Trail Maintenance Standards

Mount Rainier National Park

Prepared by Ranger John Dalle-Molle

APPROVED: William J. Briggle
Superintendent

DATE: 5/16/78

RATIONALE FOR TRAIL MAINTENANCE STANDARDS

Objective

The objective of trail maintenance standards is to establish measureable statements describing the results and conditions that will exist when trail maintenance activities are performed satisfactorily.

Need for Revised Standards

The present standards need to be revised because they no longer provide sufficiently comprehensive measureable statements to adequately cope with changes in trail maintenance problems due to:

(1) Increases in visitor use in recent years have resulted in some unacceptable changes to park resources. Some old problems have become more severe and some new problems have arisen. Due to these changes the present standards no longer adequately describe all the results and conditions that should exist.

(2) As management has increased maintenance efforts to deal with these problems by the use of more park crews, contract crews and others, such as YCC and SCA crews, it has become more difficult to insure that the interpretation and implementation of existing standards stay within the intent of management policy. To overcome this situation the standards need revision to be more comprehensive and detailed so that they give greater guidance to crews and supervisors.

Direction Setting Documents for Establishing Standards

National Park Service Management Policies
Mount Rainier National Park Master Plan and Wilderness Plan
Mount Rainier National Park Resource Management Plan (Backcountry Plan section only presently completed portion)

Some pertinent quotes from NPS Management Policies for establishing trail maintenance standards:

Development (chapter III):

Commensurate with its mandate for resource protection, the National Park Service will assure reasonable access to and circulation within the areas of the National Park System to provide for visitor use and enjoyment and park management. In so doing, the Service will choose the methods of access and circulation having the minimum impact and physical and biological disturbance on the park resources. (III-1)

Trails, like roads, should provide enjoyable access to interesting park environments without endangering fragile resources... Heavily used walking trails may be surfaced as necessary to conform with visitor safety, resource protection, and erosion conditions. However this does not apply in backcountry or wilderness areas, where regulation of use and trail relocation would be the desired solutions. (III-3)

In large parks, different levels of trail construction and maintenance standards should be applied to accomodate a range of trail users. However, backcountry trails should be unsurfaced and of modest primitive character, except where permitted horse travel requires a more durable surface. No artificiality in the form of non-native materials should remain visible in a final trail product. (III-4)

Trail bridges may be placed in backcountry areas for stream crossings involving high or swift water constituting a safety hazard or where the absence of a bridge would require crossing hazardous terrain.(III-5)

Wilderness Preservation and Management (chapter VI):

The visitor must accept wilderness largely on its own terms. Modern conveniences are not provided for the comfort of the visitor; and the risks of wilderness travel, of possible dangers from accidents, wildlife and natural phenomena must be accepted as part of the wilderness experience. (VI-4)

For a majority of park visitors, park wilderness will be appreciated primarily from outside wilderness boundaries as part of the park scene viewed from park roads and developments. To them, as well as to the visitor who hikes into the wilderness, protection of the wilderness character is essential to the quality of the park experience. (VI-4)

Narrow,unpaved foot and horse trails are permissible. (VI-7)

Interpreting Policy

In establishing standards, policy must be interpreted to some degree. In the following proposed standards the policies in the direction setting documents were ... interpreted with the following consideration in mind: the minimum necessary alteration to natural resources consistent with providing access should be reflected in standards. The least change to natural resources and the natural character of the Park, while maintaining access,is most consistent with policy. Even where structures or facilities are needed for safety reasons they should be designed, constructed and maintained in ways that least alter the environment. Trail maintenance must be guided by a philosophy oriented toward resource management rather than facility management, for it is the resources that give meaning to the Park, that justify the Park's existence. As a superintendent of this park wrote over 20 years ago regarding trail maintenance: " Our responsibility to preserve the wilderness is the compelling factor and unless we can accomplish this by preserving plant growth and the landscape we are not carrying out our responsibility".

Contents

Trail Classification Mt Rainier

Based on land classification

Trail Class		Land Classification: NPS Management Policies	MT Rainier Master Plan
1 (heaviest used trails, in developed areas, some paved)	-----in --->	Development Zone/Landscape management subzone	Class II General OUtdoor Recreation Area
2 (Fairly heavy use trails near developed areas)	-----in--->	Natural Zone/Natural Environment subzone	Class III Natural Environment Area
3 (All trails in Wilderness proposal areas)	-----in--->	Natural Zone/Wilderness subzone	Class V Primitive Areas

* *

Unofficial Trails

Way trails - unplanned and unmaintained paths formed by repeated visitor use going to destinations. Maintenance to prevent resource damage only will be on a case-by-case basis as approved by the Superintendent. Some way trails may be closed.

Social trails - similiar to way trails but occuring at specific sites - entering or exiting sites like radiating spokes of a wheel. Maintenance to prevent resource damage only will be on a case-by-case basis as approved by the District Ranger. Most social trails will be closed.

TRAIL MAINTENANCE SCHEDULE

Work will be scheduled according to the following priorities:

1. Start of season: Check all trails for hazardous bridges, snowmelt, blowdowns, slides, washouts or other problems that interfere with visitor access or need immediate attention to prevent serious resource damage, in order to:

    a) Notify visitors of problems

    b) Plan for work ahead so those problems needing the most immediate attention will receive it.

2. Perform those tasks needing immediate attention to remove any serious hazards from structures and to prevent serious resource damage. Then
    a) Open all trails to use, as snowmelt permits
    b) Clean all drainage

3. Special projects: rerouting, restoration, install new drainage facilities, replace bridges, brushing etc.

4. End of season: clean all drainage, drop suspension bridge decking, prepare plans for next seasons work (rough out initial plan ideas before snow comes in case it is necessary to go back out to get some specific trail data needed for the planning during the winter).

5. Late fall and winter: prepare short and long range programs and budgets, contracts, order supplies, repair equipment, follow up on work orders for pre-constructed items, review standards and crew manuals.

6. Spring: follow up on pending work orders, equipment requisitions, pre-work meeting with contractors, hiring seasonals.

Unit 1 CLEARING MAINTENANCE

Contract Item ___

Description

Clearing maintenance consists of the removal of all windfalls, leaning trees, loose limbs and wood chunks from the trail travelway. (Contractor: with special payment for designated excess work as follows:

Where snags and/or hazardous trees, as marked by the government, are to be felled and removed by the contractor. Total number of designated snags or trees _____.)

Methods - All-purpose trails (Foot and Stock)

Trail classes 1, 2, and 3: Logs, windfalls and leaning trees within the travelway will be removed to the lower side of the trail and off of the travelway. The travelway will be cleared to a width of 8 feet (4 feet on each side of the trail centerline), and to a height of 10 feet. The portion of any log that remains on the upper side of the trail should not have the potential of sliding into the trail. If necessary it will be firmly anchored or moved across and off of the travelway on the lower side of the trail.

Remove all loose limbs, sticks and wood chunks exceeding either one inch in diameter or 12 inches in length that are on the trail tread.

Hazardous trees and snags, as marked by the government, will be felled and cleared from the travelway. All stumps will be cut as close to the ground as possible.

Logs, loose limbs and wood chunks will not be disposed of in any water course or drainage channel, either natural or manmade. (Government crews: where shortcuts or social trails exist, logs, limbs and wood chunks removed from clearing will be placed, whereever practical, to block use of the shortcuts and social trails.)

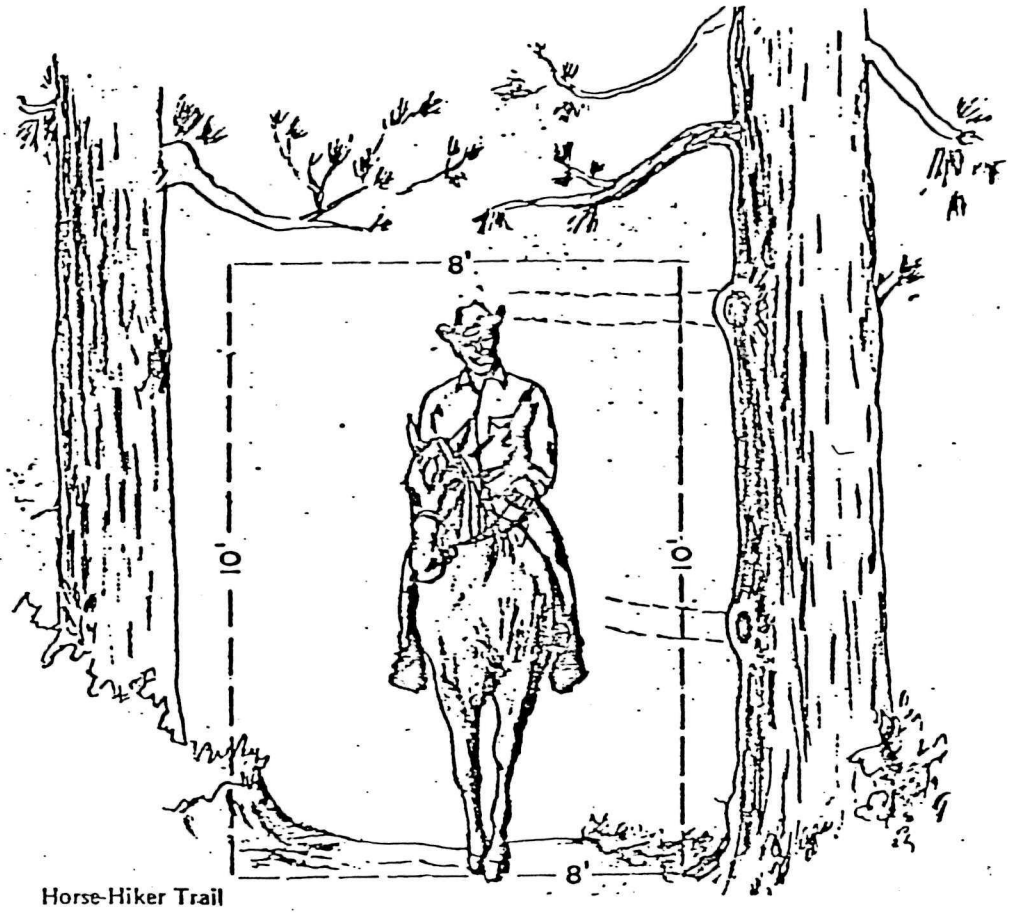
Methods - Foot-only trails

All methods and specifications which apply to All-purpose trails also apply to Foot-only trails, with the following exceptions:

Class 3 trails: clearance will be to a width of 4 feet (2 feet on each side of the trail centerline) and to a height of 8 feet over the travelway.

Class 2 and 1 trails: clearance will be to a width of 2 feet beyond the trail tread margins and to a height of 8 feet over the travelway.

TRAVELWAY CLEARING



Horse-Hiker Trail

Class 3
Hiker Trail

2' beyond tread margin
for Class 1 and 2 trails

Figure 1

Unit 2 BRUSHING MAINTENANCE

Contract Item ___

Description

Brushing maintenance will consist of the removal of all woody vegetation (contractor - 4 inches or less in diameter) from the trail travelway.

