOL (If applicable)	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c ADDRESS (City, State, and ZIP Code) Washington, DC 20314-1000	10 SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO EIRP 31631

11 TITLE (Include Security Classification)
Wooden Fences: Section 5.2.4,
US Army Corps of Engineers Wildlife Resources Management Manual

12 PERSONAL AUTHOR(S)
Marcy, Larry E., and Martin, Chester O.

13a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
Final report	FROM _____ TO _____	July 1986	25

16 SUPPLEMENTARY NOTATION
Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Fences; Wooden fences; Board fence; Rail fence; Zigzag fence; (Continued)

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

A management techniques report on wooden fences is provided as Section 5.2.4 of the US Army Corps of Engineers Wildlife Resources Management Manual. The report was prepared as a guide to assist Corps biologists and resource managers in the selection of fence designs and construction and installation techniques where wooden fences are desirable for wildlife and habitat management programs. Topics covered include wildlife value, placement, design and construction, and cautions and limitations.

A variety of wooden fence designs are suitable for Corps projects and, in special situations, should be considered for use instead of wire fences. Wooden fences are particularly appropriate for improving the appearance of scenic areas and can be used to control access and provide wildlife benefits in habitat development programs. Fence designs described in this report are the board fence, post and rail fence, zigzag rail fence, buck and pole

(Continued)

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT	21 ABSTRACT SECURITY CLASSIFICATION
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	Unclassified
22a NAME OF RESPONSIBLE INDIVIDUAL	22b TELEPHONE (Include Area Code) / 22c OFFICE SYMBOL

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

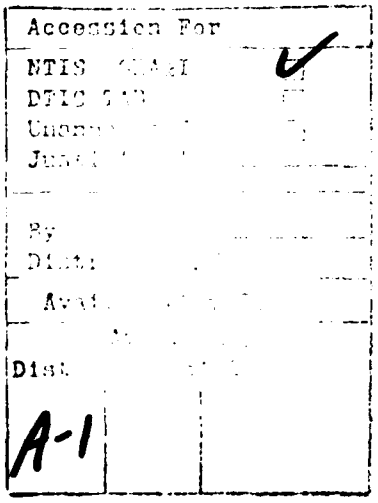
A

18. SUBJECT TERMS (Continued).

Pole fence	Wildlife fence designs
Log fence	Habitat management
Wildlife management	Management practices and techniques

19. ABSTRACT (Continued).

fence, and block and log fence. Details are provided on construction, installation, placement, and maintenance of each fence type; specification drawings and material requirements are included. Recommendations are given on the use of wooden fences to improve wildlife habitat.



PREFACE

This work was sponsored by the Office, Chief of Engineers (OCE), US Army, as part of the Environmental Impact Research Program (EIRP), Work Unit 31631, entitled Management of Corps Lands for Wildlife Resource Improvement. The Technical Monitors for the study were Dr. John Bushman and Mr. Earl Eiker, OCE, and Mr. Dave Mathis, Water Resources Support Center.

This report was prepared by Mr. Larry E. Marcy, Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, Tex., and Mr. Chester O. Martin, Wetlands and Terrestrial Habitat Group (WTHG), Environmental Laboratory (EL), US Army Engineer Waterways Experiment Station (WES). Mr. Marcy was employed by WES under an Intergovernmental Personnel Act contract with Texas A&M University during the period this report was prepared. Mr. Martin, Team Leader, Wildlife Resources Team, WTHG, was principal investigator for the work unit. The authors wish to thank personnel of the US Army Engineer Division, North Pacific (NPD), Portland, Oreg., and the US Army Engineer District, Walla Walla, Walla Walla, Wash., for providing information and specifications on zigzag rail fences. Report review was provided by Dr. Wilma A. Mitchell, WTHG; Mr. E. Paul Peloquin, NPD; and Mr. Ted B. Doerr, Colorado State University, Fort Collins, Colo. Mr. Robert S. Wardwell, Armed Forces Pest Management Board, Forest Glen Section, WRAMC, Washington, D.C., provided precautionary information on the use of wood preservatives.

The report was prepared under the general supervision of Dr. Hanley K. Smith, Chief, WTHG, EL; Dr. Conrad J. Kirby, Chief, Environmental Resources Division, EL; and Dr. John Harrison, Chief, EL. Dr. Roger T. Saucier, WES, was Program Manager, EIRP. The report was edited by Ms. Jessica S. Ruff of the WES Publications and Graphic Arts Division (PGAD). Drawings were prepared by Mr. David R. (Randy) Kleinman and Mr. John R. Harris, Scientific Illustrations Section, PGAD, under the supervision of Mr. Aubrey W. Stephens, Jr.

At the time of publication, COL Allen F. Grum, USA, was Director of WES, and Dr. Robert W. Whalin was Technical Director.

This report should be cited as follows:

Marcy, Larry E., and Martin, Chester O. 1986. "Wooden Fences: Section 5.2.4, US Army Corps of Engineers Wildlife Resources Management Manual," Technical Report EL-86-20, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

NOTE TO READER

This report is designated as Section 5.2.4 in Chapter 5 -- MANAGEMENT PRACTICES AND TECHNIQUES, Part 5.2 -- FENCES AND CROSSINGS, of the US ARMY CORPS OF ENGINEERS WILDLIFE RESOURCES MANAGEMENT MANUAL. Each section of the manual is published as a separate Technical Report but is designed for use as a unit of the manual. For best retrieval, this report should be filed according to section number within Chapter 5.

WOODEN FENCES

Section 5.2.4, US ARMY CORPS OF ENGINEERS
WILDLIFE RESORUCES MANAGEMENT MANUAL

A variety of wooden fences are suitable for Corps project settings and, in special situations, should be considered for use instead of wire fences. Wooden fences have a longer maintenance-free life expectancy than wire fences, but they are less commonly built now than in the past because of the high cost of labor and scarcity of local sources of poles, rails, and logs (Vallentine 1971). Where aesthetics are important, the best approach may be to use a mixture of fence types to produce a variety of visual effects (Hampe and Noe 1983).

Wooden fences are particularly appropriate for improving the appearance of scenic areas and visitor centers. They are also used to control human and livestock access to fragile riparian zones and to protect campsites, nature trails, reseeded pastures, food plots, and other management areas while permitting unrestricted wildlife movement. Rail fences have been used effectively at some Corps projects to (1) function as a transition zone between plantings, meadows, and pastures, (2) provide interconnecting travel lanes between plantings, (3) act as a physical barrier to prevent the inadvertent destruction of plantings by mowers, and (4) provide shade during the first few years of site development until associated plantings can assume the role (USACE 1979).

