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FOREST TRAIL HANDBOOK

1.—PURPOSE

The purpose of this handbook is, first, to state a general policy of trail construction and maintenance; second, to establish a uniform classification of National Forest trails according to their use; third, to establish standard specifications for each class; and, fourth, to describe and illustrate for purposes of reference and application, approved methods of location, construction, and upkeep.

SECTION I—POLICY AND GENERAL INSTRUCTIONS

2.—RELATIVE NEEDS

In making many of the National Forests more accessible, the first and largest need is for ways and secondary trails. The second important, but less urgent, need is for primary trails. To maintain the present degree of accessibility by adequate upkeep of existing trails is more important as a general rule than the building of additional mileage.

3.—PROGRESS

The progress made in trail work will depend, first, on the amount of money available, and second, on the capacity of the available organization to direct and control such work properly.

4.—THE JOB

Trail location and construction is relatively a simple job. Money, proper workmanship, common sense, abundant energy, and simple tools and equipment are the only requisites to good work. The employment of
location and supervising engineers and specially organized survey parties, and the use of precise methods involving technical practices such as accurate leveling, transit work, detailed field notes, and profile maps of location, have no place in the trail program.

5.—PLACE OF FOREST OFFICERS

Responsibility for selection of the projects, correct location, and adequate supervision must rest squarely upon the supervisor. Members of the regular forest organization or specialists designated by them will do at least the major part of the preliminary location work, and will give such supervision to crews as may be necessary to get the work done in accordance with established policy and practice.

6.—USE OF HANDBOOK

It is recognized that to prescribe rules or to outline methods of construction to cover all details, or to fit all the varying conditions encountered, is not possible. No attempt to do it has been made in this handbook. The points covered, and instructions given, are confined to the more obvious and major principles of trail construction. They are based on methods and principles which have proved their worth; furthermore, experience has proven their general applicability.

Field officers are not expected to memorize the contents of this handbook. It is expected, however, that they will always remember: First, the handbook is available; second, it is to be consulted and studied before starting a job; third, every man placed in charge of trail work will have a copy, supplemented by written instructions to indicate the parts of the handbook that are applicable to his job; fourth, the instructions it contains will govern on the job, unless physical conditions clearly prevent.

Burden of proof of inapplicability will always be upon the officer who is responsible for getting the work done. Officers should expect to be held personally responsible for unwarranted deviation.
7.- PURPOSES OF TRAILS

Trails will be maintained, reconstructed, and constructed in the interests of: (a) Fire control; (b) administration; (c) grazing; (d) recreation.

The objects of trail construction are (a) to provide safe and unobstructed passage of loaded animals and foot travelers at a walking gait and in single file; (b) durability designed to meet expected use and liability of damage from natural causes.

8.-STANDARDS

Standards of construction designated in this handbook are sufficient to accomplish the justified objects of trail work.

9.—MAINTENANCE POLICY

The desired standards of trail upkeep are those which are necessary to maintain the standard of construction established herein. Well-balanced work, not polish, is wanted. To underdo maintenance is bad. To overdo it is worse, because a dollar unspent remains available to correct mistakes, while more dollars spent than necessary are simply wasted.

Maintenance will include the removal of obstacles from primary trail beds to facilitate the operation of plows and drags wherever the use of such horse-drawn equipment is feasible from the point of view of economy and physical practicability.

10.—SELECTION OF PROJECT

New construction into inaccessible areas requiring fire protection takes priority in the use of funds over raising the standards of a usable existing trail. Consideration should be given to this when planning the reconstruction of a trail which can be reconditioned at a lower cost. Reconstruction of trails, other than those in highly recreational areas, should be avoided until all hazardous portions of the forests have been made accessible.
New fire control or administrative projects to warrant approval, will have to be based upon:

(a) Sound reasons for, and practicability of, reducing travel time into given regions.
(b) Sound reasons for making a country accessible to animals, which is now open to foot travelers only.
(c) Sound reasons for making particular places accessible to either foot travelers or horses.

Recreation trails will be constructed where the need is made clearly apparent by public demand or by existing heavy use of trails over which travel is very laborious or difficult, or where a desirable and justifiably greater use of the National Forests will very probably result.

Grazing projects fall into two classes:

(a) Development projects.
(b) Grazing administration projects.

Grazing development projects, to justify allotments, must be based upon one or more of the following reasons:

(a) Existing demands for additional range which can be satisfied only by making unused territory accessible by construction of trails.
(b) Or, a demand which may be depended upon to materialize soon after the date of completion of a given project.
(c) To secure proper distribution of stock on allotments, parts of which are overgrazed while other sections are only partially utilized or totally unutilized because of genuine, not relative inaccessibility. Do not build trails to overcome inaccessibility which may reasonably be met by better salt distribution or proper attention to herding by the owner or his employees.
(d) To make accessible, or to increase accessibility of, unused or slightly used regions of large extent in the interest of fire control, although the anticipated demand is more or less speculative but where nevertheless it may be good business to spend money on stock trails, driveways, and bridges in order to create conditions favorable to stock, as an inducement to owners to seek grazing privileges.
Other grazing projects, not of a development nature, will be approved upon showing of real need for:

(a) The building of stock trails (driveways) to protect existing roads or trails used chiefly for other purposes.
(b) The building of stock trails (driveways) or relocation in whole or in part of existing ones in interest of fire control.
(c) The building of stock trails (driveways), or relocation of existing ones to protect recreational use of the National Forests.
(d) Trails needed to facilitate the transportation of supplies used by stockmen.

The standard of stock trails should never exceed and should seldom equal the specifications for secondary trails.

II.—TRAIL CREWS AS FIRE FIGHTERS

Two principal factors are to be given consideration in laying out a season’s trail program:

(a) The permanent forest benefit in terms of better fire control or administration, which the program will produce.
(b) The availability of men for fire fighters.

Under some circumstances it may be advisable to prolong work on a trail at the sacrifice of speedy completion, or to start work on a trail of secondary importance, in order to have a crew on the ground to form an essential part of the fire organization.

It is often important to schedule trail construction and repair projects to provide work before and after the fire season, for key members of the fire-control personnel.

Employ only men who are capable of doing fire-control work and with the definite and unmistakable understanding that they will become a part of the fire-control organization, ready and willing to go and fight fires either day or night. Train them as fire-control units.
Members of trail crews when on fire suppression or emergency guard work will be paid wages as prescribed by the Regional Forester. Special written instructions to way and trail foremen will cover this point.

During the fire season connect trail crews which are considered to be a part of the fire-control organization with the telephone system or supply them with radio if at all practicable. Supplementary instructions will state the hours of test calls throughout the day. Always equip crews with an adequate outfit of fire-fighting tools and with appropriate emergency rations for suppression work.

12.—PLOWS AND SCRAPERS

Use plows and V drags to the fullest practicable extent on construction and maintenance of those trails upon which grading is necessary.

The light reversible side-hill plow is the best known type. Various kinds of V drags are in use. One of satisfactory design is shown in figure 44.

If Service-owned animals are not available, and private stock cannot be rented conveniently, horses and mules should be purchased from trail funds where the use of plows and scrapers is good practice.

Regional Foresters are especially urged to get the instructions of this section into practice, if use of the equipment mentioned will help reduce costs.

SECTION II.—PLANS

13.—TRAIL PLANS

A trail plan should be developed for each forest as dependable data is gathered from knowledge acquired in the field. Make no attempt to complete the plan simply to have something of the nature to exhibit. Every trail constructed should justify its existence by the actual service rendered.

A standard form of plan complete in all details, will not be prescribed. The minimum requirement, however, for each forest is a map to be called, "The Plan and Progress Map." It should show the location of each
trail, with separate symbols for "proposed" and "completed." This map will be permanent. Roads may be shown on the map at the option of the Regional Forester.

SECTION III.—CLASSIFICATION

14.—TRAIL CLASSIFICATION

Forest Service trails will be classified in three groups: (a) Ways; (b) Secondary; (c) Primary.

(a) Ways are defined as plainly marked routes built primarily for foot travel, but constructed to specifications which will permit safe travel by heavily loaded pack animals.

(b) Secondary trails are defined as trails which will receive less use than that specified for primary trails, but which are built primarily for horse travel.

(c) Primary trails are defined as trails over which an average of more than one saddle or pack animal will pass each day during the field season.

Classify every proposed trail before its construction, and all existing trails in advance of reconstruction and maintenance. Specifications of work to be done will be based upon such classification.

In classifying trails, keep constantly in mind that past experience proves a tendency to overestimate probable use. Closest guarding of enthusiasm and judgment, also checking by higher officers, is necessary to hold future errors in classification to the minimum. The lowest standard fulfilling reasonably early need will be used. Officers having responsibility for trail planning and construction should expect to be called upon to justify the construction of higher type trails when the probable volume of travel and character of use calls for trails of lower types. In many sections the need for usable ways through the woods still overshadows either primary or secondary necessities.
SECTION IV.—LOCATION

15.—TRAIL LOCATION

Before definitely selecting the route for a project, a thorough reconnaissance survey should be made. This will enable the locator to secure the best possible topographical, geographical, and fire-control service location. Hazard maps and other fire-control data should be checked previous to making the final selection. Too much emphasis cannot be given to the importance of this phase of trail work.

During the reconnaissance survey, always definitely select and locate control points, and get their elevation and approximate intervening distances.

The instruments needed in trail reconnaissance, in addition to the ordinary tools of a woodsman, are an Abney level or hypsometer for laying out grades and measuring slopes, and in certain instances an aneroid barometer for ascertaining elevations.