Methods - All-purpose Trails

Woody vegetation has an aerial stem which persists for more than one season, and in most cases a cambium layer for periodic growth in diameter. Woody vegetation include trees, shrubs and vines. In contrast to woody vegetation is herbacious vegetation where the soft, supple stems die each season and new ones grow the following season, such as grasses and most meadow flowers.

Woody vegetation will be cut off at a point not more than 6 inches above tread level at the trail tread margin, tapering to 12 inches above tread level at the edge of the cleared travelway (see Figure 2). Clearing width is 4 feet on each side of the trail centerline and to a height of 10 feet over the cleared travelway. All cuttings will be removed from the travelway and scattered along the lower side of the travelway in such a manner as to leave them inconspicious.

Limbs that are cut from standing trees will be cut flush with the tree trunk, leaving no stub. Live trees will be pruned in such a manner as to prevent tearing of the bark.

Cuttings, loose limbs, wood chunks and other debris will not be disposed of in any water course or drainage channel, either natural or man-made.

Methods - Foot Trails

All methods and specifications which apply to All-purpose trails also apply to Foot trails, with the following exceptions:

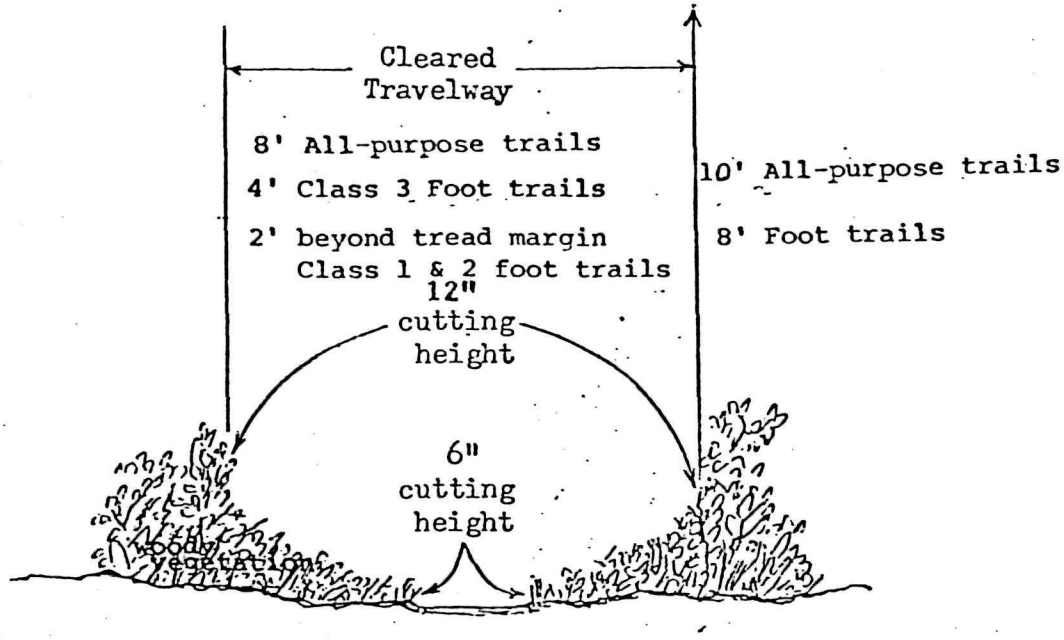
Clearing width is 2 feet on each side of the trail centerline and to a height of 8 feet over the cleared travelway.

In addition to the brushing maintenance described above, the following will apply to Class 2 and 3 trails, All-purpose and Foot:

All vegetation, woody or herbacious, which extends within the margins of the trail tread, will be removed.

Clearing width is 2 feet beyond the tread margin for woody vegetation.

BRUSHING MAINTENANCE



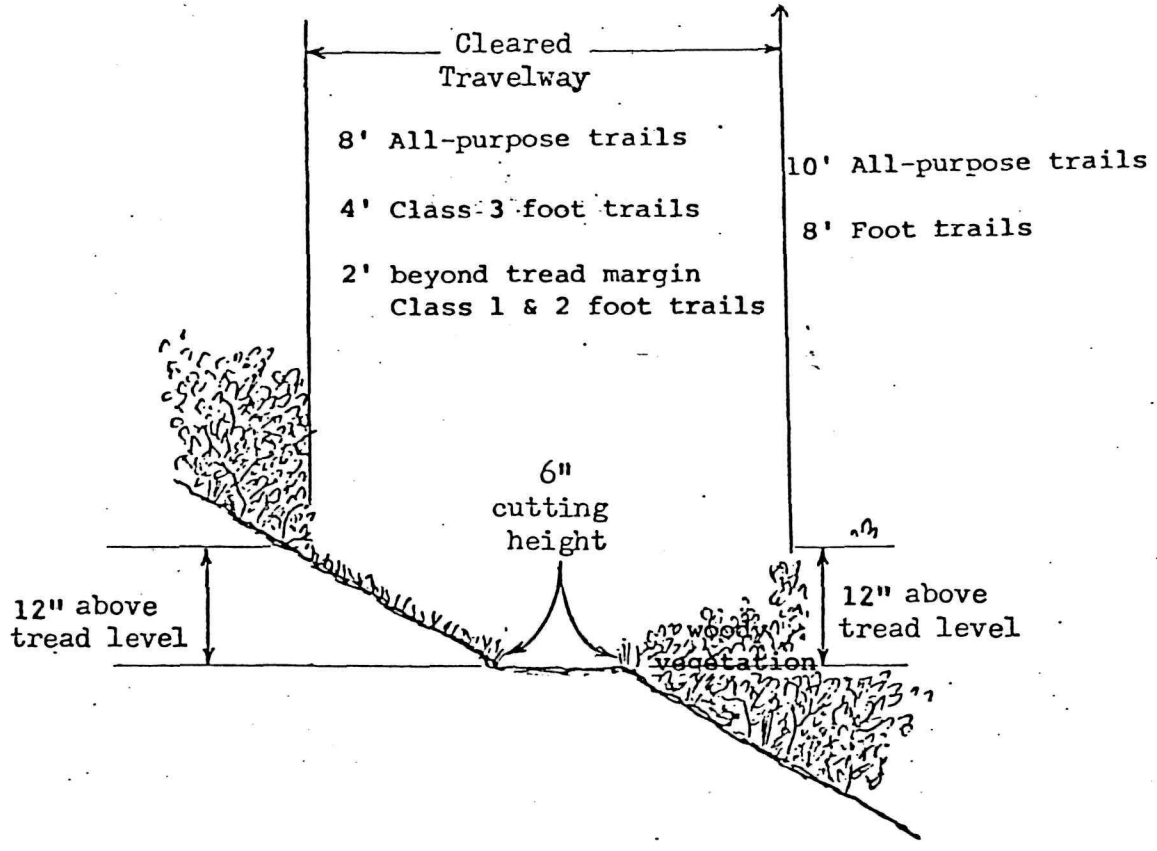


Figure 2

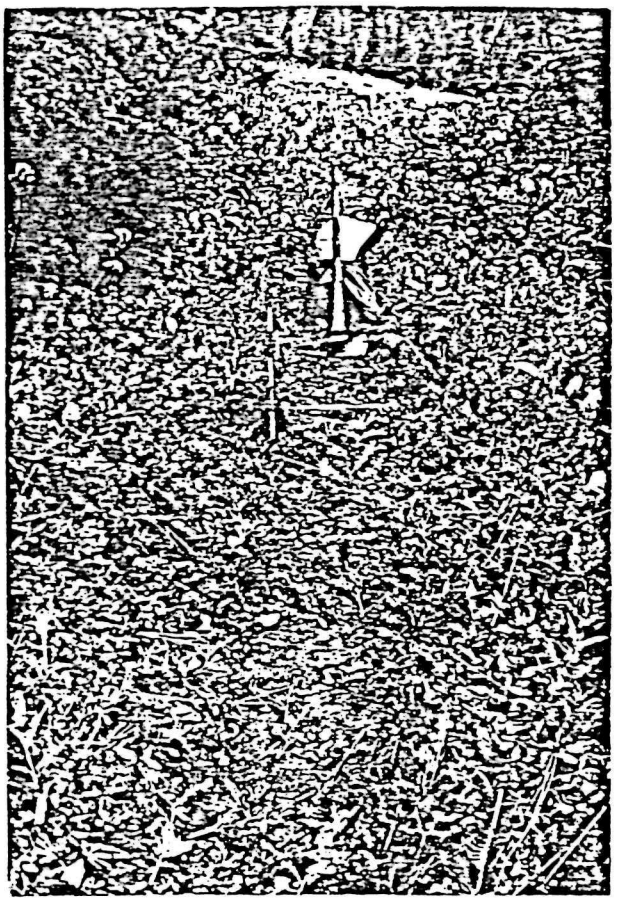


Fig. 2a

The signs of man in the backcountry, including trails, should be as unobtrusive as possible. Thus: when to brush?

If a trail is getting such light use that it is growing in, but management wants it maintained, then brushing may be needed. On the other hand, if the trail tread is adequate, as in these two pictures, there is no need to brush. yet trail in left photo was unnecessarily brushed. Also, no attempt was made to remove cut vegetation from the travelway, in fact most of tread is now obscured by cuttings. (pulaski in photo was not used for brushing!)

Onecase where routine brushing is needed is when trailside vegetation consists of woody plants that might encroach on trail - once they have grown thick they require much more work and cost to eradicate than when they are small. In the 2 photos shown the vegetation is only light herbaceous, and is not a threat.

Fig. 2b

Figure 2c

Overbrushing - the branch tip in persons right hand came from where she is pointing with left hand. Completely unnecessary.

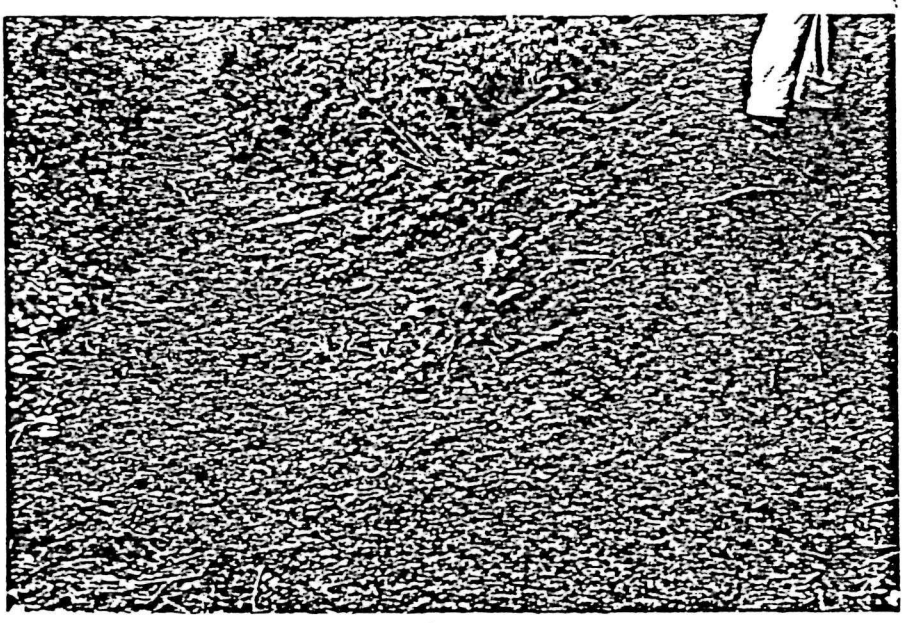


Figure 2d

Brushing was done at this switchback opening it up so that now hikers shortcut the switchback. Think about the necessity of work needs before performing and consider if more damage than good will result.