WILDLIFE VALUE

Wooden fences constructed along ecotones often create or maintain habitat diversity and are of particular value to some species of wildlife. Wooden posts are used by fence lizards (*Sceloporus* spp.) for sunning and by chipmunks (*Eutamias* spp.), raptors, shrikes (*Larius* spp.) and other birds as lookouts; they also provide shade for lizards, snakes, and small birds and mammals (Maser et al. 1979). Wooden fences, in conjunction with associated vegetation, can provide coverts in open cropland and pasture for nongame species, cottontail rabbits (*Sylvilagus* spp.), and quail and other gallinaceous birds (USACE 1979). Cavities in decaying fence posts are used by such species as bluebirds (*Sialia* spp.), house wrens (*Troglodytes aedon*), swallows, chickadees (*Parus* spp.), bats, deer mice (*Peromyscus* spp.), and chipmunks (Maser et al. 1979). Vegetated fence rows also act as barriers to wind and water erosion (Crawford 1945).

Where wire fences bisect big game trails and migration routes, replacing wire fencing with sections of horizontal rails will allow the fences to be more easily seen by game and will allow freer movement of animals over and under the fences. Elk (*Cervus elaphus*) and moose (*Alces alces*) tend to drag their hind legs when jumping fences (Vallentine 1971). Wooden rails are more visible than wire strands, and thus can help prevent entanglement, reduce injury, and decrease fence damage.

PLACEMENT

Wooden fences should usually be built on level ground, or the ground should be graded flat. On sloping ground, a firm earthen footing, 6 to 7 ft wide, should be built up and then leveled (USDA Forest Service 1972). The site should generally be free of all debris and obstructions to permit easy access for construction and maintenance equipment.

Big game habitat requirements and movement patterns should be considered when locating fences in order not to restrict access to water, food, cover, and seasonal ranges. When constructing fences near meadows, wooden fences should be placed away from the openings and in good cover so that wildlife can negotiate the fences unexposed and under less stressful conditions (Davis 1980).

All fenced sites should contain adequate water to meet the needs of livestock and wildlife in drought conditions. Where livestock grazing is permitted, watering ponds should be fenced to prevent erosion of the shoreline. Wooden fences are easily adapted to protect ponds while permitting wildlife access to the water. Water troughs should be installed outside the fence to provide water for livestock. See Conventional Wire Fences (Section 5.2.1) for more information on fence placement.

DESIGN AND CONSTRUCTION

Numerous designs for wooden fences are available. Those presented below have proven effective in wildlife and habitat management, and each can be easily modified for special uses. All of the designs described will permit wildlife passage while controlling livestock and directing human traffic.

Wooden fences can be built from several kinds of timber; however, pine and fir are most commonly used for poles, rails, and peeler logs. Poles are normally ≤4 in. in diameter, whereas rails are 4 to 7 in. in diameter. Peeler logs have had the outer bark removed and have been milled to a uniform diameter, usually ≥8 in. If a long maintenance-free life is necessary, all wooden materials should be pressure-treated with preservative. A variety of commercial wood preservatives are available, but some of the commonly used compounds have recently been designated as restricted-use pesticides by the Environmental Protection Agency (EPA). These are pentachlorophenol (penta), creosote, and the following inorganic arsenicals: copper-chromated arsenate (CCA), ammonia-chromated arsenate (ACA), and ammonia-chromated zinc arsenate (ACZA). Thus, extreme care should be used when handling pressure-treated lumber, and EPA labels and consumer information sheets must be strictly followed when applying the chemicals (Robert S. Wardwell, Armed Forces Pest Management Board, Washington, D.C., pers. commun., May 1986). Untreated materials are necessary where fences are used to protect newly established vegetation and where they are expected to decay as the vegetation becomes established.

Board Fence

The standard board fence is usually built 4 to 5 boards high and is suitable for controlling livestock and for directing foot traffic away from fragile riparian zones (Fig. 1). This fence is too tall to be easily jumped

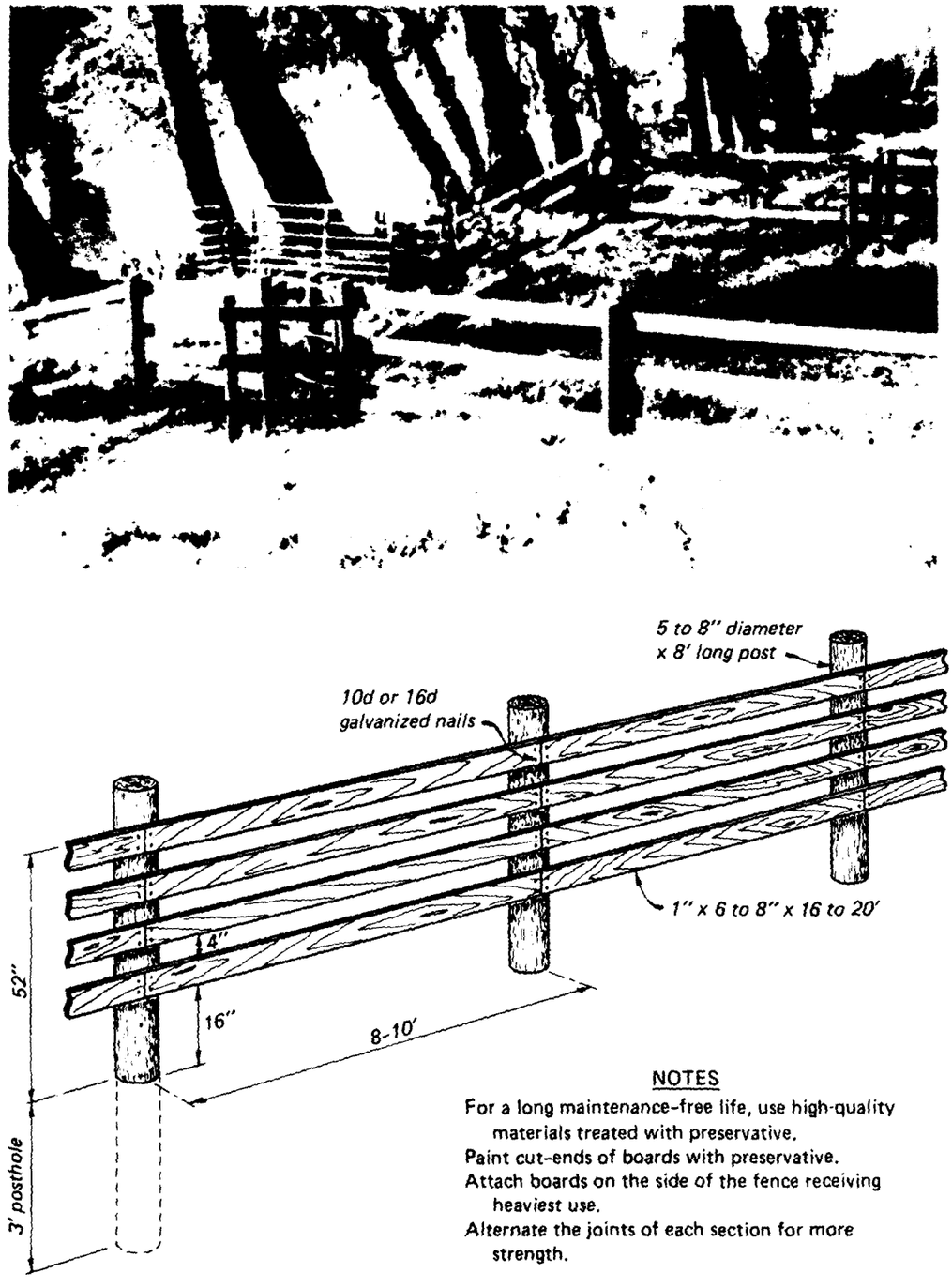


Figure 1. A board fence erected for riparian zone protection along the Stanislaus River, California (photo), and construction details for a typical board fence

by elk and moose and therefore should not be used across migration routes. The fence is adaptable to flat and gently rolling terrain; it should not be used on steep, rocky, broken terrain, or in heavily timbered or deep-snow country.