With the approximate distance and elevation between two control points known, add two ciphers to the elevation figures and divide by the distance expressed in feet to ascertain the approximate uniform grade between them. Example:

Elevation difference, 1,250 feet \(\frac{125,000}{17,160}\) = 7 percent approximate

In trail location, as far as practicable—

Avoid:

(a) Swamps and boggy land.
(b) Creek bottoms and arroyos subject to damaging floods.
(c) Slopes subject to snowslides.
(d) Locations subject to snowdrifts.
(e) Slides (see fig. 1).
(f) Unstable ground.
(g) Steep slopes.
(h) Bluffs and ledges.
(i) Frequent crossings of streams where fording is difficult and impracticable.
(j) Location requiring construction of bridges and culverts.
(k) Heavy clearing.
(l) Switchbacks where practicable. In instances where the use of switchbacks is good business, make the legs as long as the topography will permit.

Favor:
(a) Southern exposures.
(b) Ridges.
(c) Benches.
(d) Natural openings.
(e) Open timber.
(f) Light stands of brush.

Items (b) to (f), inclusive, should be favored even at the sacrifice of grade.

Do not lose sight of the desirability of having trails pass camping places, horse feed, water, and points which furnish a broad view of the surrounding country. These items are of special importance to recreation and fire-control trails.
Figure 1.—Principles to be observed in locating trails: A, 15 percent grade to escape rock and hard land by climbing on to bench; B, Rocky and hard; C, Bend in trail to escape large rocks; D, 10 percent minus grade for 200 feet; E, 15 percent plus grade for 350 feet to shorten trail across canyon with flat bed; F, Rocky flat to edge of steep slate sidehill; G, 18 percent slope of sidehill, no grading; H, 20 percent grade for 500 feet to escape bluff; I, Bluff of rock; J, 30 percent slope, no grading; K, Reverse 8 percent for 50 feet on each side; L, Rocks, tan bark oak, and heavy brush; M, Open point, switch backs on 15 percent to 18 percent grade to escape rock and tan bark oak sidehill; N, Water falls and rapids; O, Solid ground; P, Camp; Q, Meadow.
Always bear in mind that trails are used by a class of travel that is but little affected by undulations and
a steep pitch here and there, and that they are not associated with vehicles, the carrying capacity of which is
limited by the steepest pitch. Remember, too, that trails are used by foot travelers and saddle or pack animals,
traveling single file, and usually in a walk. Lay out trails accordingly, and never be influenced by the idea that
later a trail may be converted into a road.

SECTION V.—ESTIMATES

16.—COST ESTIMATES

Accurate estimates of costs of proposed projects based upon knowledge gained by field investigation, and
preferably upon data obtained from thorough reconnaissance, should ordinarily be made in advance of allotments.
Estimates are expected to be more than mere guesses. A failure to arrive at a reasonably close approximation
of the cost of a project is a reflection upon an officer's qualifications.

Ordinarily, proposed primary or secondary projects should be described in memoranda, boiled down to
essential facts. The major elements to be considered and dealt with in a brief common-sense manner are:
(a) Purpose.
(b) Length of project.
(c) Classification, with reasons.
(d) Types of cover, expressed in miles of each type.
(e) Statement relative to amount of grading and blasting required.
(f) Number of bridges, brief description of each, and materials available for construction.
(g) Number and description of signs needed.
(h) Organization of crew:
   (1) Size of crew proposed.
   (2) Transportation facilities needed.
   (3) Equipment needed.
   (4) Forage needed.
   (5) Camping plans.

(i) Period when work should be done.

The trail foreman should daily measure the completed trail and keep a current check of the cost of wages and materials as directed by the Regional Office.

SECTION VI.—CONSTRUCTION

17.—SIZE AND ORGANIZATION OF CREWS

Crews composed of 8 or 10 men, including foreman and cook, are the most economical on heavy construction. If work is to be rushed, use two or more separate crews of this size on sections worked from different camps rather than one large crew. On way trails, construction crews of from 2 to 4 men are generally most economical. Exceptions are those cases where a number of radiating trails can be worked from one camp.

Plan to have blacksmithing done by the foreman or the powder men rather than by any other workman.

Work swampers at least 2 days ahead of graders.

See to it that the line designating position of grade is at least 1 day ahead of graders.

Wherever practicable, work graders far enough ahead of rock men so that blasting will not interfere with graders. Assign graders to stations 25 feet, 50 feet, or 100 feet apart. Do not permit them to crowd up.

Work rock men and powder men behind graders. Do not blast stumps ahead of hand graders.
The trimmer men following the crew are to smooth up tread, install water breaks, decrease angle of back slopes where they are too steep, and cut any interfering brush left by the swampers.

The organization can be put into operation only after the job is well started. Entire crews might clear at the outset in order to get 3 or 4 days clearing ahead. Then all but the regular swampers will grade until the grading proceeds a safe distance ahead of the blasting work. After grading is well advanced, rock men and powder men can be assigned their job. In turn, the trimmers can take up their work.

For light work see organization under Maintenance.

18.—CAMPS

Keep camps as near as possible to the work and never more than 1 mile in advance of construction to enable the crew to work both ways from them.

The ordinary sanitary requirements of the Forest Service will be observed in all trail camps.

19.—STANDARDS FOR WAY TRAILS

Way trails will be constructed and maintained entirely for fire control purposes. The objects of way trail construction are:

(a) To prepare as rapidly as possible for the extreme fire emergency.

(b) To provide a system of ways sufficiently intensive to permit any part of a forest being reached to afford adequate protection.

In locating way trails emphasis should be placed on finding the cheapest route that will serve the desired ends. Way trails will not be located with the idea of using the same route for a higher class trail at a later date. Nevertheless, disregarding the principles of determining a location will not be tolerated. A reconnaissance of the country to be traversed should always be made, followed by the clear marking of control points and the placing of
marks (blazes, strips of cloth on brush, etc.) at intervisible points to indicate the general line to be followed by the way in connecting the control points.

Stakes should not be set for way trails except on the portions to be graded, and where rock or other obstacles make an exact location necessary.

Clearing for way trails should be of sufficient width to provide for the passage of loaded pack animals. Remove obstacles within reach of the extended arms of a man standing in the center of the trail. Overhead clearing to a height of 10 feet above the ground is sufficient. Only brush and small trees should be cut and these should be cut as close to the ground as can be done without increasing the cost. The object of the trail is to make certain of a passable route in the time of need. The amount of work done should be gaged accordingly.

Grading of way trails is not necessary except to provide footing for pack animals. All grading work should be cut to a minimum.

Ruling grades of way trails should be 15 percent. Grades over 15 percent to a maximum of 40 percent, within the limitations expressed in table 1, should be used to get the best location at the minimum cost.

**Table 1.—Permissible grades above 15 percent on ways**

<table>
<thead>
<tr>
<th>Grade (percent)</th>
<th>Distance ordinarily permissible</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 to 25</td>
<td>One-half mile.</td>
</tr>
<tr>
<td>26 to 35</td>
<td>One-fourth mile.</td>
</tr>
<tr>
<td>36 to 40</td>
<td>100 yards.</td>
</tr>
</tbody>
</table>

Reverse grades up to 40 percent, at reasonable intervals, may be used.
Marking of way trails is of first importance. Way trails should be marked by signs, blazing, or otherwise so that they can be readily found and followed by a fire fighter at night.

20.—STANDARDS FOR SECONDARY AND PRIMARY TRAILS

Do not start work on any trail until the route has been definitely chosen after careful reconnaissance and the main control points established. Never begin construction on any section of a trail until the location of that section has been marked on the ground by stakes or other plain markers.

21.—STAKING

At intervals of 25 to 50 feet where excavating is to be done, mark the grade line with stakes or some other form of durable indicators. Place the indicators on grade, that is, where digging work starts. On flats and along slopes under 30 percent, where a simple mark will take the place of grading, space stakes or indicators only close enough together to make or correct alinement of the trail and uniformity of the grade.

Wherever practicable, foreman or some other experienced man should scratch a narrow line between indicators or stakes. This should insure an evenly sustained grade. Mattock men or pick men should never start work before the grade line has been thus indicated. The foreman should see that graders always use this line as a base. (See fig. 2.)

22.—GRADES

No standard gradients are established. Use the grade up to 15 percent which will result in the least amount of construction, or shortest distance between control points. If the shortest route lies along a gradient in excess of 15 percent for more than one-half mile, cut the grade down to 15 percent by increasing the distance, but do not go below 15 percent.

To avoid expensive construction and to get the best location at a justifiable cost in ascending or descending, use of grades over 15 percent to a maximum of 30 percent within the limitation expressed in table 2 is considered
Figure 2.—Trails constructed from marked and unmarked grade lines.
to be good practice. To accomplish the same object, it is also good practice to use reverse grades up to 30 percent at reasonable intervals for distances which will not give a loss of elevation of more than 50 feet in one reverse section.

<table>
<thead>
<tr>
<th>Grade (percent)</th>
<th>Distance ordinarily permissible</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 to 20</td>
<td>One-half mile.</td>
</tr>
<tr>
<td>21 to 25</td>
<td>One-fourth mile.</td>
</tr>
<tr>
<td>26 to 30</td>
<td>100 yards.</td>
</tr>
</tbody>
</table>

Along creeks of slight fall, or in paralleling the contour of a mountain, make no effort to maintain uniform grades if construction cost can be materially reduced without material decrease in rate of travel. By use of undulating grades to a reasonable extent, avoid bluffs, slides, and exceedingly steep slopes.