Methods (continued)

use and normal exposure will be filled and resurfaced to the original trail condition as determined by the adjacent trail.

Fill and borrow material will be obtained according to the priorities listed in Unit 7.

All loose rocks over 2 inches in diameter deposited on the tread will be removed beyond the travelway.

Methods - Class 3 All-purpose Trails

All methods and specifications which apply to Class 3 Foot trails also apply to Class 3 All-purpose trails, with the following exceptions:

Tread width on sharp switchbacks may be up to 6 feet wide on the landings.

Where the outer trail tread margin is along a very steep slope or cliff the tread may be up to 4 feet wide.

Methods - Class 2 Trails

All methods and specifications which apply to Class 3 trails also apply to Class 2 trails, with the following exceptions:

Tread width will be a minimum of 18 inches and a maximum of 48 inches. Width will depend on the amount of use. If there is considerable two way or passing traffic the wider width will be maintained.

Rocks inbedded in the tread and protruding over 2 inches above the tread, which can be removed by a small bar or pick, will be removed beyond the travelway. and the resulting hole filled with compacted mineral soil and/or rock not exceeding 2 inches in diameter.

All exposed roots protruding over 2 inches above the tread and all loose roots protruding over 1 inch above the tread will be cut out to at least 4 inches beyond the margins of the tread and to a depth of at least 4 inches below tread level and removed from the travelway. Holes resulting from root removal will be filled and compacted with mineral soil and/or rock not exceeding 2 inches in diameter.

Methods - Class 1 Trails

All methods and specifications which apply to Class 3 trails also apply to Class 1 trails, with the following exceptions:

Tread width will be a minimum of 48 inches and a maximum of 72 inches. Width will depend on the amount of use. If there is considerable two way or passing traffic and congestion, the wider width will be maintained.

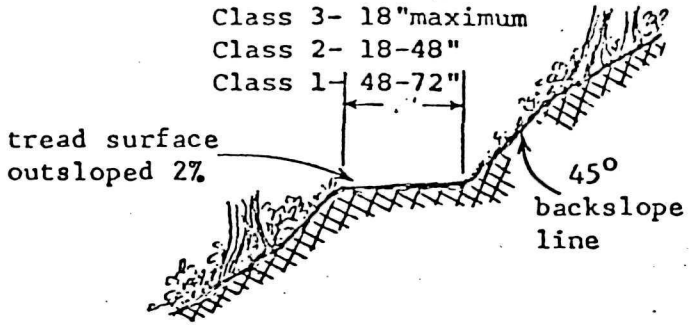
All loose rock, except gravel on graveled trails, will be removed beyond the travelway. All rock protruding above the normal tread surface will be removed beyond the travelay. All roots protruding above the normal tread surface will be removed beyond the travelway. All resulting holes will be filled and compacted with mineral soil and/or rock not exceeding 2 inches in diameter.

TREAD MAINTENANCE (continued)

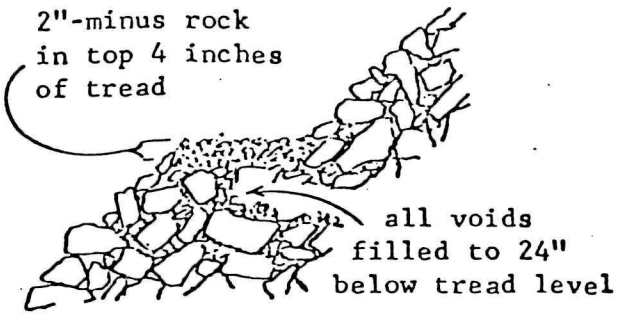
Methods (continued)

As part of tread maintenance, the decks of briges and puncheon, including under and along curb/bull rails, will be cleaned of all accumulated deposits of dirt, duff, moss, needles and other loose material or deteriorating matter.

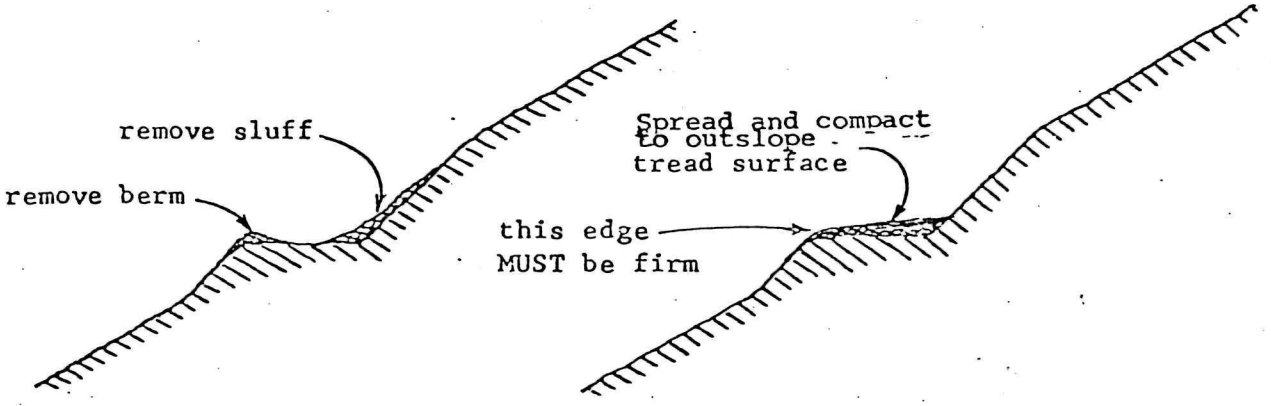
Trail tread is considered to extend across and through all stream crossings (fords) and all applicable tread maintenance specifications will apply to the travel surface. In addition, stream fords shall be cleared, for a distance of 20 feet on either side of the trail, of limb, log and rock jams or other obstacles that might impede or cause deviation of the stream flow into the trail travelway outside of the ford. Care shall be taken to avoid causing major changes in natural streambed gradients that are presently stable.



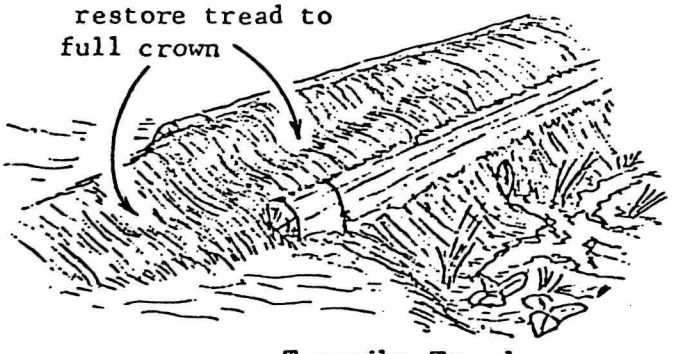
Cross-section



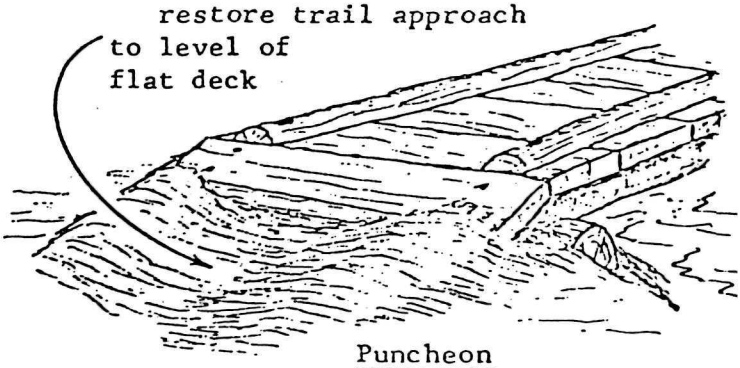
Talus



Sluff and Berm



Turnpike Tread



Puncheon
and Bridges

Figure 3

Unit 4 DRAINAGE MAINTENANCE

Contract Item ___

Description

Drainage maintenance will consist of maintenance and minor repair of existing drainage facilities and replacement of rotted or worn out ones and installation of new ones (contractor - with special payment for designated excess work as follows:

Installation of new drainage facilities

Type: _____ Number: _____

" _____ " _____

" _____ " _____)

Methods

Drainage facilities include: outsloping, dips, water bars, cross ditches, parallel ditches and culverts.

Restore outsloping to trail tread and clean out drainageways on the upgrade side of all drainage facilities and fill in on the downgrade side of all drainage facilities to bring tread level with top of facility. Repair loose drainage facilities. Replace or install new drainage facilities where needed (contractor - with special payment for designated ones). See attached Units 4.1 through 4.6.

Open and clean out all water collection and escapement ditches, catch basins, discharge basins and drains so water will be free-flowing without any ponding which could cause a soft or unstable section of the trail tread. Head and footwalls will be repaired to original standards.

Soil from cleaning or constructing drainage will be used to restore tread and/or backfilling eroded areas.

The selection of new or replacement facilities will be based on the following priorities:

Class 1 and 2 trails

1. Outsloping
2. Dips
3. Rock water bars
4. Log water bars
5. Fiberglass culverts
6. Parallel ditches

Class 3 trails

1. Outsloping
2. Dips
3. Rock water bars
4. Log water bars
5. Rock lined cross ditches
6. Log lined cross ditches
7. Rock culverts
8. Wood culverts
9. Parallel ditches

DRAINAGE MAINTENANCE (continued)

Methods (continued)

In determining which drainage facility to use, the order of priorities may not always be possible to follow, depending on terrain features, volume of water involved and soil characteristics. For example, water bars may have to be used rather than dips where soils lack cohesion, such as sandy soils in which dips may erode out or fill in.

The intent of the order of priorities is to use the means which is least disturbing to the natural environment.

Unit 4.1 DRAIN DIPS

Contract Item ___

Description

This pertains to the construction or restoration of drain dips. (Contractor: each new dip location has been staked at the drain point and is listed by station number on the attached location list. The total number of drain dips to be constructed is _____.)