Vertical fence posts should be 5 to 8 in. in diameter and 8 ft long. Fence boards should be 1 in. thick, 6 to 8 in. wide, and 8 to 10 ft long (USDA 1961). All wooden materials should be pressure-treated with preservative. Procedures for constructing the board fence are as follows:

(1) Clear the fence line of all debris and brush; establish the fence center line as straight as possible.

(2) Mark posthole locations at 8- to 10-ft intervals along the fence line and dig the holes 3 ft deep.

(3) Position the posts in the holes and set them by tamping soil solidly around the bases.

(4) Mark the bottom board locations on the posts 16 in. above the ground. The 16-in. gap at the bottom of the fence will allow wildlife easy passage. Fence boards should be attached on the side facing heaviest use.

(5) Nail the bottom boards to the posts with 10d or 16d galvanized nails. If the boards must be trimmed to size, paint the cut-ends with preservative.

(6) Attach the remaining boards in each section leaving a 4-in. space between sections. For additional strength, stagger the joints of each section.

(7) The completed fence should be approximately 52 in. high.

Post and Rail Fence

The post and rail fence is suitable for short, straight spans to accent visitor center facilities and nature trails, and to direct foot traffic away from revegetation sites or fragile areas. This fence is less costly than other types of wooden fencing in terms of materials and labor. However, it should not be used as a livestock fence, and it is not adaptable to rough terrain or where a sharp bend in the fence line is needed. Two designs are described below.

Design A. Vertical posts for the post and rail fence should be 8 to 10 in. in diameter and 6-1/2 ft long. Rails should be 4-1/2 to 7 in. in diameter and 10 ft long. Step-by-step procedures for constructing and installing a post and rail fence are as follows (after Wisconsin Highway Department 1965):

(1) Establish a fence line as straight as possible. Space the postholes approximately 10 ft apart, and dig the holes 3 ft deep.

(2) Notch posts and rails as shown in Figure 2.

(3) Position the posts in the holes; set the first post and tamp the soil solidly around the base.

(4) Trial-fit the rails into the notches of the first and second posts. The second posthole should not be filled in until the rails fit correctly in the posts (a loose second post allows for easy fitting of the rails and modification of the notches).

(5) To prevent decay, coat the ends of the rails and inside the notches with mastic or other preservative.

(6) Reposition the rails in the notches and fill in the second posthole. Tamp the soil solidly around the post.

(7) Secure the rails to the post with 40d cadmium-plated or galvanized spikes driven at an angle through the rails and into the posts. Retamp the soil around the posts.

(8) Additional fence sections can then be constructed in the same manner.

Design B. The rail fence is a straight-line fence with 2 posts used side-by-side to secure the rails (Fig. 3). Straight fences require fewer rails, take up less ground, and are easier to maintain than zigzag fences (USDA 1961). The rail fence is used frequently for general aesthetics and to discourage unnecessary human traffic around recreational facilities (USDA Forest Service 1972).

Vertical posts for the rail fence should be 6 to 8 in. in diameter and 7 to 8 ft long. Rails should be 4 to 6 in. in diameter and 18 to 22 ft long. Construction and installation details are as follows:

(1) Establish the fence center line on level ground and mark the post locations at 16- to 20-ft intervals along the line.

(2) Position 2 posts on opposite sides of the center line and set them in holes 3 ft deep. Enough space should remain between the posts to allow placement of the fence rails. A snug fit is desirable between the posts and rails.

(3) Place a 4- to 6-in.-diam × 18-in.-long log spacer on the ground between each pair of posts and secure the spacer to the posts with 40d spikes or lengths of 3/8-in.-diam rebar (Fig. 3). Predrilled horizontal holes are helpful in driving spikes or rebars through the posts and into the spacers.

(4) The rails are then positioned between the posts and secured as done for the spacers. Rails should extend beyond the posts at least 1 ft. If rails have not been milled to a uniform diameter, end diameters of the rails should alternate between large and small in order to keep the fence level.

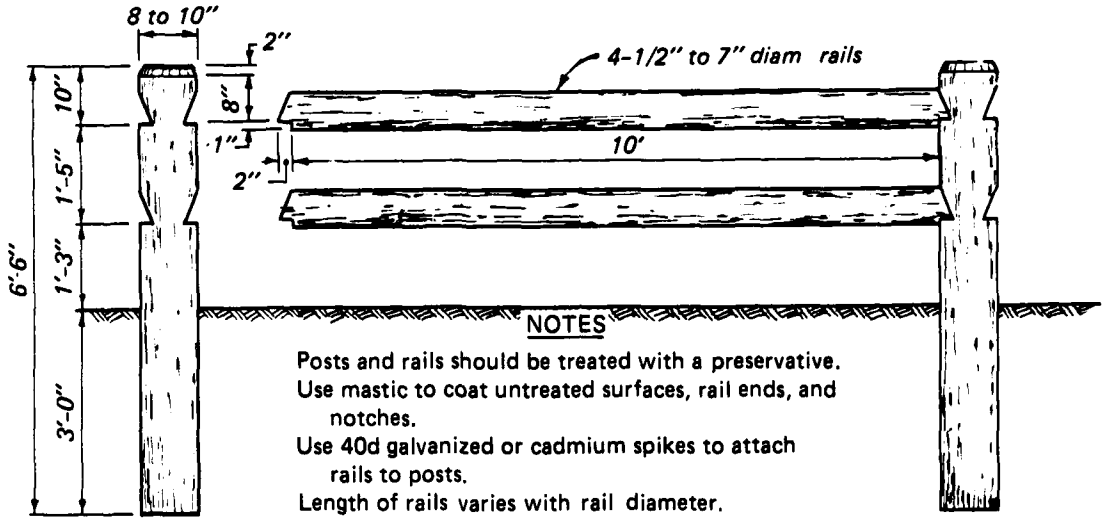


Figure 2. Construction details for a post and rail fence, Design A in text (after Wisconsin Highway Department 1965)