Along ridges and points, always use the crest of the ridge if its ups and downs do not exceed an approximate average of 15 percent for distances greater than those shown in table 2, or if the crest is not obstructed by a series of projecting bluffs or rocks.

23.—CLEARING ON SECONDARY AND PRIMARY TRAILS

Clear to a sufficient width and height to provide unobstructed passage of loaded pack animals and horsemen, even when the brush is loaded with snow. A rough rule of thumb generally applicable, but not always so, is to remove obstacles from either side within reach of the extended arms of a man standing at the approximate center of the tread or point of travel. Overhead clearing 10 feet from trail bed is the general working average required.
Cut large trees only where location around them is impracticable. Always keep in mind the point of view of a forester as well as that of a trail builder. 

Cut trees and brush as close to the ground as is practicable without unduly increasing the cost.

Do not blast stumps in advance of grading. Stumps at the top of back slopes should seldom be blasted out. Never blast stumps located at the outer edge of the tread. Cut interfering roots but leave the stump to serve as a support to the trail. (See fig. 4.)

In clearing right-of-way always fall timber downhill, where possible, and throw brush downhill if it is not to be burned.
Don't blast trees at this point, swing around large trees if practicable. If necessary to remove them, cut here and thus. Blast only in case of last resort.

To blast stump at points shown always causes more work and poorer trail.

Don't blast trees at this point if large swing around them, or if they are cut here, leave stump in place to act as support for the trail.

Form of trail when grading is finished.

Figure 4.—When not to remove stumps.
21. **BRUSH DISPOSAL**

Pile and burn brush, limbs, and tops under 1 inches in diameter on projects to be used largely by the general public, if in accordance with the prevailing timber sale practice. Wherever safe, burn at the time of clearing.

On recreational trails, all brush and debris must be disposed of by burning. If clearing has been accomplished during the fire period, the debris should be piled for later destruction.

On projects in more isolated regions to be little used by the public, dispose of the debris by lopping and throwing it downhill, or by roughly piling it beside the trail on level or nearly level locations. However, where the Regional Forester considers it sound practice to dispose of brush completely, pile and burn it. Brush should not be piled and burned merely for the sake of the brush-burning principle.

25. **WIDTH OF TRAIL**

Width of trail means the distance from the inside edge to the outside edge of the trail. (See fig. 5.)

Table 2 and figures 6 to 10 indicate specifications and designs applicable to primary trails under varying slopes. Exception may be made only:

(a) Where a ditch is necessary to carry off seepage from springs. (See fig. 17.)

(b) On certain recreation trails where the Regional Forester can justify the construction of wider trails than described in the specifications and diagrams.

To warrant any exception, a showing must be made in every case that the exception is justified by some inescapable demand rather than upon a Forest Officer's interpretation or opinion of what the recreationists want or need in the way of trails. Under normal conditions and circumstances, trails built upon the specifications for primary trails are adequate for all purposes including recreational use. Forest Officers should educate the public in good trail economics and will never encourage extravagant ideas in trail construction.

It is recognized that completed secondary trails on steep slopes and rough ground may approach the stand-
FIGURE 5.—How to measure width of trail.
Remove loose earth and slide rock 2' to 3' above edge of backslope which will obviously soon slide into trail. Leave no stump to sprout at this angle.

Clear inside corner. Leave no rock roots or earth in position designated by shaded triangle.

Clear tread of rocks and stumps. Leave no small rocks or roots at position indicated by dotted line.

Heap earth in form of a dirt rail to height of 6" to 8". Place rocks on dirt rail or put big rocks in place of dirt rail.

Figure 6.—Cross section of typical trail on slopes between 30 and 85 percent.
Clear inside corner. Leave no rock roots, or earth in position designated by shaded triangle.

Clear tread of rocks and roots. Leave no small rocks or roots at position indicated by dotted line.

Heap earth in form of a dirt trail to height of 6’ to 8’. Place rocks on dirt rail or put big rocks in place of dirt rail.

Remove loose earth and slide rock 2’ to 3’ above edge of rockslope which will obviously soon slide into trail.

Leave no stump to sprout at this angle.

Primary Trails.
24” to 30” wide on slopes from 85% (40) and 165% (60)
Secondary Trails.
Not to exceed dimension given above. Less in most cases will suffice.

**Figure 7.**—Cross section of typical trail on slopes between 85 and 185 percent.
Provide pack clearance in easiest possible way. Half tunnel effect may be used to advantage under certain conditions.

Start backslope 24" above trail tread.

Leave bench in place if land so breaks.

Stones piled on outer edge.

Don't make treads wider to get pack clearance. The width shown intends that pack clearance be provided by excavating the bank starting at a point approximately 2 Ft. above tread.

FIGURE 8.—Trail construction around bluffs.
Remove loose earth and slide rock 2' to 3' above edge of backslope which will obviously soon slide into trail. Leave no stump to sprout at this angle.

Clear inside corner. Leave no rock roots, or earth in position designated by shaded triangle.

Clear tread of rocks and roots. Leave no small rocks or roots at position indicated by dotted line.

Place rock firmly embedded in fill ranging from 6" to 12" apart.

Fill made from excavated dirt.

FIGURE 9.—Type of trail suited to regions of heavy rains.
Between these points make trail 6" wider than standard. Distance usually ranges from 3' to 4' on each side of deepest point on turn.

On trails closely following contours at slight turns make tread 6" wider than standard and build up higher obstruction than on straight away sections of dirt or rock to prevent cross cutting.

Augment inslope and outslope rail.

FIGURE 10.—Inapplicable construction in Southwest.
ards of width and finish of primary trails, but should seldom equal and never exceed them. Always confine work on secondary trails to that which is just necessary to furnish reasonably easy and safe passage and no more. Do not grade treads on ways except where impossible for loaded animals to pass. Confine work to clearing logs and brush and unescapable groups or reproduction.

26.—ROCK SLIDES

In building either class of trail across rubble slides remove only sufficient material to provide good footing for an animal. Do not attempt to make a nice-looking job. To do so may mean the making of a deep cut which, if the rock is small, seriously disturbs the equilibrium of the material. This disturbance frequently leads to never-ending obstruction and continuous maintenance (figs. 11–12).

27.—TURNOUTS

Along very steep slopes, under certain circumstances of use, it may be necessary to improve natural turnouts at intervals. Such places are most commonly found on points, or in gullies or ravines.

Short, rough treads above or below the regular one may be made to provide passing places for pack trains or other forms of heavy travel on long stretches of abrupt slopes lacking in natural turnouts. Confine work on passing trails to the minimum; merely make a passing place safe.
Figure 11.—Trail on rubble consisting of small rocks.
Figure 12.—Trail on rubble consisting of large rocks.
## Width of Ways and Trails

<table>
<thead>
<tr>
<th>Class of trail</th>
<th>Side slopes</th>
<th>Width over all (inches)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percentage</td>
<td>Corresponding degree of slope</td>
<td></td>
</tr>
<tr>
<td>Ways</td>
<td></td>
<td></td>
<td>Do not grade where loaded pack animals can get footing. Where grading is actually necessary, make treads only wide enough to give footing. Twelve to fifteen inches is enough.</td>
</tr>
<tr>
<td>Secondary</td>
<td>0 to 50</td>
<td>0 to 26</td>
<td>None.</td>
</tr>
<tr>
<td>Primary</td>
<td>0 to 30</td>
<td>0 to 18</td>
<td>do.</td>
</tr>
<tr>
<td>Secondary</td>
<td>50 to 85</td>
<td>27 to 40</td>
<td>24 maximum</td>
</tr>
<tr>
<td>Primary</td>
<td>31 to 85</td>
<td>18 to 40</td>
<td>do.</td>
</tr>
<tr>
<td>Secondary</td>
<td>85 to 165</td>
<td>40 to 60</td>
<td>30 maximum</td>
</tr>
<tr>
<td>Primary</td>
<td>85 to 165</td>
<td>40 to 60</td>
<td>24 to 30 maximum</td>
</tr>
<tr>
<td>Secondary</td>
<td>Over 165</td>
<td>Over 60</td>
<td>36 maximum</td>
</tr>
<tr>
<td>Primary</td>
<td>85 to 165</td>
<td>40 to 60</td>
<td>24 to 30 maximum</td>
</tr>
</tbody>
</table>

[32]
If additional space is required to give ample clearance for packs and stirrups, provide it by extending the backslope from a point not less than 2' above the tread as indicated by hachured area.

Normal 4:1 or 2:1 slope
Start to dig back slope at this point.

Most economical method of providing clearance for pack and stirrup on slopes.

Figure 13.—Economical method of clearing for pack and stirrup.

28.—BACK SLOPES

In earth, start back slopes from inside edge of tread. Give sufficient pitch to the back slopes to bring the earth to angle of repose. If packs or stirrups will not then clear, provide ample room by removing more earth from the bank at the position designated in figure 13. These instructions apply to both primary and secondary trails.

In solid rock, start back slope 2 feet above trail tread. Additional clear space for packs or stirrups should be provided in the easiest possible way. (See fig. 8.)
Guard rail to prevent cross cutting 10" to 14" long 2' to 2½' high. Set posts at least 2' in solid earth. Use rot resistant timber if available. (Not needed on secondary trails).

Figure 14.—Desirable width of turn and guard rail.

Switchbacks are undesirable and involve the moving of large quantities of material. They are often necessary on primary and secondary trails where the physical characteristics limit the location rather definitely, and where the difference in elevation between two points is such that the maximum allowable grade is not sufficient to meet the required rise in the distance obtainable.