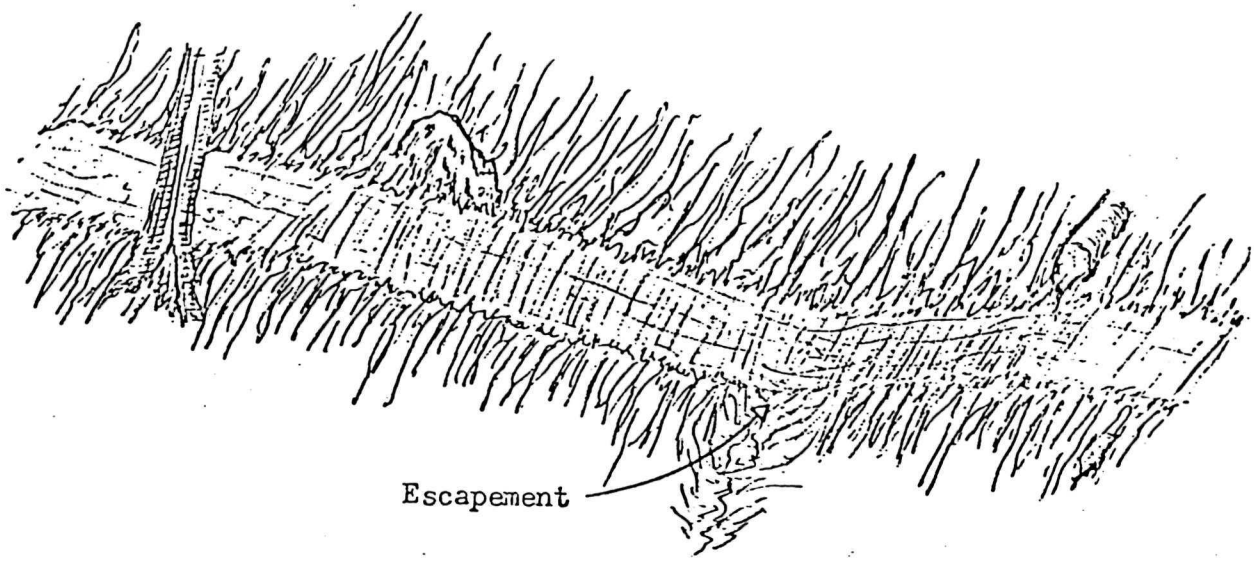
Methods - All Trails

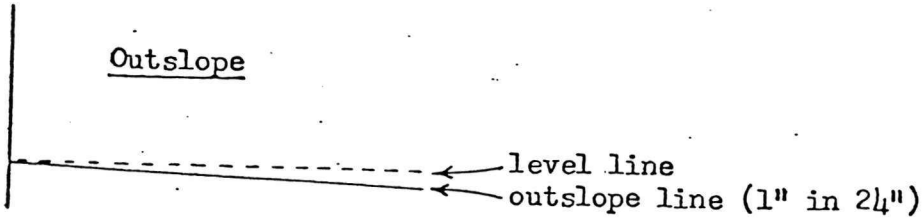
Repair or restoration of existing dips will be to original specifications. Construction of new dips will usually consist of excavating a 12 inch depression in the trail tread at the drain point and sloping the trail evenly into the depression for a distance of 10 feet upgrade and 5 feet downgrade from the drain point. The trail tread will be outsloped 2° to 3° over the full 15 feet of the dip. Depending on the grade of the trail and volume of water, the depression may be less than 12 inches.

A water escapement channel will be cleared, or if necessary an escapement ditch will be constructed, which allows free flow of water completely beyond any portion of the trail tread.

Excavated soil not used in construction of the dip will be used to outslope or repair tread where needed and/or used to backfill eroded areas such as on closed trails. If excess soil cannot be used for these purposes, it will be scattered off the travelway.

DRAIN DIPS





Profile

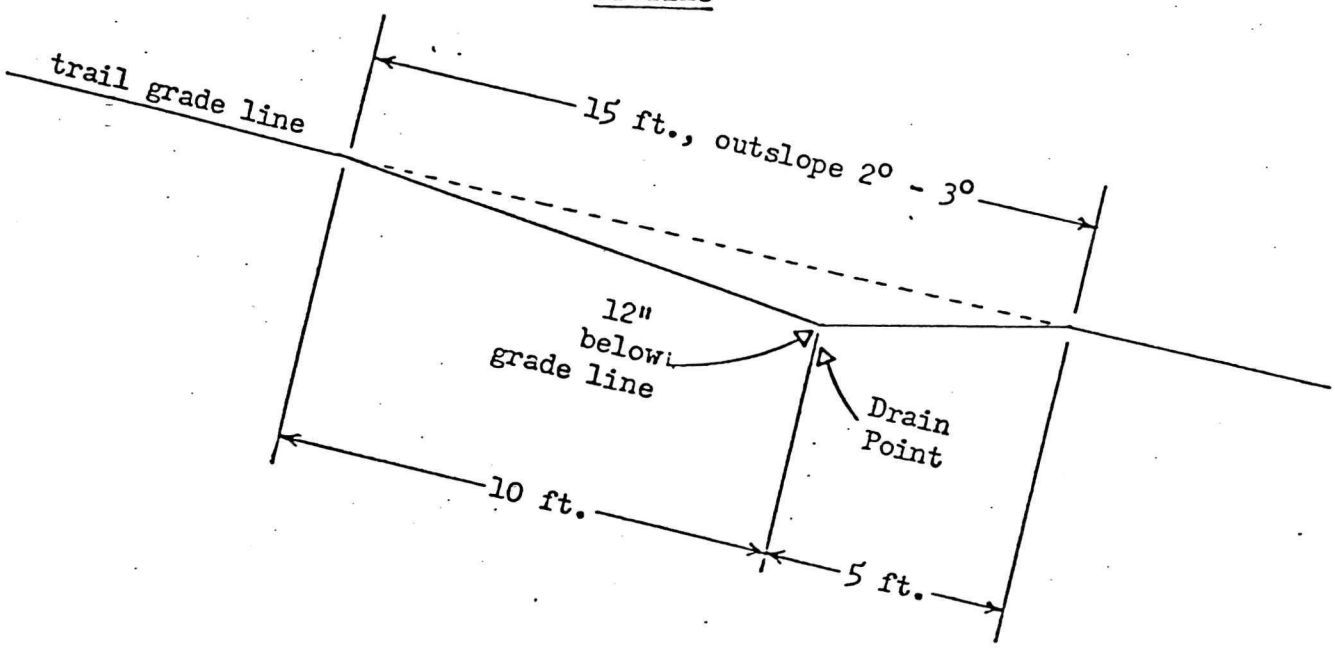


Figure.4.1

DRAIN DIP EXAMPLES

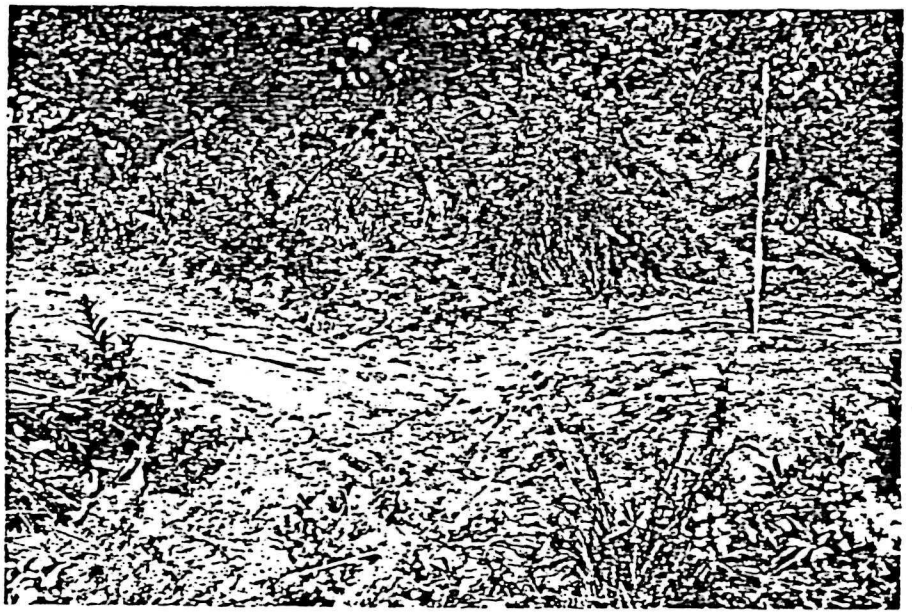


Figure 4.1a

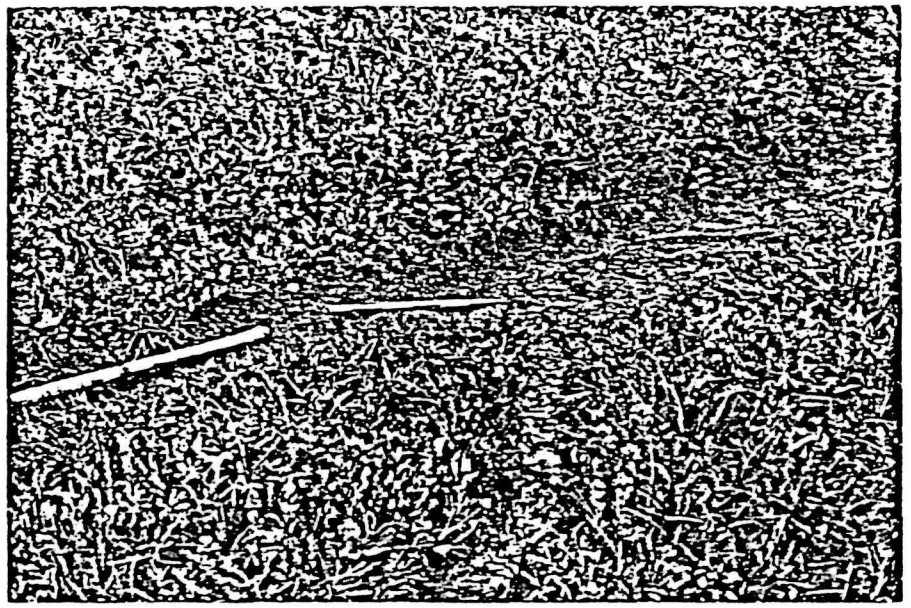


Figure 4.1b

Unit 4.2 WATER BARS

Contract Item ___

Description

This pertains to the repair or construction of water bars. (Contractor: each new water bar location has been staked at the drain point and is listed by station number on the attached location list. The total number of bars to be constructed is: rock bars ___: log bars ___.)

Methods - All trails

Rock and log: The water bar will be laid at a downward angle of about 30° across the trail, depending on trail grade and volume of water. The inside end will be locked into the cutbank and the bar will be buried about ½ its diameter in the tread so it will remain firmly in place under normal trail usage. The outside of the bar will extend to the tread margin. The tread will be flush with the top of the bar on the lower side (downgrade) of the trail.

Rock: use firm rock not prone to crumbling or shearing and large enough to be firmly buried so it can not work loose. Preference should be given to using one large rock rather than several smaller ones whenever possible. Adjoining rocks should be secured against each other so water can not flow between them.