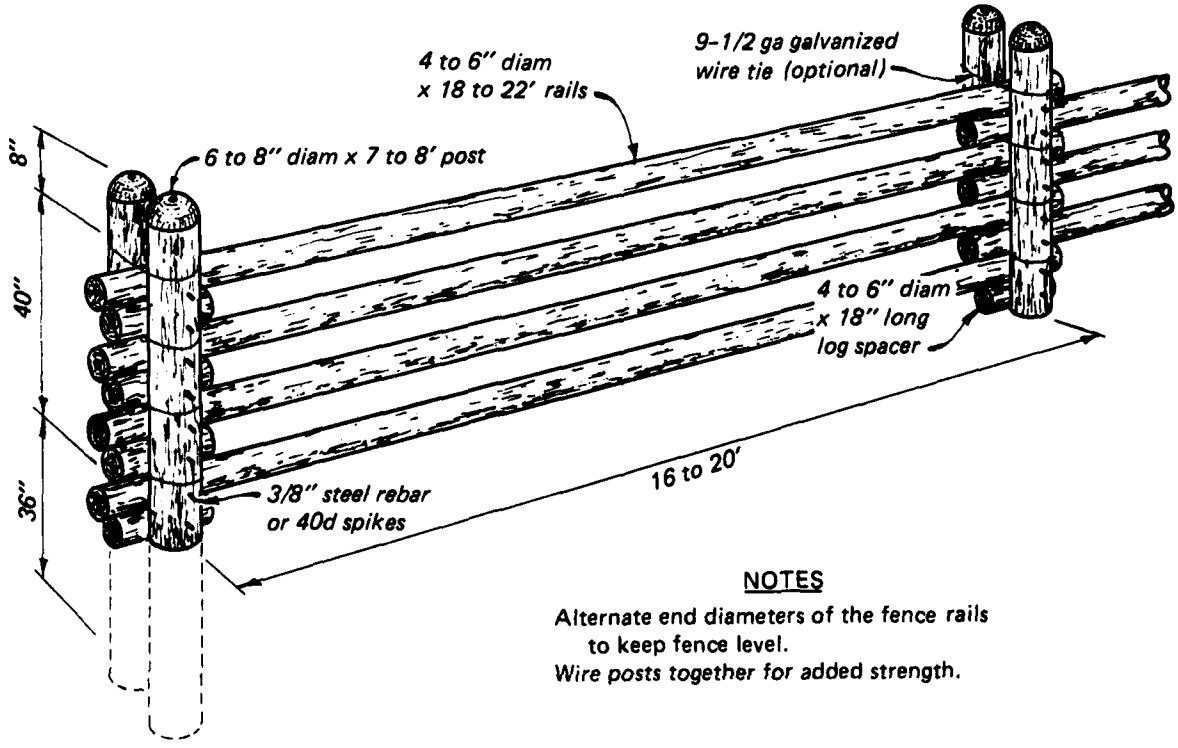


Figure 3. Construction details for a post and rail fence (Design B in text) built from unmilled lumber (modified from USDA Forest Service 1972)

(5) Rail fences can be strengthened by wiring the posts and rails together with double strands of 9-1/2-ga galvanized wire.

Zigzag Rail Fence

The zigzag rail fence, also known as the worm fence or Virginia fence, is suitable for protecting and aiding in the establishment of a hedge line or corridor of vegetation across pastures, along roadsides, and around food plots. It can also be used as a snow catchment and to control foot traffic around recreational facilities (USDA Forest Service 1972). The U.S. Army Engineer District (USAED), Walla Walla, has used this type of fence for habitat development projects and to protect newly established vegetation from mowers; the fences were constructed of untreated fir peeler logs that were allowed to decay as vegetation grew and replaced the fence (USACE 1979).

A zigzag rail fence is usually built 4 to 11 rails high depending on rail diameter (USDA 1961) (Fig. 4). Procedures for constructing the fence are as follows:

Design A. This fence is constructed of treated materials for a longer maintenance-free life. The fence is built one section at a time (a section is the fencing between and including two posts).

(1) Establish the fence center line on the ground along which the fence will be built.

(2) Position the bottom layer of wooden rails, approximately 4 to 5 in. in diameter × 10 to 12 ft long, along the center line in a zigzag pattern so that each section advances 8 to 9 ft (Fig. 4).

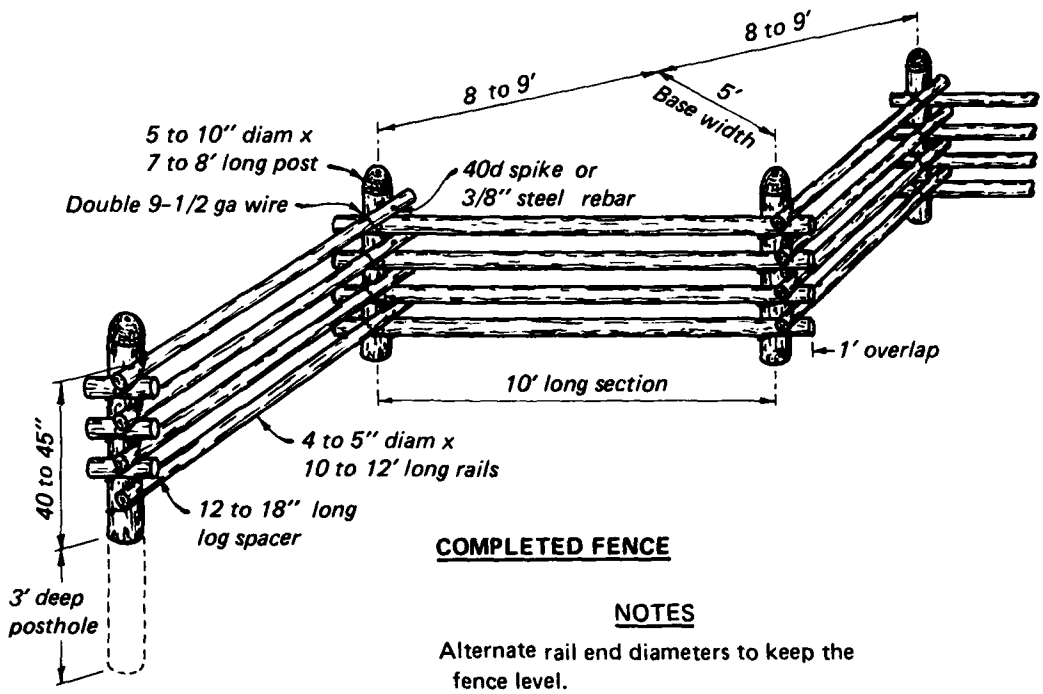
(3) Two adjoining sections of the fence form an imaginary triangle on the ground; base width is the distance from apex (junction of 2 sections) to the center of the imaginary baseline. Base width should be 4-1/2 to 5-1/2 ft for the fence to withstand high winds or drifting snow.

(4) Prepositioning the bottom layer of rails on the ground helps to accurately locate the postholes.

(5) The postholes should be 3 ft deep and located approximately 10 ft apart; rails should extend at least 1 ft beyond the posthole location. Posts, 5 to 10 in. in diameter × 7 to 8 ft long, hold the rails in place and stabilize the fence.

(6) Position the posts in the holes and mark the bottom rail location on the posts; the bottom rail should be approximately 16 in. above the ground.