Some method of preventing crosscutting should be used on primary trails unless the turn is made in solid rock, or around a large tree. Two methods are shown in figures 14 and 15.
Rock wall well set 10' to 14' long and 6' to 10' higher than the bed of the trail to prevent cross cutting. At point of the turn and from it back 3' or 4' make the wall 18' to 24' high.

Showing use of rock wall to prevent cross cutting at turns of switch backs. Use only where rock of substantial sizes are handy.

Bed of lower leg of trail.

Cross section 10' ahead of turn showing use of dirt rail or cut 18' to 24' deep and rocks on outer embankment to prevent cross cutting on switch backs.

Figure 15—Rock wall to prevent crosscutting on turns.
30.—ROCK WALLS

Rock walls should be used only where it is cheaper to construct a wall than to blast out a new trail tread. (See fig. 16.)

In wall construction, a foundation is first prepared on solid earth or rock. The minimum width of the foundation should be 2 feet, and the outer edge should then be 6 inches higher than the inside edge.

Use only sound, durable, and well-shaped rocks. Ordinarily, use no stone less than 3 inches thick nor less than three-quarters of a cubic foot in volume in the body of the wall. Use of smaller stones for chinking is permissible.

Be sure that:

(a) At least one-fourth of the front and rear face of the wall is composed of headers having a length of at least two and a half times the thickness.

(b) All projecting points are removed from top and bottom of main rocks, and that each is laid with good bearing on its broadest face.

(c) All headers are laid with their greatest dimension extending into the wall and never parallel to it, except at corners, in which case alternating headers should cross.

(d) The outer face of the wall has a batter or a slope inward of at least 3 inches to each foot of height.

(e) The wall has a front and rear face well tied together with good big header stones. Avoid, without exception, the practice of laying up a face course of any kind of rock and filling behind it with small rocks and dirt as the wall goes up. It will surely collapse sooner or later.

31.—DRAINAGE

Drainage structures will take three forms:

(a) Open ditches (fig. 17) for seepage.

(b) Water bars (figs. 18 and 19) to turn seepage and run-off of rains and snow from the trail.

(c) Culverts.
Prepare a footing in solid earth or rock

Showing a typical unavoidable depression requiring a rock wall
Don't use poles to span such a place if rock is at hand.

Showing face and intermediate layer of rocks in a correctly laid rock wall.

Use largest rock available for top course.

Slope or batter inward the face of wall from 2” to 3” to each ft of height. Use only substantial stones on bottom course. Slope foundation out 3' to 1'.

Never less than 24” on foundation.

Showing cross section of a correctly laid rock wall.

FIGURE 16.—Building a rock wall.
Make backslope flat enough to prevent constant sliding of earth into the ditch.

If ground is soft, place poles, held in place with stakes, to prevent animals from walking toward or into the ditch.

Figure 17.—Trail provided with drainage ditch.
FIGURE 18.—Profile of grade line at water bars.

Dotted line shows approximate location of trail bed after the bar is completed. See Fig. 19

Raise 6" at proposed location of water bars.
32.—OPEN DITCHES

Open ditches should be used to drain seepage or run-off from springs located above a trail. If the earth is solid, open ditches may be used to carry the water across the trail, but the use of water bars or culverts is considered better practice. Never use open ditches to drain the run-off from storms or melting snow. If the ground is soft, the ditch should be protected as shown in figure 17.

33.—WATER BARS

Install water bars at the time the grading work is done. The character of the soil and the volume of the run-off will determine the interval between water bars. This general statement must not be interpreted to mean that water bars may be entirely omitted. They must be placed at intervals of not more than 500 feet on long grades where other provision for cross drainage is not made. They should be installed at an angle of $30^\circ$ to $45^\circ$ to a straight line across the trail.

In selecting places for water bars and other forms of drainage, advantage must be taken of natural obstructions. Trees, stumps, roots, and rock aid materially in preventing erosion of the outer embankment. It is sometimes good practice to riprap the lower side of the trail when the soil is loose and natural obstructions are not available. Figures 18 and 19 illustrate the construction of water bars.

34.—CULVERTS

Culverts should be constructed when necessary. It is sometimes necessary to construct culverts to cross streams where soft bottoms and boggy land on each side make travel difficult. Culverts are sometimes constructed to drain seepage water across trails when the earth in the trail is soft and subject to erosion. Culverts should be constructed of large stones or durable timber.
Avoid boggy land to the fullest possible extent, even if to escape it the best topographical location of a trail must be sacrificed, the best grades abandoned, and the length of a trail materially increased.

If impracticable to avoid swamps and bogs, first consider the possibility of making a dry tread by draining as illustrated in figure 21. If that is not feasible, lay corduroy across such places.

Do not try to fill boggy places with large rocks. It is bad practice, and the result is simply a place in which a horse may injure or break his leg.

Principles to be observed in all corduroy constructions are:

(a) Extend the ends to solid ground.
(b) Use the most durable timber available of substantial size.
(c) Remove the bark from the logs.
(d) Wherever practicable, place the entire structure—sills, stringers, and flooring—below the mud line instead of placing it on sills which elevate the structure above the line of permanent moisture. This practice will help to prevent rot.
(e) Provide an adequate base of stringers and add sills to prevent sagging and tipping of any section of the structure.
(f) Fasten the flooring in place.
(g) Lay flooring crosswise. This prevents stock from slipping, especially where corduroy is necessary on a grade.
FIGURE 19.—Section of trail showing water-break log.
Where trails cross arroyos, draws and ravines give the trail an up grade each way from the water course for a distance ranging between 2 to 4.

Detail of crossing of water courses

Dip of 6" to 24" depending upon amount of probable run off.

FIGURE 20.—Trails across arroyos, draws, and ravines.
Figure 21.—Trail on flat soft wet ground.
Do not use round material less than 8" in diameter laid lengthwise nor split material less than 10" wide.

Place entire structure below the mud line if practicable

Split cedar or fir
Not less than 4" thick.

Spikes or tree nails 1" in diameter
Latter preferred

Not less than 30' wide
30''

Sills not less than 6" in diameter and 4½' long.
Sills where two sections join not less than 8" in diameter

Sill centers not further apart than 4 or 5 ft.

Flatten top of sill to give good bearing.

Cover with dirt
Joint

Side view of split corduroy

FIGURE 22.—Section of split corduroy.
FIGURE 23.—Views of ordinary sill and stringer corduroy.
Fords, in place of bridges, are to be favored where suitable ones can be located. The ideal ford is at a point where the stream widens out, with a slackening in velocity and a gravelly bottom. Carry grading to the water's edge so an animal will not drop off on one side and have to scramble out on the other. Wherever practicable, rocky fords should, during low water, be improved by rolling out or blasting rocks from the tread and filling in with smaller rocks and gravel, or by rolling the loosened rock to the downstream side to restrain debris in the form of sand and small rocks which in time will accumulate and make a good bottom. A log firmly fixed across smaller streams may sometimes be effectively used to form a barrier to hold debris.
SECTION VII.—MARKING

37.—BLAZING

Place Forest Service trail blazes so that they are visible to a traveler approaching in either direction. Graded sections, except in deep snow country, require little or no blazing. Ungraded sections should be carefully marked. Any more blazing than actually needed is a waste, and is often very unsightly.

Blazing should be done only as construction progresses. Trails into temporary camps should not be marked with standard blazes.

Table 4 specifies a system of marking Forest Service trails. It applies to all existing trails not adequately marked and to all new construction.

<table>
<thead>
<tr>
<th>Location</th>
<th>Character of markers in order of preference</th>
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<tbody>
<tr>
<td>In timber</td>
<td>(1) Forest Service blazes on both side of trees; optional on graded trails, except in deep snow country.</td>
</tr>
<tr>
<td>Across meadows and other openings over 600 feet wide</td>
<td>(1) Posts, or posts and markers or stone monuments 300 feet apart (approximately). Blaze trees on both sides of the opening.</td>
</tr>
<tr>
<td>Both sides of fords</td>
<td>(1) Blazes on trees on both sides of trail; (2) posts, or posts and markers or monuments on both sides of the trail.</td>
</tr>
<tr>
<td>Above timber line</td>
<td>(1) Small rocks placed on larger ones commonly known as “ducks”; (2) monuments, 300 feet apart (approximately); (3) posts, or posts and markers.</td>
</tr>
<tr>
<td>All other places where a traveler may be in doubt</td>
<td>(1) Blazes; (2) posts, or posts and markers or stone monuments.</td>
</tr>
</tbody>
</table>
On thin bark trees make neat box-like blaze, not a long ragged one resulting from a careless swipe of an axe. See to it that axe-men do not exceed dimensions given. Do not waste time making square corners. A stroke up, a stroke down, and the removal of the bark between, in the easiest possible manner, is the correct practice.

Figure 24.—Trail blaze.
Cut no deeper into heavy bark trees than necessary to make clear blaze. Don't cut into sap. A clear blaze can be made otherwise. See to it that axe-men do not exceed dimension given.

Figure 25.—Trail blaze.
38.—SIGN POSTING

Simple and inexpensive markers are desirable on a main trail. The location of markers should be indicated as the construction progress is measured. If permanent signs are not available, use temporary signs. The roughest sign, lettered with charcoal, pencil, or crayon is better than none at all. The ultimate objective is to have metal signs of standard design for the Forest Service at all trail forks, intersections, fords, etc. (See figs. 26 to 28.)