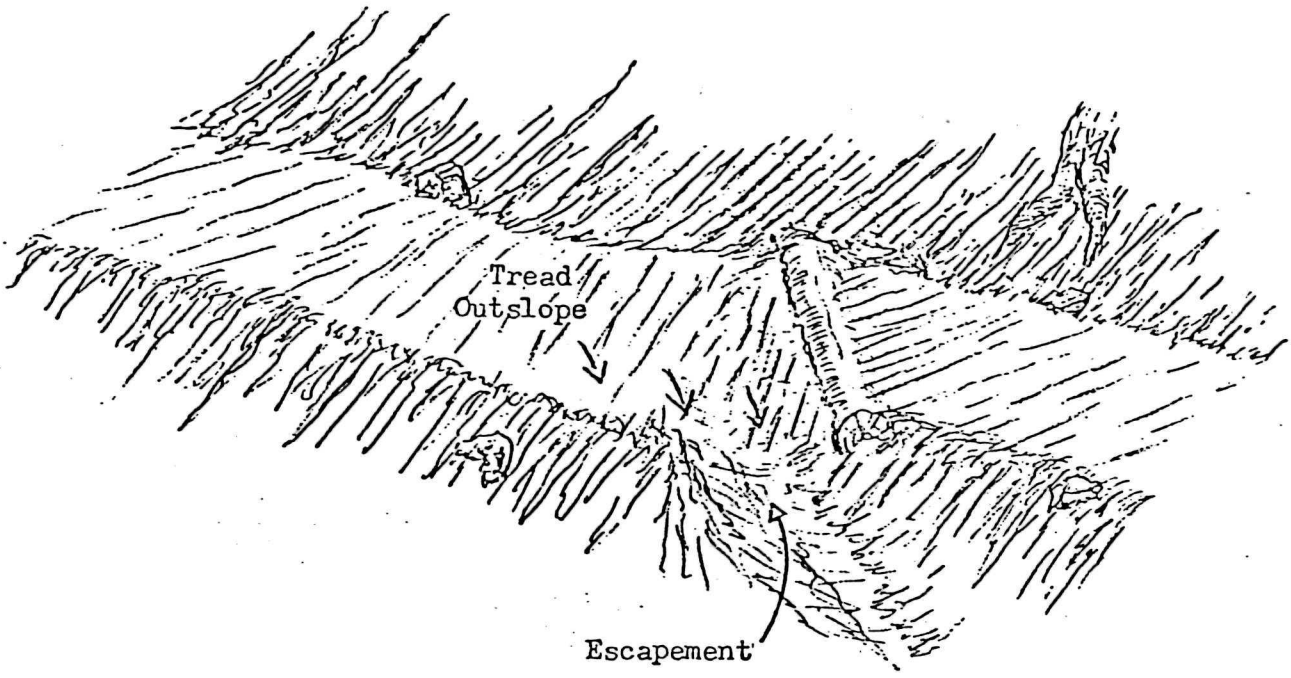
Log: use sound peeled logs, preferably cedar, 6 to 12 inches in diameter.

The trail tread will be outsloped ½:12" for a distance of 5 feet on the upgrade side of all water bars. A water escapement channel will be made which allows free flow of water away from the trail.

When excavating material to lock bars into the inside cutbank, only remove enough material to accomdate the bar. After installing the bar repack any spaces with excavated material. If vegetation has to be removed, try to remove it in a clump and replant it over the bar as much as possible.

Sources of water bar material: see Unit 7.

WATER BARS



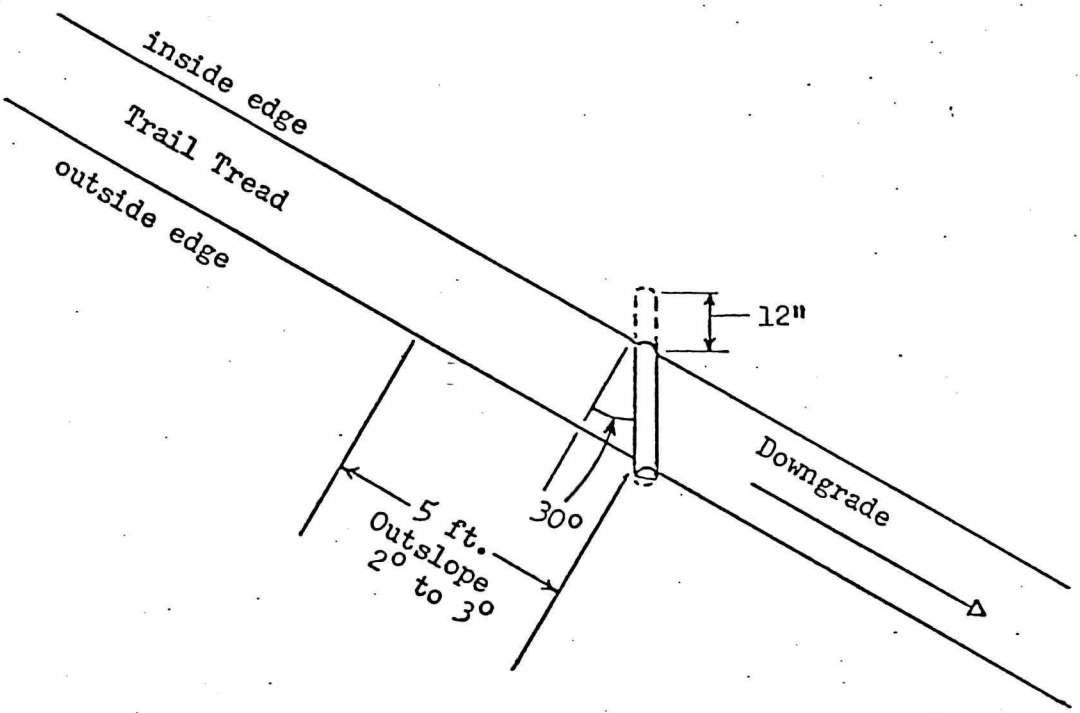
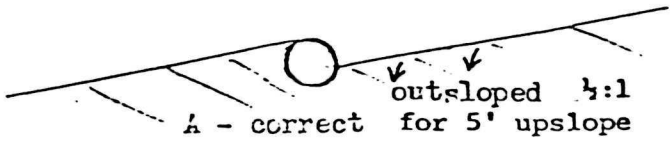
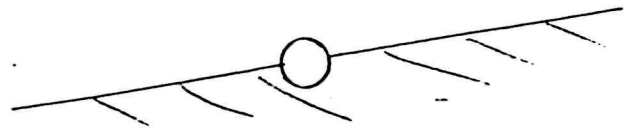


Figure 4.2

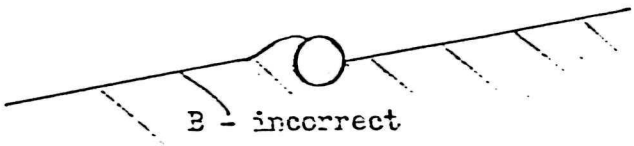
Water bars - rock or log



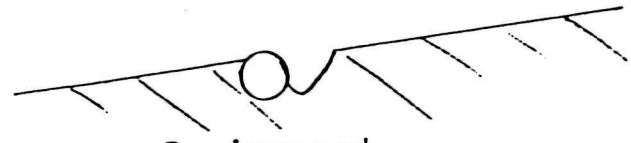
A - correct for 5' upslope



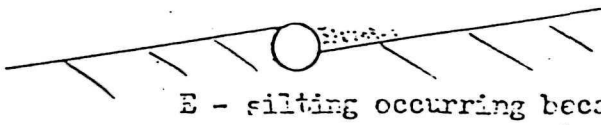
C - incorrect



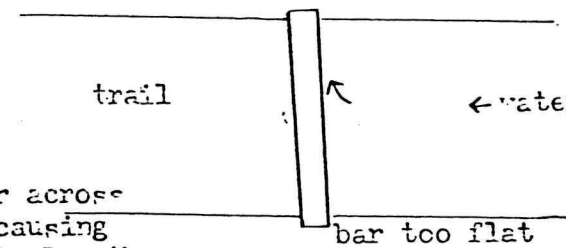
B - incorrect

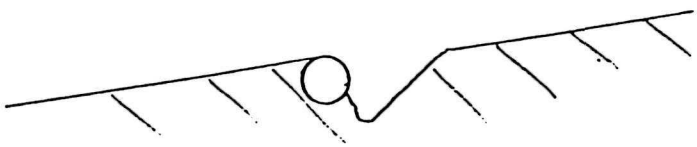


D - incorrect

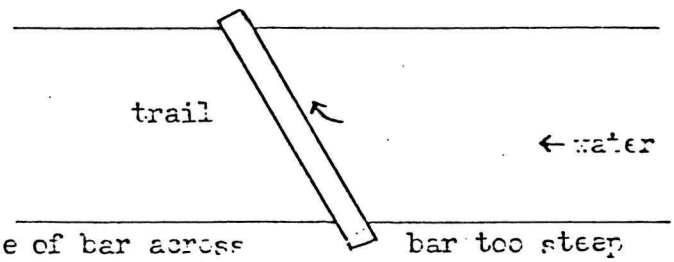


E - silting occurring because angle of bar across trail is too flat causing water to run too slowly, thus not enough speed to carry silt off.





F - erosion occurring because angle of bar across trail is too steep causing water to run too fast, thus speed washes away soil.



As a general rule, the steeper the grade of the trail, i.e., the less the angle of the bar should be across the trail.