(7) Notch the posts to fit the rail and attach the rail to the posts with 40d spikes or 3/8-in. steel rebar. Boards, 1 in. wide, 6 to 8 in. in diameter, and 10 to 12 ft long, can be substituted for



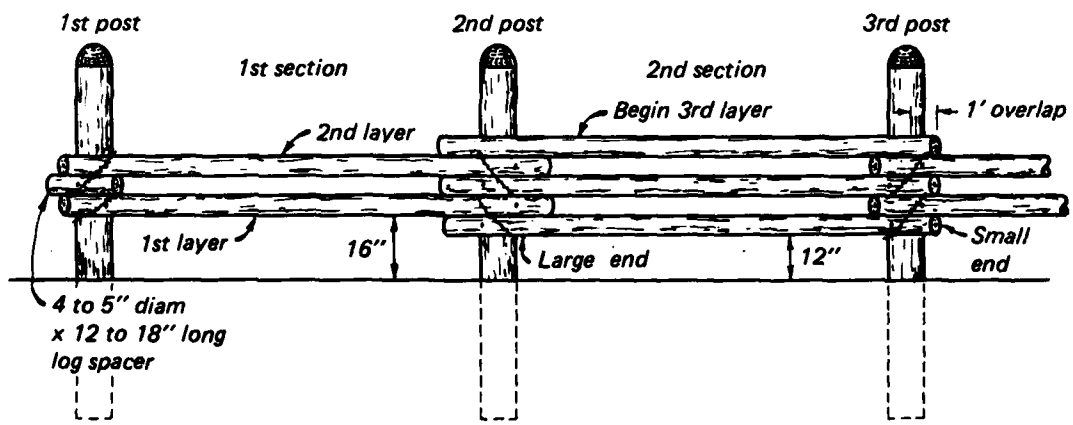
COMPLETED FENCE

NOTES

Alternate rail end diameters to keep the fence level.

Attach fence poles to posts with 40d spikes or 3/8" steel rebar; wire is optional.

A log spacer is necessary at each end of the fence to maintain rail spacing.



STACKING DETAIL

Figure 4. Construction details for a zigzag rail fence, Design A in text (modified from USDA Forest Service 1972)

rails. Nail the boards to the posts with 10d or 16d galvanized nails.

(8) The bottom rail of the second section should be placed below the end of the rail of the first section and attached with spikes.

(9) If unmilled rails are used, keep the fence level by alternating end diameters of the rails.

(10) Attach the bottom rail of each section before adding the second layer of rails. Careful planning, prepositioning of the bottom rails, and proper attachment of the bottom rails will result in a level, well-built fence.

(11) The second rail layer should begin between the second and third posts in a span and continue with adjoining sections until the next to last post in the span is reached.

(12) A log spacer, 4 to 5 in. in diameter × 12 to 18 in. long, must be attached to each endpost above the bottom rail in order to complete the second layer of rails.

(13) Complete the second rail layer and subsequent layers until the desired height of the fence is reached (approximately 40 to 45 in.).

(14) If additional strength is needed, wrap the rails and posts together with double strands of 9-1/2-ga galvanized wire.

Design B. An alternative zigzag fence design is the type in which no vertical posts are used; instead, 5/8-in.-diam steel rebar is used to secure the rails together (Fig. 5). This design has been used successfully at projects in the USAED, Walla Walla (USACE 1979).

(1) Mark the fence center line on the ground and determine the number of rails needed. The fence should advance in 8- to 9-ft sections as stated in Design A.

(2) Rails should be 4 to 5 in. in diameter and 10 ft long.

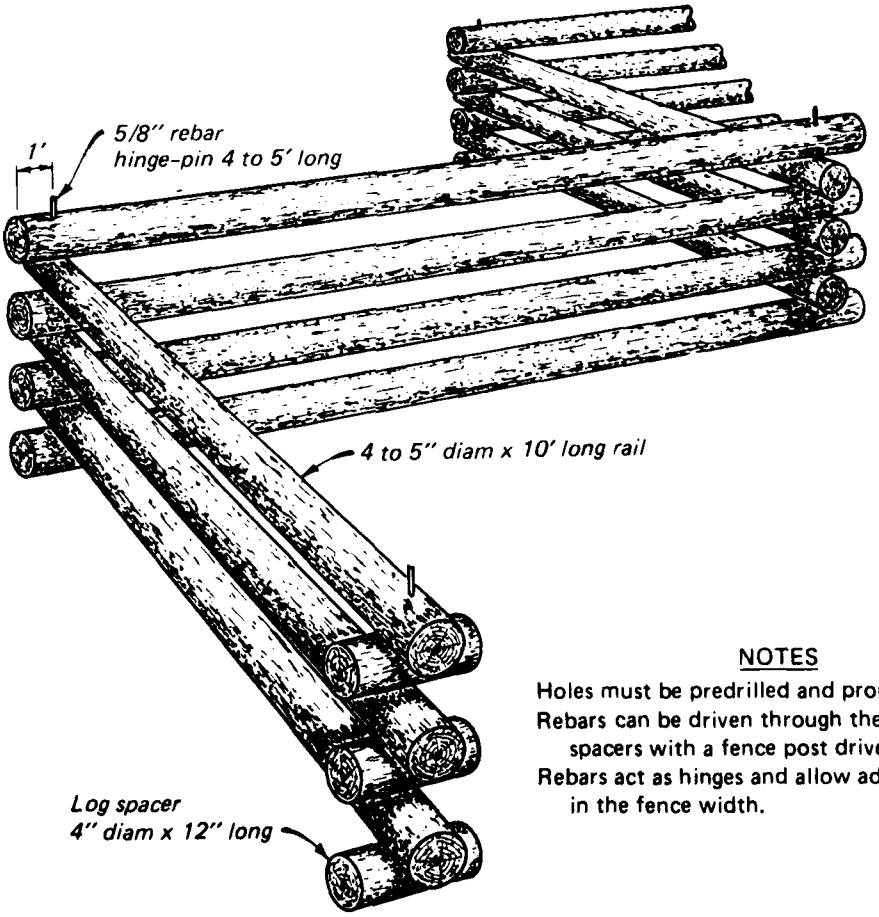
(3) Drill each rail with a 11/16-in.-diam hole located 1 ft from each end. Holes must be aligned properly to aid assembly. If the holes are off-center or not vertical, assembly at the site will be difficult.

(4) Log spacers 4 in. in diameter × 12 in. long should be used at each end of the fence to separate the rails. Drill each log spacer with an 11/16-in. hole centered lengthwise.

(5) At the site, position the bottom rails of each section at an angle to the center line, as described for Design A.

(6) Three or 4 personnel are needed at this point to help hold the fence together. Stack the rails of the first section with log spacers between rails and align the holes.

(7) Drive a 5/8-in.-diam × 4- to 5-ft-long rebar through the rails and spacers (length of the rebar depends on the height of the fence). Rounding off the shoulders on the end of the rebar with a file will



NOTES

Holes must be predrilled and properly aligned.
Rebars can be driven through the rails and spacers with a fence post driver.
Rebars act as hinges and allow adjustment in the fence width.