Use substantial posts of the most durable timber at hand, peeled, and well set, for signing all heavily used trails (fig. 29). Otherwise, put all the better types of signs on correctly located large trees wherever possible and never on a limber or crooked sapling or bush. Do not place signs on poorly located trees, such as trees out of line or ones bordering the trail, but 50 or more feet ahead of or back of an intersection of two trails. Never place signs lower than 5 feet, and, as a rule, not more than 6 feet above the ground. In regions of heavy snowfall, or in localities where damage by cattle is probable, heights up to 7 feet are approved. Metal signs should always be backed with boards and attached with screws, preferably blued screws, never with nails. The instructions on the mechanical features of sign posting may be summed up by saying: “Give sign posting the stamp of good workmanship.”

AN AXIOM

At every intersection there should be at least TWO directional signs
FIGURE 26.—Example of careless practice in placing signs.

FIGURE 27.—Neatly placed signs.

FIGURE 28.—Example of duplication in placing signs.
Figure 29.—Sign-board posts.

Flatten seat for sign

Peel off bark of round material.

6" diameter or 4" x 4" to 6" x 6" square.

Cut top A or diamond shape

Set 2½" in earth.

Method of setting posts for signs where impracticable to set in hole.
39.—PRACTICE

The following suggestions are worth the study of all users of this handbook:

Good practice—

1. To use bits of rags or paper, or any other mark easily obliterated, to mark preliminary location lines.
2. To start to dig tread from the grade line.
3. To use the undercut method of digging.
4. To have grader stand on the lower side of the grade line in order that he can draw the dirt outward and shape the dirt rail without the need for a shovel.
5. To use shovels sparingly on the average trail job.
6. To have the foreman designate sections 25 feet to 50 feet long for each man, to prevent bunching of men.
7. To have the foreman equipped with a measuring stick to check up width of tread.
8. To use “single jacks” on drills in soft rock.
9. To use 40 percent explosives for rock work.
10. To use 20 percent explosives for stumping.
11. To study the comparative cost in time and material in use of explosives as against labor for the doing of a given job.
12. To do all blasting just before noon or evening quitting time whenever practicable.
13. To have at least one wheelbarrow on every primary trail job.
14. To have plenty of tools and to have sharp ones in the hands of every man who uses an edged or pointed tool.
15. To make camps comfortable for men.
16. To serve good, substantial food, and to go light on fancy stuff.
17. To have cooks carry hot food to men on the job rather than serve cold lunches or to walk men long distances to dinner.
18. To treat men fairly and to expect and get a full day's work from everyone.
19. To discharge promptly those who do not give a full day's work.
20. To discharge promptly the chronic "kicker."
21. To measure carefully each week the amount of trail completed and to check cost of the output.
22. To mark mile points as construction work progresses.

Bad practice—
1. To blaze out preliminary location lines.
2. To start to dig tread from a point above the grade line.
3. To dig trails so wide that the use of a shovel becomes necessary.
4. To permit mattock men or swampers to select places to start work.
5. To make trails wider in good ground than on rough, steep places simply because it is easy and nice to do.
6. To follow recklessly the notion that use of explosives is cheaper than labor in the removal of small stumps and logs.
7. Blasting at any time the rock men or powder men might have holes ready to shoot.
8. To permit men to work with dull tools.
9. To use poles covered with dirt to span depressions unless very rot-resistant material is available.
10. To use nondurable poles under fill as a support.
SECTION IX.—MAINTENANCE

40.—POLICY

The maintenance policy is stated in paragraphs 2 and 9. Slighting of maintenance work allows the standard of the trail to decline until reconstruction becomes necessary. Overdoing maintenance limits the mileage that can be maintained with available funds. Well-balanced work is required. Construction should not proceed so rapidly that maintenance cannot be kept apace. Remember that anything worth constructing is worth maintaining properly.

41.—CLASSIFICATION

Maintenance is classified under three general headings:

(a) Emergency maintenance.
(b) Ordinary maintenance.
(c) Extraordinary maintenance.

Emergency maintenance includes all work that must be done to make trails simply passable before the fire season opens or before the regular crews complete the repair of a given trail.

Ordinary maintenance has first call upon available funds, following emergency maintenance. It will be done currently, and ordinarily includes:

(a) Routine work of clearing trails of all logs and interfering brush.
(b) Clearing tread of small slides and debris from the inside of the tread, and light repair of treads.
(c) Upkeep of drainage systems.
(d) Repairing wash-outs.
(e) Light repair of bridges, culverts, and corduroys.
(f) Removing rocks and roots from treads to make feasible the use of plows and scrapers in removal of the debris.

(g) Upkeep and replacement of trail markers and signs.

(h) Tearing down and burning or burying mutilated and faded “Fire” and “Reward” signs.

EXTRAORDINARY MAINTENANCE is given high priority, usually ahead of new projects in trail work plans. It comprises:

(a) Removal of dense growth of brush and trees.
(b) Removal of heavy downfalls of timber over considerable distances.
(c) Removal of heavy slides or reconstructing new sections of trails around slides.
(d) Replacement of cribbing, preferably by rock walls, and rebuilding of damaged rock walls.
(e) Regrading of tread at proper position where it has worn downhill.
(f) Making dangerous places safe.
(g) Relocating and constructing new sections where mistakes in original location materially reduce average rate of travel over the project as a whole or where the original trail is so badly damaged that reconstruction is necessary.

(h) Replacement of unsafe bridges, culverts, and corduroys.
(i) Providing drainage which entails a large amount of work.
(j) Replacement of trail markers in considerable numbers.
(k) Improving grades on steep, broad-faced ridges.

42.—SPECIFICATIONS FOR CONSTRUCTION APPLY IN MAINTENANCE

All specifications under the section “Construction”, whether specifically mentioned under the “Maintenance” chapter or not, insofar as they cover the maintenance field, are to be followed in maintenance. For
example, in repairing treads, shape them according to proper design for the region (see figs. 6 to 10); or in the installation of water bars, follow design shown in figure 19.

43.—MAINTENANCE SEASON

Ordinary maintenance may continue throughout the field season. It should be the plan when moving crews, to place them where they will be of the greatest advantage in fire control.

44.—ORGANIZATION FOR MAINTENANCE

Use the type of organization which will do the most work for the least cost on all repair jobs.

45.—ORDINARY

To do ordinary maintenance, if dirt in small quantities only is to be removed, mobile crews composed of 3 men including a "worker boss" or foreman, equipped with suitable tools and cook outfits and 2 or 3 burros for moving camp as work proceeds, have proved to be a very effective and economical form of organization. In this handbook it will be referred to as the "burro system." Use of the system is strongly urged. Where the removal of loose or settled earth from the tread is a material factor, then, if feasible, use plows and scrapers drawn by horses or mules. Under these conditions the "burro system" may or may not be practicable.

For light maintenance, not involving much clearing of down timber or dirt work, use of a single man will often be the most economical arrangement.

46.—EXTRAORDINARY

The best organization for this class of work will approximate that outlined for the construction job. Here, too, use plows and scrapers to the fullest practicable limit.
47.—DECREASE OF EXTRAORDINARY MAINTENANCE

Need for extraordinary maintenance should gradually grow less if proper attention is given to current repair and reconditioning of the many miles of trails now in bad shape as a result of years of neglect. With extraordinary maintenance of the trail system completed, then, generally speaking, upkeep of trails will fall into the class of ordinary maintenance.

48.—MAINTENANCE UNITS

After needed extraordinary maintenance has been completed the trail systems of a forest might be divided into “maintenance units”, each unit to receive a thorough going over at scheduled intervals, as circumstances may require, by crews using the “burro system”, or by a single man. Fallen trees will have to be removed and other emergency work done as a matter of course each spring, in addition to ordinary maintenance.

Grouping trails in maintenance units may not be practicable for many years in some of the badly burned forests of the Northwest because each spring the emergency maintenance due to the enormous amount of windfall is such a huge job.

49.—DANGEROUS PLACES

Confine work under (f), extraordinary maintenance, to the elimination of actually dangerous sections, such as places with beds of slick rock on steep slopes, very rough trail beds bordering precipices, trails in boggy ground and where insufficient side clearance makes travel unsafe. Remember that conditions classed as dangerous in one locality may be merely relatively and not actually so; the same conditions might be accepted elsewhere as satisfactory without thought of need for improvement.
50.—RELOCATING

Confine work on graded sections as described under (g) extraordinary maintenance, to those where rate of travel has proved to be actually and materially slower than the average of the project.

Do not cut out pitches merely for the sake of making a section of trail look better, as, for example, the elimination of the reverse grade indicated in figure 30, by the construction of a 10-percent grade (shown by dotted line) simply because the 10-percent grade should have been built in the first instance. However, if the section of a trail, as, for example, the section shown between (a) and (b) in figure 31, is badly overgrown, its tread worn out, and the cost of reconditioning it would equal the expense of constructing a new section along the 10-percent gradient, follow the latter plan.

51.—IMPROVING GRADES ON BROAD RIDGES

In brushing out old ungraded trails which follow ridges or points, having broad faces, abandon the old route and cut a new clearing through on lower percentage of grades if the old trail is unreasonably steep and there is room to switch back. In the relocation, follow the principles outlined in paragraph 10. (See fig. 32.)

52.—REMOVAL OF OBSTACLES FROM THE TREAD

In maintenance work on secondary and primary trails, always remove all roots, stumps, and projecting rock in the bed of the trail which, if not dug out, would interfere with efficient use of plow and scraper. Give particular attention to the making of a clear-cut angle at the meeting of the back slope and the tread (figs. 6–10).