Figure 4.2a

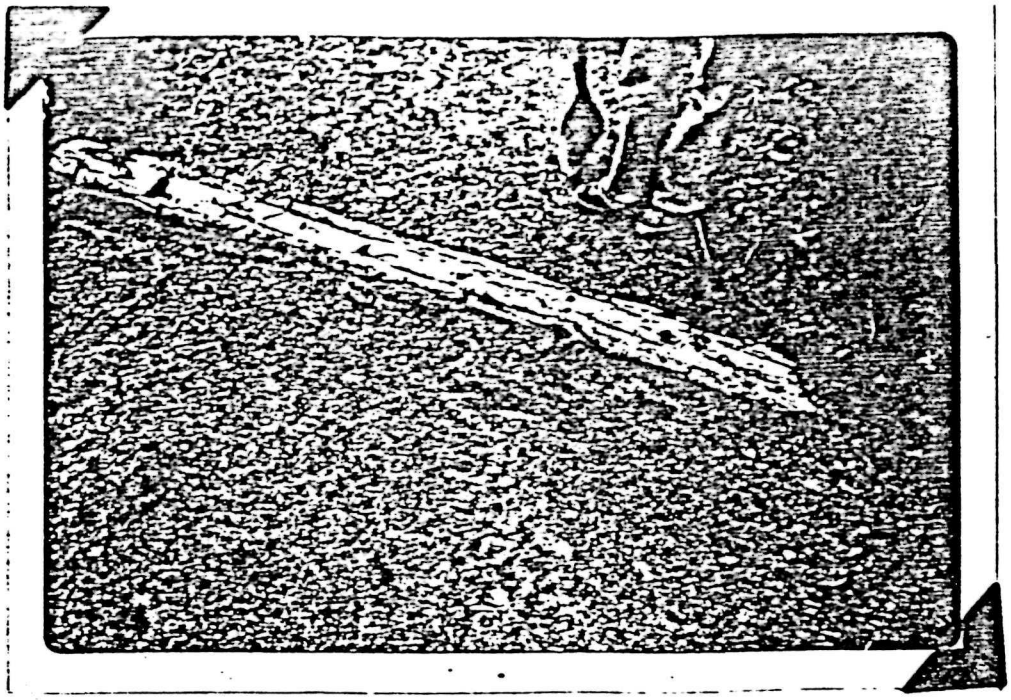


Figure 4.2b

A good example of a proper log water bar. Note the angle of it across the trail. Also it is long enough to completely span the trail and the inside end (right side of picture) is buried into the bank

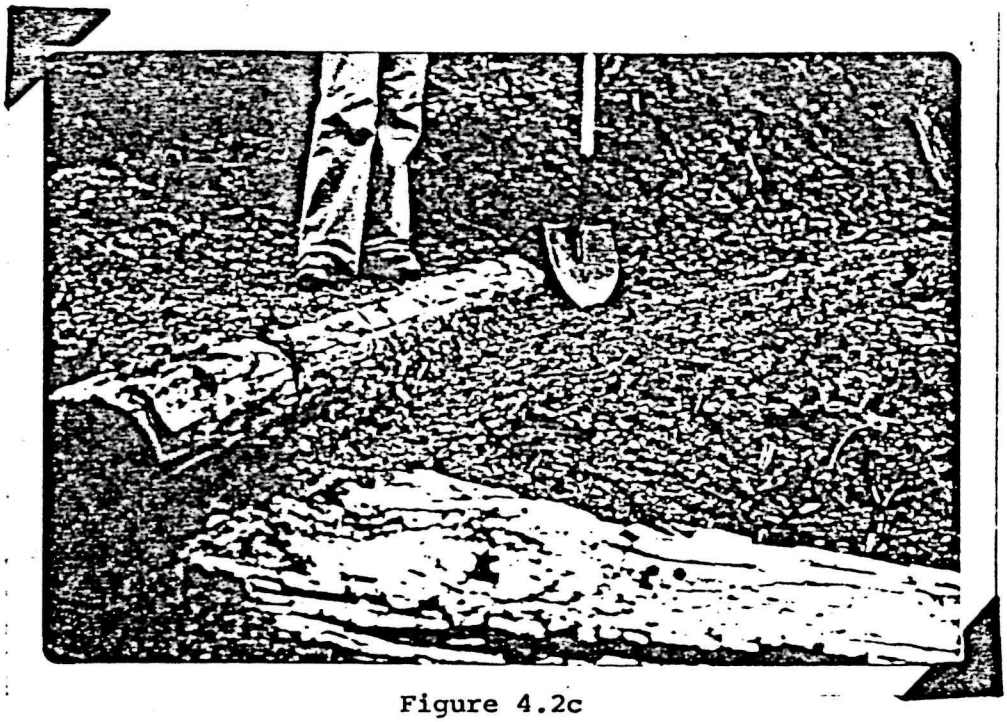


Figure 4.2c

Same water bar. Note that the angle of the trail slopes down gradually to the bar(from right to left of picture). Trail should be sloped this way rather than just a narrow ditch dug next to bar. Where there is only a narrow ditch hikers boots will tend to knock dirt into ditch plugging it. Note also that where person is standing trail comes up evenly to top of bar. See Fig. 4.2d to see what happens when bar is higher than trail.

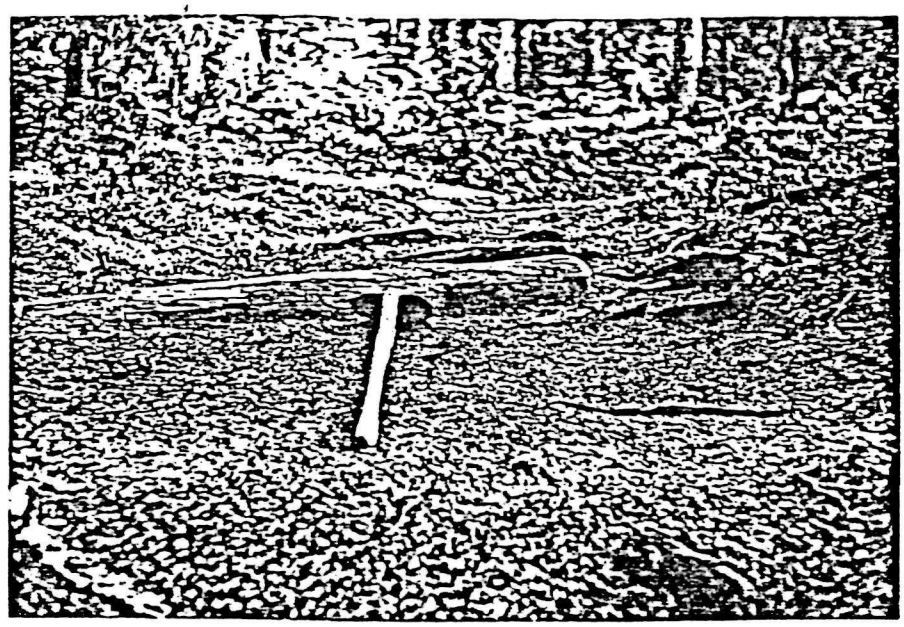


Figure 4.2d

Because this water bar is higher than the trail hikers have walked around it causing erosion and root damage. Water flows through the gap defeating purpose of the bar and causing erosion down trail. This bar should be replaced completely across the trail and the downhill side level with the trail thread. Because the trail is not very steep here a shallow dip or even a ditch might work well.

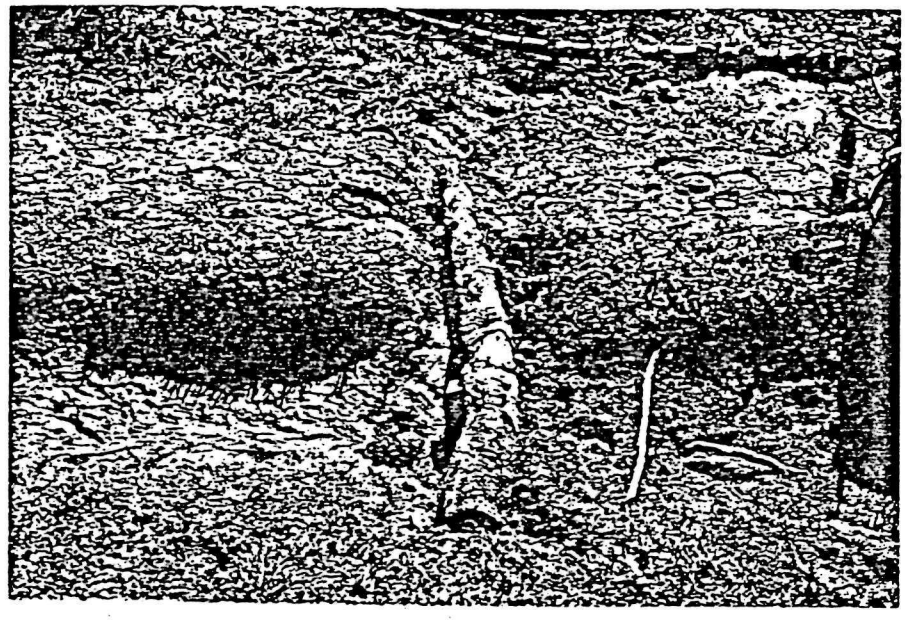


Figure 4.2e

Extremely poor water bar. Straight across trail instead of angled; not locked into bank; and outlet ditch very narrow and easily plugs.

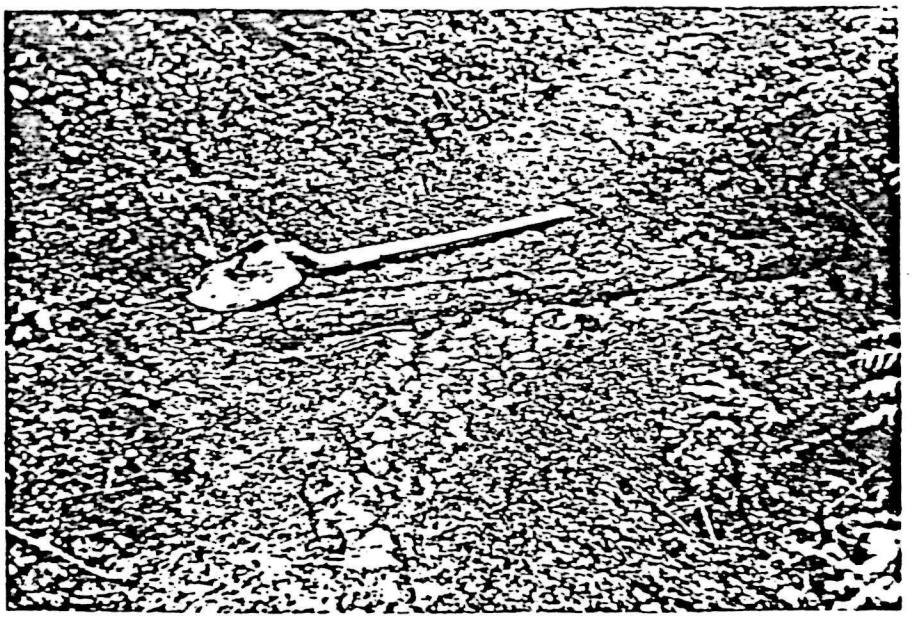


Figure 4.2f

When locking end of water bar into bank remove only enough soil to make room for bar. These pictures show damage from sloppy work in which unnecessary amounts of soil were removed. Lower picture also shows damage to slow growing heather.

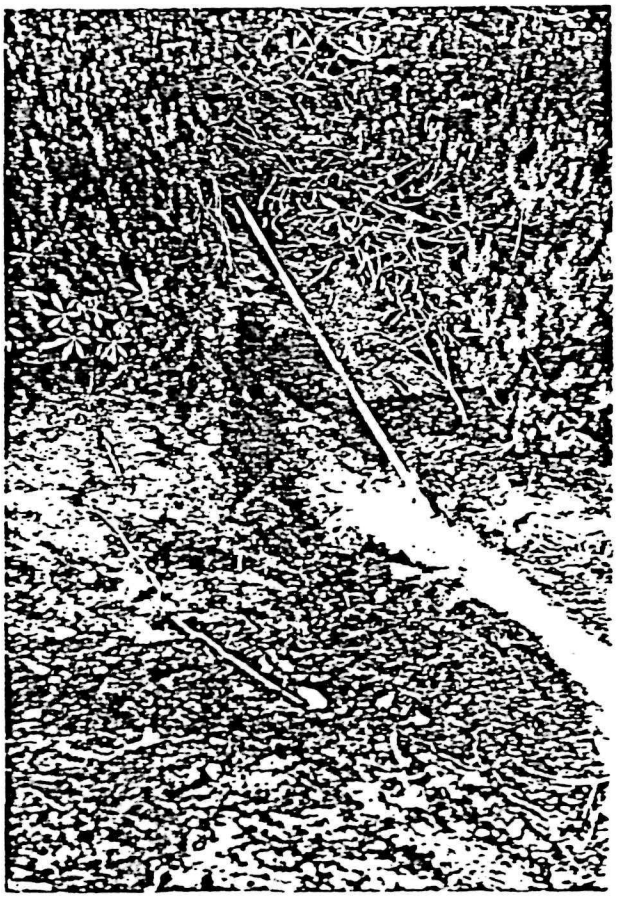


Figure 4.2g

Unit 4.3

CROSS DITCHES

Contract Item ___

Description

This pertains to the maintenance and construction of drain ditches across trails. (Contractor: the number of cross ditches to be constructed is: rock ____; log ____. Location of each is staked at the drain point and are listed by station number on the attached location list.)