Figure 5. A zigzag rail fence used for habitat development in eastern Washington (photo), and construction details for a zigzag rail fence, Design B in text (modified from USACE 1979)

make assembly easier. A fence post driver can be used to easily drive the rebar through the rails.

(8) Position the rails of the second section between the rails of the first section, align the holes, then fasten them together with rebar.

(9) Continue the process until the fence is completed.

(10) The rebar acts as a hinge between fence sections. Fence sections can be moved about the center line until the desired fence angle is obtained.

Buck and Pole Fence

The buck and pole fence is best used on level ground adjoining sections of wire fencing, or it can be used by itself for short spans. It requires a plentiful supply of materials. However, little maintenance is needed and the fence is long lived. The buck and pole fence should be used where breakage of wire fencing by snow and falling timber is a problem and in areas where elk are abundant (USDA Forest Service 1972).

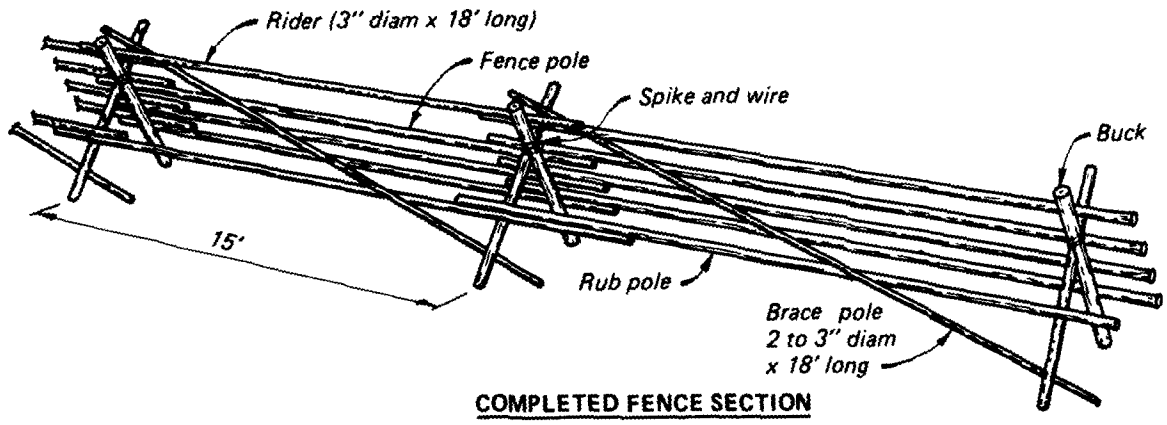
The structural components of each fence section are: (1) bucks (2 A-frame supports), (2) rider (top pole that separates 2 bucks), (3) rub pole (horizontal pole on the rear of the fence that contacts the brace pole), (4) brace pole (diagonal pole that exerts a downward force on the bucks and helps stabilize the fence), and (5) horizontal fence poles (poles that function as a livestock barrier) (Fig. 6). Construction and installation details of one section are described below:

(1) Mark the center line of the fence accurately on the ground and space the bucks at 15-ft intervals along the center line.

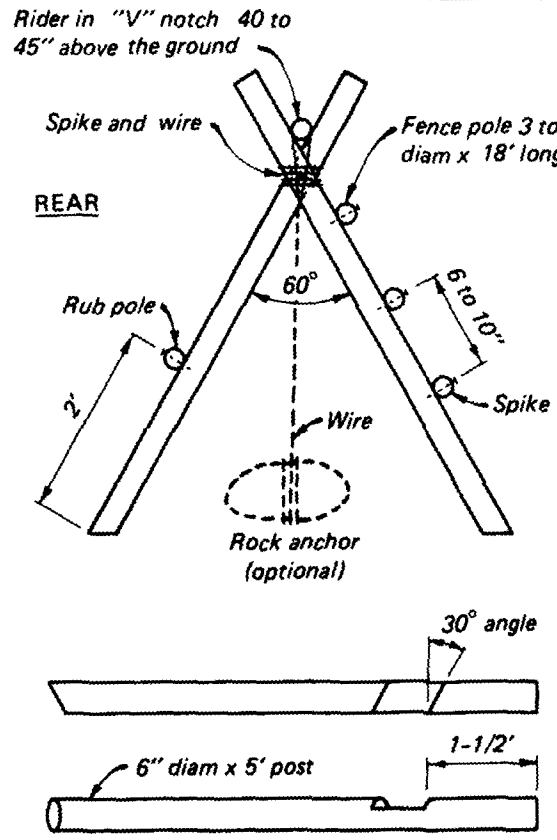
(2) A buck consists of two 6-in.-diam × 5-ft-long posts notched 1-1/2 ft from one end; the posts are fitted at the notches and attached with 40d spikes and several wraps of 9-1/2-ga galvanized wire (see detail, Fig. 6). The assembled bucks are positioned to straddle the center line. The two bucks are separated by a 3- to 4-in.-diam × 18-ft-long pole (rider) attached with wire in the top "V" of each buck. The height of the rider should be approximately 40 to 45 in.; adjust the leg spread of the bucks to obtain the correct height. There should be a 60-deg angle between the 2 legs of a buck.

(3) A rub pole (the same dimensions as the rider) is attached approximately 2 ft above the ground to the rear leg of each pair of bucks with spikes and wire. Position the rear of the fence away from heavy stress. If on a slope, the rear of the fence should be placed on the downhill side.

(4) A flexible 2- to 3-in.-diam × 18-ft-long brace pole is inserted diagonally between the outside edge of the rub pole and the bottom inside edge of the rear leg of one buck, and under the rider and in



COMPLETED FENCE SECTION



BUCK AND NOTCH DETAIL

NOTES

Place rub poles away from stress or on downhill side.

Where a buck and pole fence joins a wire fence, poles should be wired and spiked to fence post.

Buck notches must fit tightly; notch depth is 1/3 post diameter.

Figure 6. Construction details for a buck and pole fence (modified from USDA Forest Service 1972)

the "V" notch of the adjoining buck (see detail, Fig. 6). Fasten the brace pole to the bucks with wire. If additional support is needed (e.g., in heavy-snow country), a 50- to 100-lb rock can be suspended from the top of each buck with wire; the rock should hang 2 to 3 in. off the ground and should be adjusted periodically as the wire stretches.

(5) Three to 4 fence poles, 3 to 4 in. in diameter × 18 ft long, are attached to the front of the bucks (stress side) with spikes and wire; they are 6 to 10 in. apart depending on pole diameter. The bottom fence pole should be 16 in. above the ground to allow wildlife easy passage under the fence.