53.—FREQUENCY OF MAINTENANCE

All classes of trails should be maintained annually, and the maintenance plan should make it clear that low-duty trails are to get the same attention as other classes; that is, they must be opened up annually to be sure they are open, passable, and usable. Of course, the class and amount of maintenance work to be done on these low-duty trails should be in keeping with the requirements of this class of trail.
Figure 30.—Abandonment of existing trails on side hills.
Old trail following top on 22% between a and b. Between b and c. undulating.

Figure 31.—Abandonment of existing trails on ridges.
Old trail

Changes made to reduce grade

Figure 32.—Improving grade on flat ridge.
On account of the urgency and need a few years ago for a large mileage of low-duty trails, a large portion of this class of trail was built to a very low standard originally; this permitted leaving some logs and other obstructions that a horse could get over, but probably with some difficulty. Where this condition still exists, or whenever the way-trail system has slipped back so that the trail or trails do not measure up to the requirements and specifications, as set forth in this manual for low-duty trails, maintenance plans should make provision to bring this system up to these requirements as soon as practicable.

To insure systematic and efficient maintenance, the work in each Ranger District should be done according to a plan worked out by the Ranger. This plan being with a master map of all trails, shown by classes in color; each trail foreman to be given a rough sketch map on which is indicated only the trail system on which he is to work; the foreman to turn this map in to the Ranger when he completes maintenance work on a system of trails. He should indicate on the map his accomplishments. The Ranger will transfer this information to his master map to be used as a check on his inspection trips.

A work schedule should be made and given to the foreman of each crew. This schedule should have, as an example, the following information: The name, number, and mileage of trails to be worked; approximate time that each job should be completed; special instructions about contacts with packstrings, with supplies, etc.; where and when to split crews; instructions about posting signs, etc. All working tools and equipment necessary should be listed, and checked to be sure they are taken along. Foreman should be supplied with a carrying case containing all necessary instructions and time-keeping supplies, such as Trail Manual, maps, diary, time books, special instructions on use of explosives, and written instructions from the Ranger covering all necessary details as applied to local conditions.

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SECTION X.—BRIDGES

51.—LOCATION

Construct bridges only where to avoid construction is impracticable. Never build bridges—
(a) To span streams where reasonably safe fords are available during the field season or where they can be provided.
(b) To span gullies and arroyos if physically practicable to cross them by constructing a trail. Balance cost of trail against cost of bridge.
(c) To improve the alinement of a trail by a relatively small amount.

The Regional Forester should approve the construction of all truss bridges and all stringer bridges. The design of all bridges should be checked and approved by the Regional Engineer. Officers selecting sites and designing bridges need to feel a keen sense of responsibility for the permanency or failure of their work. Failure due to controllable errors calls for the application of the principle of personal accountability.

The chief points that locators and designers of bridges must keep in mind are:
(a) Minimum length of span providing at the same time for:
   (1) Stable footing for abutments.
   (2) Ample clearance above the water line to provide for free passage of drift logs and uprooted trees.
   (3) Advantage of location where the stream is straight and unobstructed.
   (4) Minimum cost of new trail for approaches.
(b) Stringers and other members of no less dimensions and in no less numbers than provided in table 5.
(c) Suitable foundations.
(d) Treatment of joints with heavy asphalt paint or some other kind of preservative.
(e) Careful study of all instructions of this chapter before going ahead with the job.

When requesting approval and plans for structures from the Regional Engineer, a topographic survey and vicinity map with profile should be prepared, giving the following data:
Vicinity map: Scale 10 feet equals 1 inch. Indicate for 100 feet on each side of center line and 200 feet at each end of approach for proposed crossing. Contours, 5-foot intervals.
Profile: Scale 10 feet horizontal = 1 inch; 10 feet vertical = 1 inch.
Depth to bedrock for piers or abutments.
Character of material at approaches.
Location of nearest sand and gravel deposits.
Location of nearest suitable timber.
Estimated cost.

Where special designs are requested and field personnel is not qualified to make the proper surveys, the Regional Engineer should be requested to make the survey and selection of bridge for the crossing proposed.

Construction details as to material used, sizes of members, etc., as outlined on the plans should be followed closely, or where materials for span are not available, and other materials used, approval of the Regional Engineer should be obtained before substitution is made.

55.—STRINGER BRIDGES

Stringer bridges will be used in the great majority of cases where construction is done by the regular trail crew. Figures show the approved types to serve as a guide. Six feet is standard width for the floor. This will be exceeded only where use of large stringers make it necessary. Observe the following in every case:

(a) Use rock for abutments and foundations in preference to logs, where possible.

(b) Where abutments and sills are of wood, they should be of the most rot-resistant species available.

(c) Fills around logs should be of rock and not earth. This permits drainage and reduces rate of decay.

(d) Always peel the bark off the logs.

(e) Wood pins or tree nails may be used in place of iron drift pins.
(f) If round material is used for flooring, hew tread along center line. Figure 33 shows a satisfactory floor. Do not put a dirt covering over the floor.

(g) Flooring on three-stringer bridges must be at least equal in strength to that of 2- by 12-inch planks.

(h) Use four stringers in heavy snow country and where timber is small; also, where span is over 20 feet. (See figures 33, 35, 36, 37, and 38.)

Table 5.—Minimum number and dimensions of stringers for spans up to 36 feet

<table>
<thead>
<tr>
<th>Span in feet</th>
<th>3-stringer bridge, 6 feet wide</th>
<th>4-stringer bridge 6 to 7 feet wide</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sawed timber</td>
<td>Round timber, diameter</td>
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<tr>
<td></td>
<td>Width</td>
<td>Depth</td>
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<td>8</td>
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<td></td>
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</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
FIGURE 33.

Plan

End View

Elevation.

FIGURE 33.

68
The calculations in table 5 were based on a uniform load of 400 pounds per linear foot of span. A maximum bending stress of 1,200 pounds per square inch was used.

The round-timber diameters are to be measured at the small end after deducting one-half of the diameter of the sapwood.

55.—TRUSS BRIDGES

Truss bridges should be used only when stringers of adequate dimensions cannot be obtained. The cost is much higher than for a stringer bridge and, unless accurately framed, only a small portion of the theoretical strength is developed.

Where the snow is exceptionally heavy and portions of the floor cannot be removed conveniently in the fall, a truss bridge may be necessary to avoid permanent sag in a simple stringer type.

Figures 34, 39, and 40 show approved plans of this kind of bridge. The same general rules are to be observed here as with stringer bridges.

57.—BRIDGE INSPECTION

Inspection of trail bridges should be made each year. This inspection should cover:

(a) Scour or washouts around piers or abutments.
(b) Timber inspection—breaks, splitting, rot, paint.
(c) Suspension bridges:
   (1) Cable curves uniform.
   (2) Evidence of sagging.
   (3) Broken wires and surface rust.
(4) Anchorage and towers.
   Signs of slipping or failure in masonry or dead man locations.
   Rot, breaks, paint.
(5) Bolts tight on all rods and bearings.

Where inspection indicates repair or replacement is necessary, such maintenance and repair should be made as quickly as possible.
SECTION ON A-B

ALTERNATE CONSTRUCTION

SCALE

LOWER CHORD SPLICING

FIGURE 34.
BILL OF MATERIAL

Table: Materials and Quantities for Stringers, Guard Rails, Bolts, etc.

FIG. 35

US DEPARTMENT OF AGRICULTURE
FOREST SERVICE
REGION 6

LOG STRINGER BRIDGE
10 TO 60 FT SPAN
3FT ROADWAY
FOOT TRAIL

S-M-26
**FIGURE 37**

**ELEVATION**

**PLAN**

**BILL OF MATERIAL**

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>10' SPAN</th>
<th>15' SPAN</th>
<th>20' SPAN</th>
<th>25' SPAN</th>
<th>30' SPAN</th>
<th>35' SPAN</th>
<th>40' SPAN</th>
<th>45' SPAN</th>
<th>50' SPAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>STRINGERS</td>
<td>1-1/2&quot;</td>
<td>1-1/2&quot;</td>
<td>1-1/2&quot;</td>
<td>1-1/2&quot;</td>
<td>1-1/2&quot;</td>
<td>1-1/2&quot;</td>
<td>1-1/2&quot;</td>
<td>1-1/2&quot;</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td>MIDDLE TIMBER</td>
<td>3-1/2&quot;</td>
<td>3-1/2&quot;</td>
<td>3-1/2&quot;</td>
<td>3-1/2&quot;</td>
<td>3-1/2&quot;</td>
<td>3-1/2&quot;</td>
<td>3-1/2&quot;</td>
<td>3-1/2&quot;</td>
<td>3-1/2&quot;</td>
</tr>
<tr>
<td>RAILING &amp; POSTS</td>
<td>2&quot; x 4&quot;</td>
<td>2&quot; x 4&quot;</td>
<td>2&quot; x 4&quot;</td>
<td>2&quot; x 4&quot;</td>
<td>2&quot; x 4&quot;</td>
<td>2&quot; x 4&quot;</td>
<td>2&quot; x 4&quot;</td>
<td>2&quot; x 4&quot;</td>
<td>2&quot; x 4&quot;</td>
</tr>
<tr>
<td>DECKING G55x3&quot;</td>
<td>6&quot; x 6&quot;</td>
<td>6&quot; x 6&quot;</td>
<td>6&quot; x 6&quot;</td>
<td>6&quot; x 6&quot;</td>
<td>6&quot; x 6&quot;</td>
<td>6&quot; x 6&quot;</td>
<td>6&quot; x 6&quot;</td>
<td>6&quot; x 6&quot;</td>
<td>6&quot; x 6&quot;</td>
</tr>
<tr>
<td>DRIFT BOLTS</td>
<td>3/4&quot; x 12&quot;</td>
<td>3/4&quot; x 12&quot;</td>
<td>3/4&quot; x 12&quot;</td>
<td>3/4&quot; x 12&quot;</td>
<td>3/4&quot; x 12&quot;</td>
<td>3/4&quot; x 12&quot;</td>
<td>3/4&quot; x 12&quot;</td>
<td>3/4&quot; x 12&quot;</td>
<td>3/4&quot; x 12&quot;</td>
</tr>
<tr>
<td>MACHINE BOLTS</td>
<td>1&quot; x 3/4&quot;</td>
<td>1&quot; x 3/4&quot;</td>
<td>1&quot; x 3/4&quot;</td>
<td>1&quot; x 3/4&quot;</td>
<td>1&quot; x 3/4&quot;</td>
<td>1&quot; x 3/4&quot;</td>
<td>1&quot; x 3/4&quot;</td>
<td>1&quot; x 3/4&quot;</td>
<td>1&quot; x 3/4&quot;</td>
</tr>
<tr>
<td>HERRINGBONE</td>
<td>2-1/2&quot;</td>
<td>2-1/2&quot;</td>
<td>2-1/2&quot;</td>
<td>2-1/2&quot;</td>
<td>2-1/2&quot;</td>
<td>2-1/2&quot;</td>
<td>2-1/2&quot;</td>
<td>2-1/2&quot;</td>
<td>2-1/2&quot;</td>
</tr>
<tr>
<td>ROOFING FELT</td>
<td>1 SQUARE</td>
<td>1 SQUARE</td>
<td>1 SQUARE</td>
<td>1 SQUARE</td>
<td>1 SQUARE</td>
<td>1 SQUARE</td>
<td>1 SQUARE</td>
<td>1 SQUARE</td>
<td>1 SQUARE</td>
</tr>
</tbody>
</table>