Methods - Class 3 Trails

Maintenance of existing ditches will be to the same specifications as for construction of new ones.

Construction will consist of excavating a depression across the trail tread and lining the walls with flat rock not subject to crumbling or shearing or with sound, peeled logs. Rock will be firmly buried below the bottom of the drain so it will not work loose under normal trail use. Rock may be set slightly slope back toward the tread and the bottom lined with rock or may be set at more sloping in a V shape. Logs will be firmly buried in the bottom of the ditch with abutment logs at the level of the tread. All rock or logs will abutt each other.

The ditch will have a down drain slope of at least 2% over its entire length. A water escapement channel will be provided which permits free flow of water away from the trail tread. The trail tread will be flush with the top of the logs or rocks. Cross ditches should be deep enough to carry the maximum anticipated volume of water but no more than 12 inches wide at the top.

Excess soil removed from constructing ditches will be used to backfill eroded areas and/or outslope or restore tread.

Cross Ditches

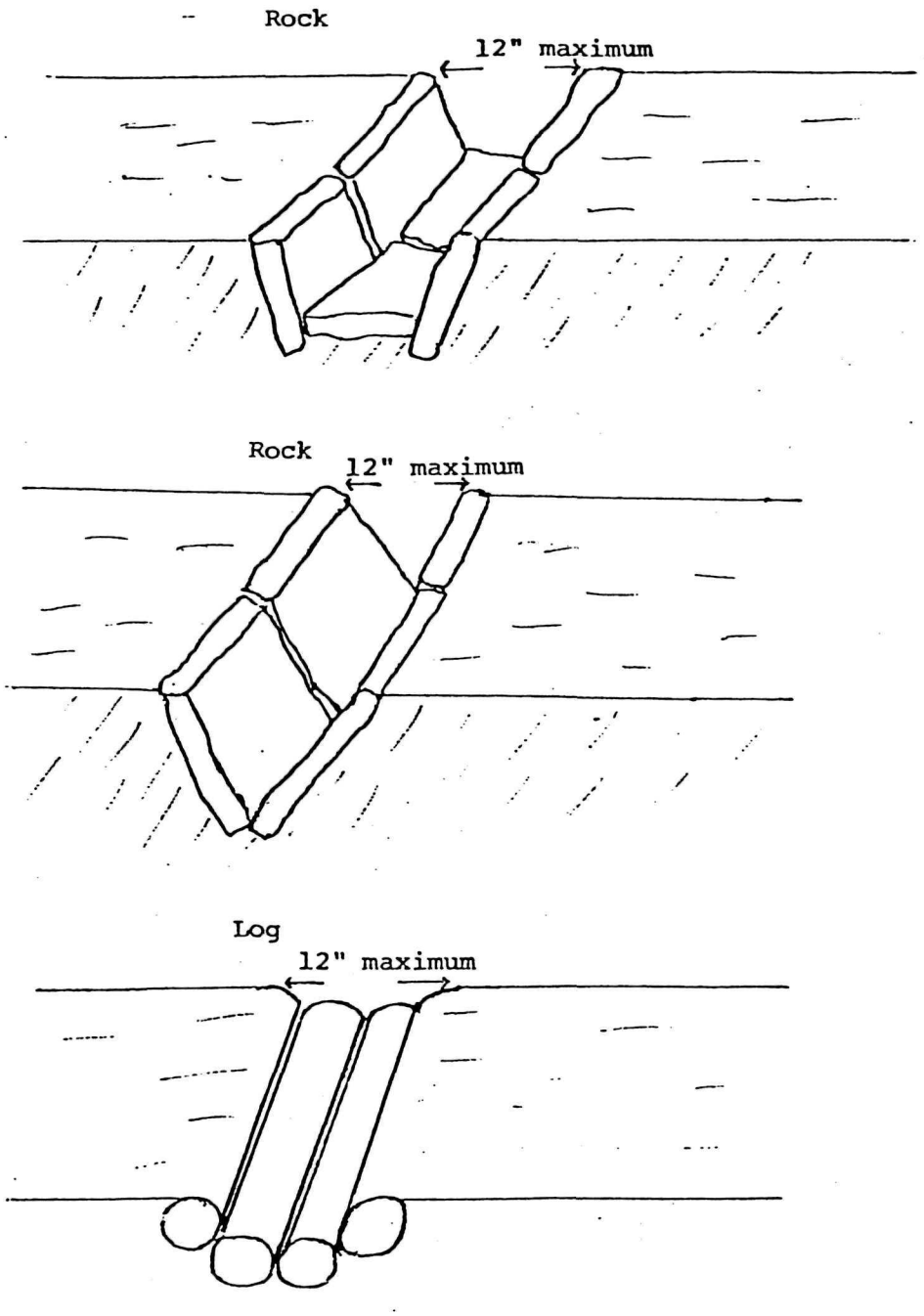


Figure 4.3

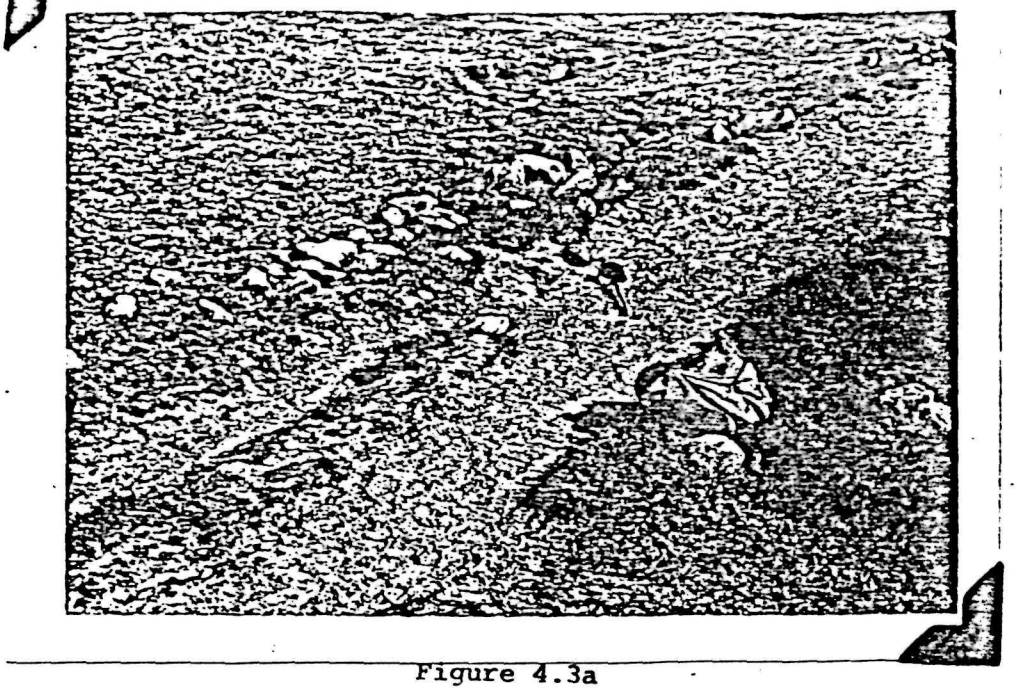


Figure 4.3a

Plugged culvert - note pipe by shovel blade; rest of pipe is buried under trail (under shovel). This culvert plugged because the gradient was not steep enough to allow enough water pressure to clean culvert. Also the length is too long to permit manual cleaning. Because of lack of maintenance pipes eventually separated allowing water to flow down trail causing serious erosion down trail.

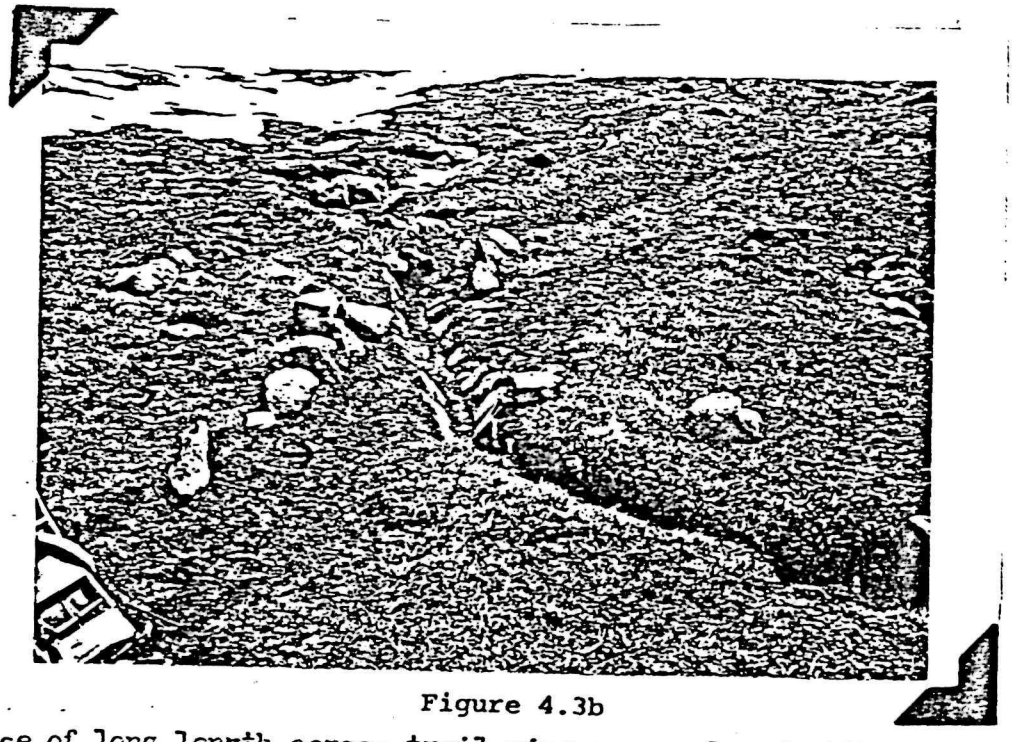


Figure 4.3b

Because of long length across trail, pipe was replaced with rock ditch rather than new culvert. Large, flat rocks firmly seated should be used. Water can now flow into natural stream channel again.