Block and Log Fence

Block and log fences are constructed of large logs, approximately the size of telephone poles, and are suitable for a variety of settings where a very strong, durable fence is needed. This fence is excellent for deep-snow country and heavily timbered areas. If constructed properly, it requires a minimum of maintenance. The block and log fence is not suited for steep slopes or broken terrain (USDA Forest Service 1972). Two designs of the block and log fence are described below:

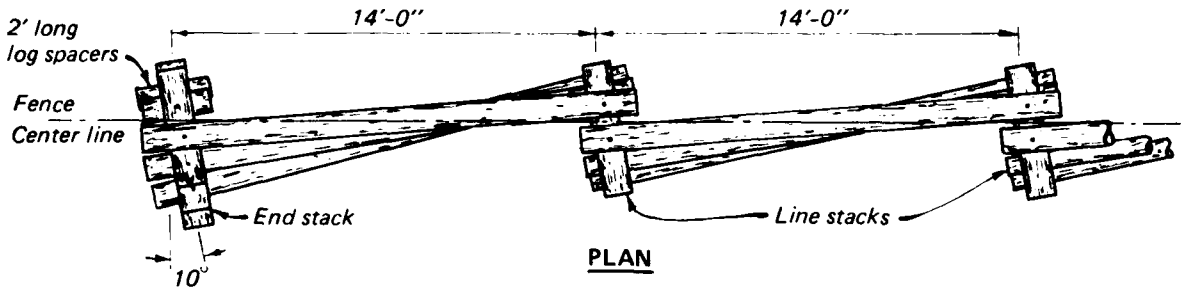
Design A. The first design consists of multiple sections with 3 layers each of 10- to 12 in.-diam × 16-1/2-ft-long fence logs supported by notched support logs (Fig. 7). Support logs at the ends of the fence (end stack) are 10 in. in diameter but vary in length; the bottom support logs are 5 ft long, middle logs are 4-3/4 ft long, and top logs are 3-1/2 ft long. Logs for the interior supports (line stacks) are 10 in. in diameter × 4 ft long (see stacking detail, Fig. 7). The lower side of the bottom support logs are sawed off flat so that they sit squarely on a rock base; used railroad ties can be substituted as support logs, if available. Support logs are notched 1 to 2 in. deep as shown in the notching detail (Fig. 7) to form a seat for the fence logs. Installation details are as follows:

(1) Grade and/or level a footing approximately 7 ft wide and as long as necessary.

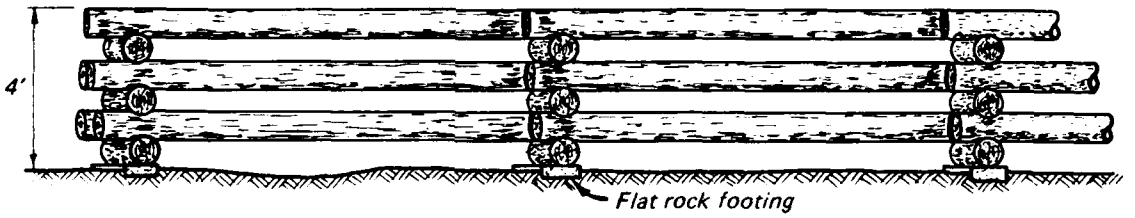
(2) Establish a fence center line and mark the positions of the support logs approximately 14 ft apart.

(3) To elevate the bottom support logs off the ground, set flat rocks or bricks (12 in. square × 6 in. tall) 3 in. deep in the footing at each stack location.

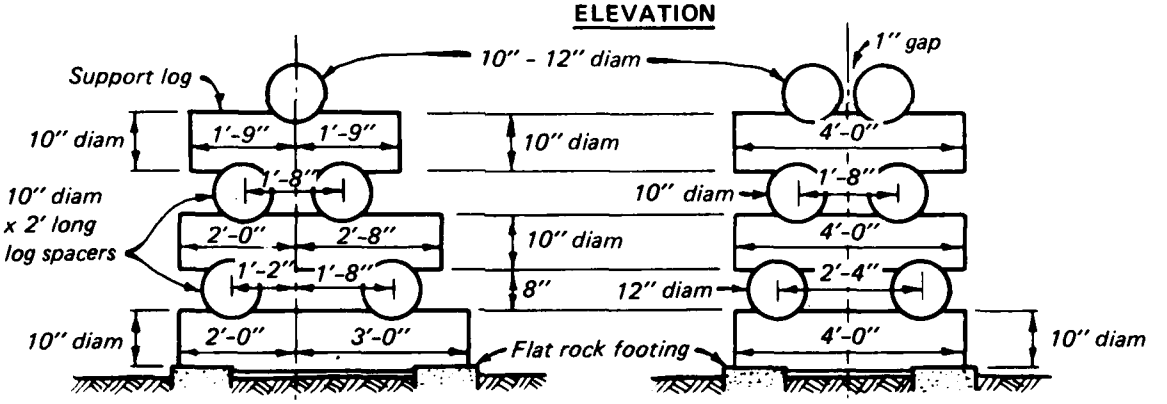
(4) Position the bottom support logs at an angle of 10 deg to a line perpendicular to the fence line (see detail, Fig. 7).



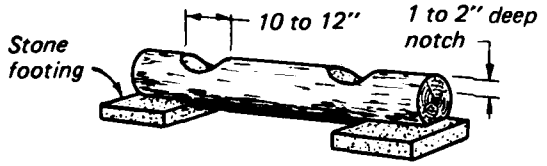
PLAN



ELEVATION



END STACK STACKING DETAIL LINE STACK



SUPPORT LOG NOTCHING DETAIL

NOTES

Support logs are notched to fit fence logs.
Bottom support log is trimmed flat to sit squarely on rock footing.
Fence logs are 10 to 12" in diameter x 16-1/2 'long .
Alternate fence log end diameters to keep the fence level.
Two log spacers must be used at each end of the fence to separate support logs.
Where top fence logs overlap leave a 1" gap between logs to allow water to drain.

Figure 7. Construction details for a block and log fence, Design A in text (modified from USDA Forest Service 1972)

(5) Set the first layer of fence logs in the notches of the bottom support logs and secure them to the support logs with 3/8- × 18-in. steel rebar driven vertically through predrilled holes (rebar length will vary depending on log diameter). Two log spacers (10 in. in diameter × 2 ft long) must be used between the support logs at each end stack to keep the support logs level.

(6) Position the second layer of support logs and secure them with 40d spikes driven at an angle into the fence logs.

(7) Add the second layer of fence logs and secure them with 3/8-in. rebar as done for the first layer.

(8) If unmilled logs are used, end diameters of the fence logs should be alternated at each stack to keep the fence logs level; otherwise, there will be high and low points along the length of the fence.

(9) The third layer of support logs and fence logs should be added to each stack. Secure the top layer of support logs with spikes driven into the fence logs below, and attach the top fence logs with rebar driven into the support logs. Where top fence logs overlap (line stack), leave a 1-in. gap between logs for water drainage.