**NOTES**
- FASTEN DECKING WITH 5 S-HOES PER PLANK
- PLACE ASPHALT ROOFING FELT 12" WIDE OVER STRINGER
- BORE DRIFT HOLES 1/2" UNDER SIDES FOR SLEEP TRACK, PARALLEL RAILING WITH 4" ROUNDED POLES 6" C.T.D. FROM DECK

**DESIGNED FOR 3 FT OF SNOW**

**SNOW LIVE LOAD = 350 LBS PER LINEAL FOOT OF BRIDGE**

**FIG 37**

**U.S. DEPARTMENT OF AGRICULTURE**
**FOREST SERVICE**
**REGION 6**

**LOG STRINGER BRIDGE**
10 TO 50 FT SPAN
6 FT ROADWAY
HORSE TRAIL

*PS-27*
FIGURE 38.

75
FIGURE 39

BILL OF MATERIAL

NOTE:
ALL TIMBER, JOISTS, AND FLOOR BEAMS TO BE SELECT STRUCTURAL AND ALL OTHER
TIMBER TO BE SELECT MERCHANTABLE, EITHER
MERCHANT OR S1S TO FULL SIZE ALL LUMBER
EXCEPT HARDWOODS PREPARED PRESSURE
CHEMICALS OF NOT LESS THAN 350 LBS PER FT
AND KEPT JOINTS ANDchORD JOINTS
WITH ASH ALT. ROOFING WEIGHS 3.5 LB OR
MORE PER SQ FT AND EIGHT JOINTS AND
OF ANGLE BLOCKS IN BOLTING CHEMICAL
ANGLES TO BE SELECT LUMBER SEASONED
BEFORE FRAMING.

LY DECK WITH 1 1/2" SPANS USE 2-ROM SPARKES
AT EACH END AND ONE IN EACH INTERMEDIATE
STRAIGHTLINE INCREASE THE NUMBER OF SPARKES IF SHORTER
CHORD MEMBERS ARE DESIRED.
NICE HOLES 1/2" OVER SIZE FOR BOLTS, 1/2"
OVER SIZE FOR TRUSC ROLES, AND 7/8" UNDER-
SIZE FOR CRISP BOLTS.
DESIGNED FOR 3 FT OF SNOW.
SHOW USE LOAD 1.15" PER LINEAL FT OF GROOCE.

FIG 39

US DEPARTMENT OF AGRICULTURE
FOREST SERVICE
REGION 6

TIMBER HOWE TRUSS
50-60 & 70 FT SPANS
6 FT ROADWAY
HORSE TRAIL

DESIGNED BY M A L
S M 44
FEB 1975

Figure 39.

76
Figure 40.
Figure 41.
FIGURE 42.

TABLE 42

<table>
<thead>
<tr>
<th>Material</th>
<th>Force (kips)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1000</td>
</tr>
<tr>
<td>B</td>
<td>500</td>
</tr>
<tr>
<td>C</td>
<td>250</td>
</tr>
</tbody>
</table>

SUSPENSION BRIDGES

70 FT TO 700 FT SPAN

MARCH 1951
Figure 44.

Note: Put key in all threaded bolts and the grips in nose of ditcher.
APPENDIX
TOOLS

Provide trail and bridge crews with all the tools likely to be needed on any part of the job. Some of the tools may not be used, but it is better to have them on hand when and if required than to lose valuable time securing them or trying to improvise substitutes.

TOOL EQUIPMENT LIST

Suggested Standard List For Trail Crews

<table>
<thead>
<tr>
<th>Tool Type</th>
<th>2-man</th>
<th>5-man</th>
<th>8-man</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axes, D. B., 3 1/2-pound</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Bags:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Man-pack, 5-gallon (only where needed)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Water, 2 1/2-gallon</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Bars, crow (where needed)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chains, log, 12-foot (where needed)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chest, medicine, crew</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Crimpers, cap (where needed)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Files:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8-inch</td>
<td>3</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>10-inch</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Flags, United States</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Grader, Beatty trail (where needed)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Grinder, carborundum</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Grindstone and frame, Army</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Hammers:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Claw</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Falling, 4-pound</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Handles:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ax</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Mattock</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Saw</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Hooks, brush</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kits, timekeeper's</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Level, Abney</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mattocks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outfits:</td>
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<td></td>
</tr>
<tr>
<td>Cobbler</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saw-filing</td>
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<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Smokechaser's, complete</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Peavy</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Picks, mattock</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Smokechaser's, pocket</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Plow, trail (where needed)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Rasp, wood</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Sacks, pack, Duluth no. 2, or pack frames</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Saw, C. C., 6 1/2-foot</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Shovel, L. H. R. P</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Stone, carborundum, pocket</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Wedges, falling</td>
<td>2</td>
<td>2</td>
<td>4</td>
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</tbody>
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## MESS EQUIPMENT

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<th>Item</th>
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<td>Basin, wash</td>
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<tr>
<td>Beater, egg</td>
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<td></td>
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</tr>
<tr>
<td>Board, wash</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Boiler, 2-gallon</td>
<td>1</td>
<td></td>
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</tr>
<tr>
<td>Boiler, 3-gallon</td>
<td>1</td>
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<tr>
<td>Bowls, mixing, 6-quart</td>
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<td></td>
<td></td>
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<tr>
<td>Bowls, soup, granite</td>
<td>4</td>
<td></td>
<td>10</td>
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<tr>
<td>Buckets, water, 10-quart, canvas</td>
<td>1</td>
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<td></td>
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<tr>
<td>Can opener</td>
<td>1</td>
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<tr>
<td>Clocks, alarm</td>
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<td>1</td>
<td>11</td>
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<tr>
<td>Collander</td>
<td></td>
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<tr>
<td>Cups, nested</td>
<td>4</td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>Canvas, table top (feet)</td>
<td>1-5</td>
<td></td>
<td>1-8</td>
</tr>
<tr>
<td>Forks:</td>
<td></td>
<td></td>
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<tr>
<td>Meat</td>
<td>4</td>
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<td>Table</td>
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<tr>
<td>Griddle, pancake</td>
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<td>Kettles:</td>
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<tr>
<td>2-quart</td>
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<tr>
<td>4-quart</td>
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<td>2</td>
<td>3</td>
</tr>
<tr>
<td>6-quart</td>
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</tr>
<tr>
<td>Knives:</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Butcher</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Paring</td>
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<td>4</td>
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<td>Nails, assorted, pounds</td>
<td>5</td>
<td>6</td>
<td>10</td>
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<tr>
<td>Oilcloth, white, 46 inches wide, yards</td>
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<td>3</td>
<td>5</td>
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<tr>
<td>Pans:</td>
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<td>Bread:</td>
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<tr>
<td>Medium</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Large</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Dish</td>
<td>1</td>
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<td>2</td>
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<td>Dish-up:</td>
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<tr>
<td>1-quart</td>
<td>2</td>
<td>3</td>
<td>2</td>
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<tr>
<td>2-quart</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3-quart</td>
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<td>1</td>
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<tr>
<td>Fry:</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Medium</td>
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<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Large</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Plates, enamel</td>
<td>4</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Platter, meat</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Pots, coffee</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Sacks, cloth, lunch</td>
<td>6</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>Saw, meat</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Screen, cheesecloth, yards</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Shaker, salt</td>
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<td></td>
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<tr>
<td>Sifter, flour, flat, 16-inch bottom</td>
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<td></td>
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<tr>
<td>Spoons:</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Desert</td>
<td>4</td>
<td>6</td>
<td>8</td>
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<tr>
<td>Mixing</td>
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<td></td>
</tr>
<tr>
<td>Table</td>
<td>4</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Telephone, complete</td>
<td></td>
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<td>1</td>
</tr>
<tr>
<td>Tins, pie</td>
<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>Toweling, dish, 50-pound flour sacks</td>
<td>6</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Tubs, wash</td>
<td></td>
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<tr>
<td>Turner, cake</td>
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## TENTAGE

<table>
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<th>Item</th>
<th>1</th>
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<tbody>
<tr>
<td>Flies, 10 by 12 feet</td>
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</tr>
<tr>
<td>Tents, 10 by 12 feet</td>
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<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
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83
### BEDDING

<table>
<thead>
<tr>
<th></th>
<th>2-man</th>
<th>5-man</th>
<th>8-man</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blankets, wool (6 thicknesses per bed)</td>
<td>12</td>
<td>30</td>
<td>48</td>
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<tr>
<td>Extra bed each crew for Forest Officer</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Tarps</td>
<td>2</td>
<td>5</td>
<td>8</td>
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<table>
<thead>
<tr>
<th></th>
<th>2-man</th>
<th>5-man</th>
<th>8-man</th>
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</thead>
<tbody>
<tr>
<td>Stoves, cook, Lang or sheep</td>
<td>1</td>
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</table>

### STOVES

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Stovepipe, joints</td>
<td>5</td>
<td>5</td>
<td>5</td>
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</tbody>
</table>
BLACKSMITH OUTFIT

(To be furnished only on jobs where need is fairly constant)

Anvil ............................................. 1
Chisel, hot ........................................ 1
Coal, sack ........................................ 1
Drill, spoon ...................................... 1
Drill steel, set or detachable bit set .................. 1
Forge, portable ................................... 1
Hammer:
  Blacksmith, ball pein ........................... 1
  Double jack ..................................... 1
  Flatter .......................................... 1
  Rock, 12-pound ................................ 1
  Single jack ..................................... 1
  Tool-sharpening ................................ 1
Hardie ................................................ 1
Tongs:
  Bolt ............................................. 1
  Pick ............................................. 1
  Plain ........................................... 1
Vise ................................................ 1
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<thead>
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<tr>
<td>V-DRAGS (fig. 44)</td>
<td>12</td>
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<tr>
<td>WATER BARS:</td>
<td>33</td>
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<td>Angle of crossing of</td>
<td>33</td>
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<td>Installation</td>
<td>33</td>
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<td>Location of</td>
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<td>Ways</td>
<td>14, 19</td>
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<td>Wheelbarrows, use of</td>
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<td>Why trails are built</td>
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<td>Width of trails (table 3)</td>
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<td>Work on trails by Forest officers</td>
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<tr>
<td>Work schedules for foremen</td>
<td>53</td>
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<tr>
<td>Written instructions to foremen</td>
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</table>

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SUPPLEMENTAL INSTRUCTION
FOR
TREATMENT OF RECREATION TRAILS
BY

Frederic A. Baker (Snoqualmie)
RECREATION TRAILS

The recreational trail is built for recreationists in order that they might enjoy some scenic route or reach some point of scenic interest. The recreation trail is different from other Forest Service trails which serve some definite utilitarian purpose of land area coverage, for use under ordinary circumstances by experienced Forest Service employees. Because the recreation trail is built for a different purpose and is used by different types of people, different requirements are established which necessitate different methods of trail construction.

Recreation trails may be grouped into two classes for consideration—(1) short trails to points of particular scenic interest, and (2) long trails of extended scenic interest. A short trail to a point of scenic interest, used by tourists and inexperienced recreationists, should have an easy grade or when the differences in elevations are such that an easy grade cannot be maintained, the trail
should have an ample number of resting points, overlooks, seats, etc., built at convenient points. A longer trail connecting extensive recreation features and used by experienced recreationists might be of various grades arranged to meet the difficulties of construction as economically and as easily as possible.

A few general considerations regarding the design and construction are given, realizing that no specific sets of directions will meet all conditions.

GENERAL DESIGN

A curved line in plan is usually more interesting from a scenic point of view than a straight line, as all the features cannot be seen at one time and are undfolded as progress is made along a trail. However, in passing through an area of uniform natural conditions, the trail might become uninteresting by too much indirectness and meandering. Interest may be maintained and even intensified under such circumstances by building a straight trail through the uninteresting area with interest created by modifying the profile. That is,
a straight trail through a long uniform setting with a concave or undulating profile is often better than a very irregular line with uniform grade.

The building up of interest until an objective is reached will help lead the recreationist to the objective point. This kind of climax interest may be accomplished by opening up minor views of the objective itself and taking advantage of incidental side views of minor interest along the way.

A trail with varying grades, not necessarily a loss in elevation is preferable to a sustained uniform grade.

In areas of great scenic interest it is often desirable to locate trails so that the interest is centered at outstanding points rather than to attempt to feature all views at one time. The reason for this method of treatment is that the human eye is so constructed that the concentrated vision at one point is limited to an angle of about thirty degrees.
Also, because of this fact, panoramic views are often more pleasing when framed by natural barriers, concentrating the vision at particular points.

CONSTRUCTION

Recreation trails along streams and lake shores should not exactly follow the waterline. Under actual field conditions this would be often impossible because of construction difficulties. Ideally, the trail should be away from the stream or lake shore but accessible to the water's edge and touching it at a few important points of interest. Side trails or spur trails may often be built to interesting points when the trail is away from the water's edge.
Trails connecting extensive recreation features may also have spur trails built to points of interest that are not on the main trail itself. Added interest may be incorporated in scenic areas by having loop trails serve as alternate routes.

Trails to be built to approved recreation standard may have many of the construction characteristics of roads, only on a smaller scale, as, inslope, outslope, waterbars, drain logs, switchbacks, culverts, bridges, turnpiked areas and areas requiring surfacing, etc. The construction method which will stand up under long periods of use with the least maintenance is the method which should be used to meet the existing conditions.

Clearance and tread should be wide enough for two people walking abreast in areas of mild exertion and with ample clearance for a pack horse. The width of the tread may be narrowed in trails of the extended sort, but should have ample pack horse clearance.
The grade of the trail should vary, avoiding long stretches of uniform grade. The ideal maximum grade should be ten percent but under certain circumstances may be increased to fifteen percent for short distances where certain definite objectives must be reached.

Switchbacks should be avoided whenever possible as people descending the trail will want to "shortcut" which will result often in forming unsightly wash channels. In rocking up the inside point of the turning area of the switchback, special attention should be given to the placing of the rocks. They should be placed with their longest dimension into the bank so that they become imbedded into the earth and rest securely on their own faces. Do not build a veneer of rocks on the earth's surface subject to wash and slipping.
CLEARING AND BURNING

Because the recreation trail is used chiefly by the public, particular attention should be given to clearing, burning and construction. All burning should be done along the actual trail where the trail construction will cover the scars left by burning or well away from the trail. The brush piles should be small and will be less noticeable if on the uphill side of the trail or well below, out of sight of the trail. Particular care should be given at all times in safeguarding and protecting existing growth. While rocky ledges may provide a safe place for burning, the damage done to surrounding plant and lichen growth is very severe and such places for fires should be used only when there is no better place.

SIDE SLOPES

Side sloping on the recreation trail is an important feature. When properly done, it will blend the trail construction into the existing surroundings with little damage to the landscape picture. The side slopes should vary with the ground conditions in which the
trail is constructed. A much more natural cross section will result if the slopes are varied instead of being built at a set standard as 1 to 1 or 2 to 1. The rounding of the top of the slope should also vary with conditions. The raking down of the slope and removal of needles and plants makes a neat looking job from an engineer’s point of view but may do considerable damage to plant growth. The natural damage will be greatest at this point because of the change in natural condition. Much plant growth should be left undisturbed, preventing surface wash and future sloughing to a large extent.

BARRIERS AND RAILINGS

Trails along steep side hills, and along or near precipices should have some form of barrier along the outside edge. The barrier may take the form of logs securely fastened to the ground, log railings, irregular stones, dry stone walls or masonry walls. The kind of barrier to be used will be determined to a large extent by the expected use of the trail and the kind of material at hand. Trails convenient to recreation centers will have more varied use and will require greater safety precautions than a trail in the remote back country.
SURFACING

Under ordinary conditions, the existing dirt will provide suitable trail surfacing; but under special situations, the trail surface will require special treatment. In areas of rock where there is insufficient fine material, dirt should be brought in for surfacing. In areas through bogs and wet places even if the trail is properly drained, sandy gravel may have to be brought in to make the trail usable during wet weather. When a trail has exceptionally heavy use and becomes dusty, other surfacing methods may have to be used. Oil, if lightly and correctly spread, will keep the dust down without damage to plant growth; under severe conditions regularly prepared tarred aggregate may have to be used. Calcium chloride may have some use in well defined trails but the correct amount for use will have to be determined by experiment.
FIXTURES AND FEATURES

Recreation trails of meandering, intimate scenic surroundings, convenient to highways and centers of recreation concentration may well have seats, benches, picnic tables, etc., located in secluded nooks convenient to the trail and featuring some scenic focal point. Shelters and registry booths may also be located at strategic places. Structural features should not be located at every important point as they may interfere with the natural surroundings. Usually such points require and should be given special study in order to fit the proposed development into the surroundings in the best and most satisfactory manner. Where trails are loops or portions of an extensive system of trails, shelters and mountain camps should be provided at suitable scenic spots, ordinarily an easy day's travel from each other. The location of such sites should be given special attention especially in connection with highway takeoff points. Other minor stopping points should be provided where the traveler might stop for lunch in a suitable prepared area.