Design B. An alternative type of block and log fence is shown in Figure 8. Construction is similar to Design A except that fence sections are parallel with the fence line rather than at an angle and fewer logs are required. Fence logs are 15 to 16 ft long and should be approximately 10 in. in diameter at the smaller end and 12 in. in diameter at the larger end (milled logs with a uniform diameter are preferred). Support logs are 10 to 12 in. in diameter × 4 ft long and notched, as shown in Figure 8. Flat rocks are used as a footing for the bottom support logs. At each end of the fence (end stack), a log spacer should be used between support logs to keep the fence level. Installation details are as follows:

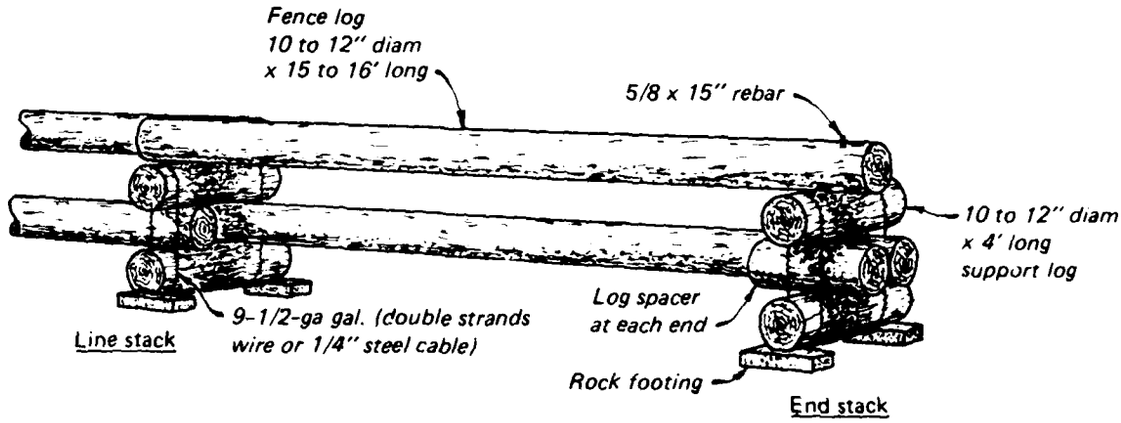
(1) Prepare a footing as done for Design A.

(2) Establish the fence center line and mark the locations of the support logs about 12 to 14 ft apart.

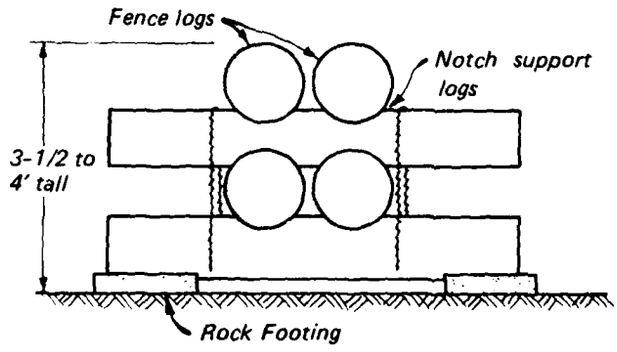
(3) Position flat rocks for the footing of each support log.

(4) Place bottom support logs perpendicular to the fence line, then set the first layer of fence logs in the support log notches (notches are 1 to 2 in. deep). The bottom edge of the lower support logs should be trimmed flat, as shown in Design A. The ends of each fence log should overlap the support logs by about 1-1/2 ft. Fasten the logs together with double strands of 9-1/2-ga galvanized wire or 1/4-in. steel cable and clamps (Fig. 8).

(5) Add the second layer of support logs and secure them as done for the fence logs. Log spacers, 10 to 12 in. in diameter × 2 ft long, must be used at each end of the fence (end stack) to separate support logs.



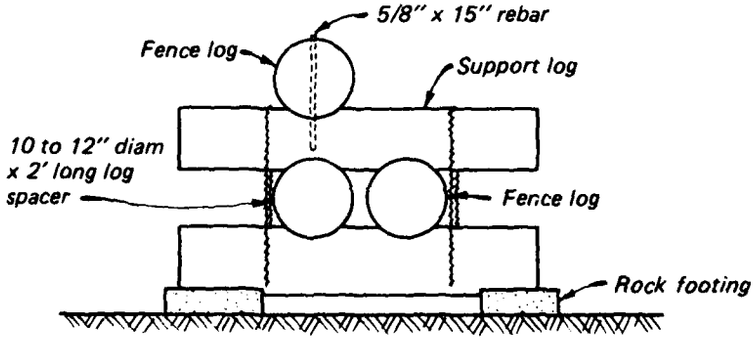
COMPLETED FENCE SECTION



LINE STACK

NOTES

Support logs of each section are 12 to 14' apart.
A log spacer, 10 to 12" in diam x 2 ft long,must be used at each end of the fence to separate support logs.
Top fence logs are secured with 5/8" x 15" steel rebar.
Alternate fence log end diameters to keep fence level.



END STACK

Figure 8. Construction details for a block and log fence, Design B in text (modified from USDA Forest Service 1972)

(6) Add the top logs and secure them by driving 5/8-in.-diam × 15-in.-long steel rebar vertically into the support logs through predrilled holes (length of the rebar varies, depending on log diameter). The completed fence should stand from 3-1/2 to 4 ft tall.

CAUTIONS AND LIMITATIONS

Vandalism of wooden fences can be a major problem. In campgrounds and picnic areas, fences are often cut for firewood. Wooden fences are also easily defaced by graffiti, and fences near parking areas are subject to damage by motor vehicles. Fences should be located a sufficient distance away from the roadway and parking areas to prevent damage by vehicles turning or backing into them.

Permanent fences should be made of good materials and should be well built. Low-grade lumber and poor construction lead to high maintenance costs and a short fence life (USDA 1961). Gloves should always be worn when building fences, and extreme care should be taken when handling pressure-treated lumber and heavy timbers. Wooden fences are expensive in terms of materials and labor and should generally be used only where wire fencing would be aesthetically unappealing.

LITERATURE CITED

Crawford, B. T. 1945. Hedge fences and prairie wildlife. Mo. Conserv. 6:10-12.

Davis, J. W. 1980. Fences and wildlife. USDA For. Serv. Southwest Habitater 1:1-2.

Hampe, G. D., and F. P. Noe. 1983. A study in the aesthetics of boundaries: Fences along a national parkway. J. Environ. Manage. 17:239-248.

Maser, C., J. W. Thomas, I. D. Luman, and R. Anderson. 1979. Wildlife habitats in managed rangelands - The Great Basin of southeastern Oregon: Manmade habitats. USDA For. Serv. Pacific Northwest For. and Range Exp. Sta., Gen. Tech. Rep. PNW-86. 40 pp.

USACE. 1979. Design memorandum for wildlife habitat development, Supplement No. 1: Lower Snake River Project. U.S. Army Eng. District, Walla Walla, Wash. 189 pp.

USDA. 1961. Farm fences. USDA Farmer's Bull. No. 2173. 24 pp.

USDA Forest Service. 1972. Structural range improvement handbook. USDA For. Serv., FSH 2209.22, R-3. 316 pp.

Vallentine, J. F. 1971. Range Developments and Improvements. Brigham Young Univ. Press, Provo, Utah. 516 pp.

Wisconsin Highway Department. 1965. Park Practice Program. P-2309. 1 p.

END

DTIC

10-86