Note use of excess dirt from ditch excavation to fill in eroded areas (red arrows) Note also water now flowing in ditch (1 year later) and placement of rocks to channel hikers into 1 trail.

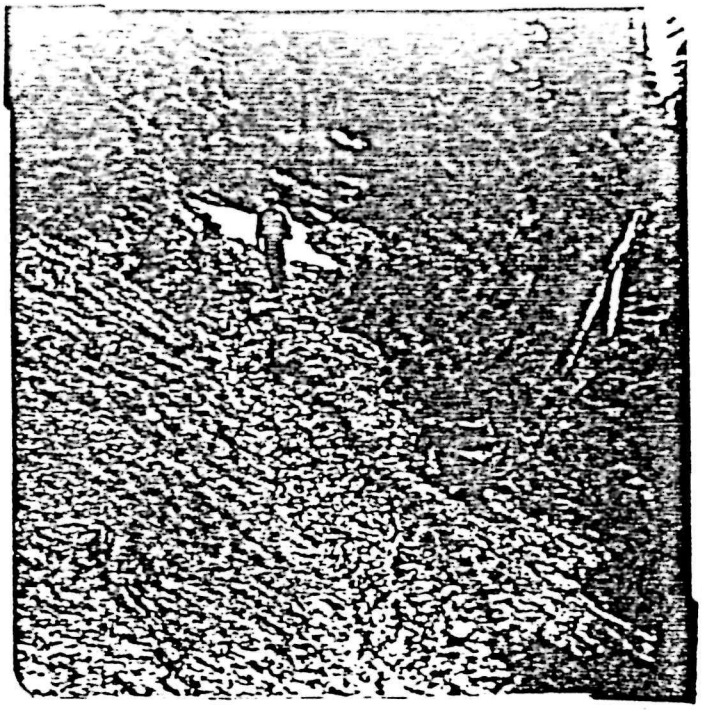


Figure 4.3c

Above- a stream crosses trail where man is standing but due to lack of good drainage most of water is running down the trail.

Below- A rock lined ditch is constructed and now all the water is divert across the trail back down into the stream channel below the trail.

Figure 4.3d

Unit 4.4 WOODEN CULVERTS

Contract Item ___

Description

This unit pertains to the construction and installation of wooden culverts. It includes backfilling of the culvert in place, and construction of a suitable catch basin at the upper end of each culvert installed. The location of each culvert is staked on the ground and listed by station number in the attached location list. Length measurement will be from end to end of each culvert in place.

Methods - All trail classes

The culvert will be constructed of sawn or split cedar or fir planks, with all bark removed, having a minimum thickness of 6 inches. The culvert walls will be spiked onto a sill plank, and a cap plank will be spiked onto the walls in such manner as to prevent culvert collapse from trail compaction (see Figure 4.4.). Guide holes will be bored for spikes to prevent splitting of the wall planks.

The culvert will be bedded in an earth foundation of uniform density, carefully shaped to fit the lower part of the culvert exterior. Where a firm foundation is not encountered at the grade established due to soft, spongy or otherwise unstable soil, all such unstable material will be removed and replaced with rock or other suitable mineral soil to form an adequate support for the culvert. Each culvert will be laid such that a down-drain slope of 2% is achieved over the length of the culvert.

Each culvert will be so laid that the minimum coverage from the culvert to the finished trail surface is not less than 4 inches. The coverage will also be level with the prevailing trail tread. All backfill material will be placed in layers not exceeding 6 inches and thoroughly tamped on each side of the culvert for a distance at least as great as the diameter (given interior dimension) of the culvert.

All drainage ditches leading to the catch basins must be cleaned and adequate drainage for the water must be provided on the downstream side of each culvert by removing all brush, rocks, and other debris which would impede the flow of water.

WOODEN CULVERT

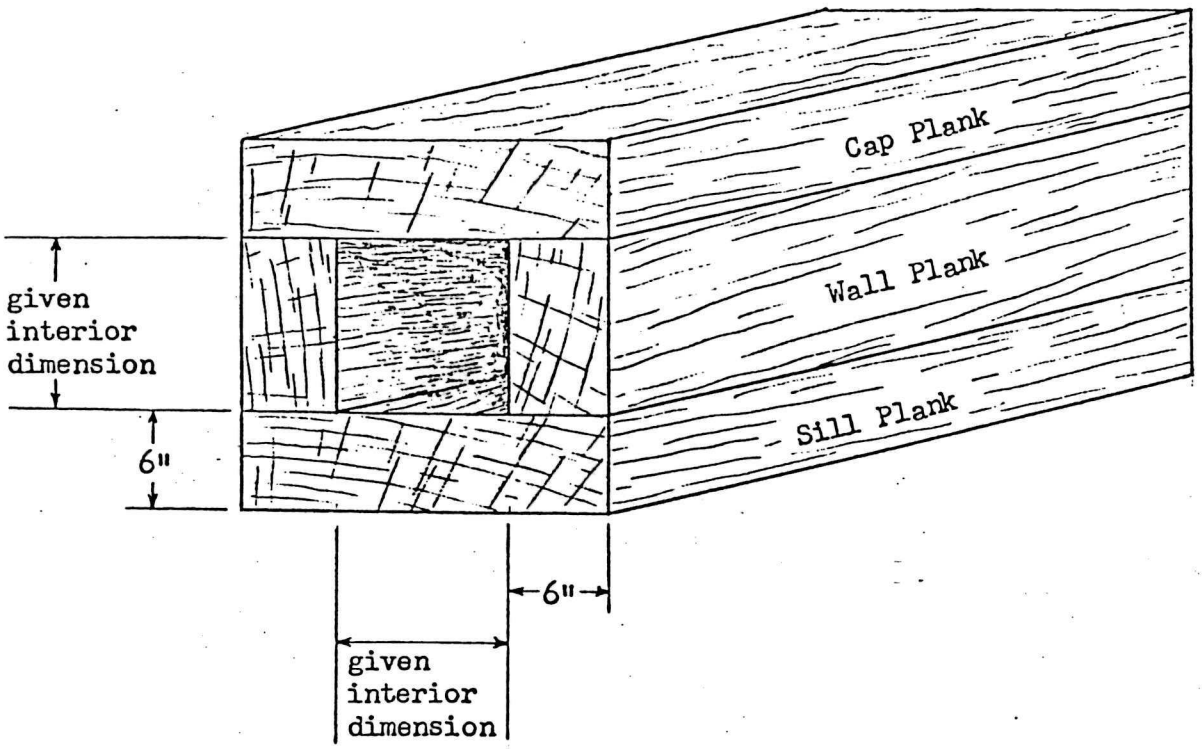


Figure 4.4

Unit 4.5 METAL AND FIBERGLASS CULVERTS

Contract Item ___

Description

This pertains to installation of metal and fiberglass culverts. It includes furnishing, hauling, installing and backfilling of the culverts. It also includes construction of a suitable catch basin at the upper end of each culvert installed. The location of each installation is staked on the ground and listed by station number in the attached location list. Length measurement will be from end to end of each culvert in place.

Methods - Class 1 and 2 trails

The culvert will be bedded in an earth foundation of uniform density, carefully shaped to fit the lower part of the culvert exterior. Where a firm foundation is not encountered at the grade established due to soft, spongy or otherwise unstable soil, all such unstable material will be removed and replaced with rock or other suitable mineral soil to form an adequate support for the culvert. Each culvert will be laid such that a down-drain slope of 2% is achieved over the length of the culvert.

Each culvert will be so laid that the minimum coverage from the culvert to the finished trail surface is not less than 9 inches. The coverage will also be level with the prevailing trail tread. All backfill material will be placed in layers not exceeding 6 inches and thoroughly tamped on each side of the culvert for a distance at least as great as the diameter of the culvert. Both ends of each culvert will be completely masked with rock, soil, or other natural material so that exposed metal does not show.

All drainage ditches leading to the catch basins must be cleaned and adequate drainage for the water must be provided on the downstream side of each culvert by removing all brush, rocks, and other debris which would impede the flow of water.

The corrugated culvert, connecting sleeves, and bolts will be zinc-coated iron or steel or aluminum alloy. All culverts will be at least 16 gauge in thickness.

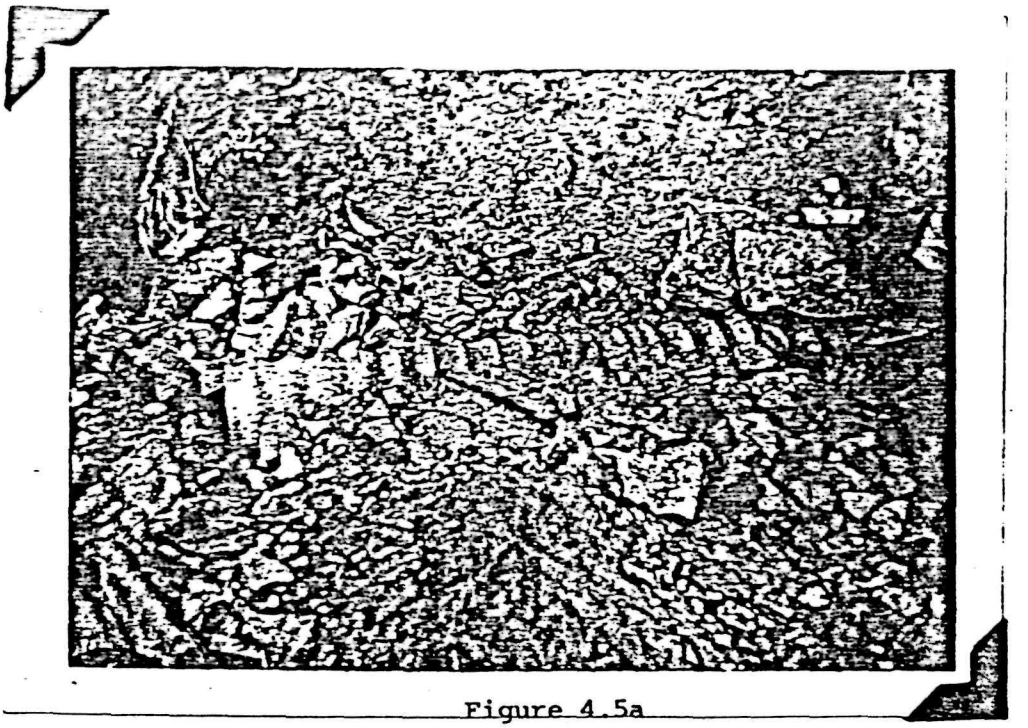


Figure 4.5a

Exsposed culvert - unsightly. This culvert is difficult to keep covered because of the large amount of small, loose rocks in this section of trail. They are easily dislodged by hikers boots and the horse traffic on this trail. Perhaps deeper burial of the culvert would help. Two large rocks on right should be removed from the trail.

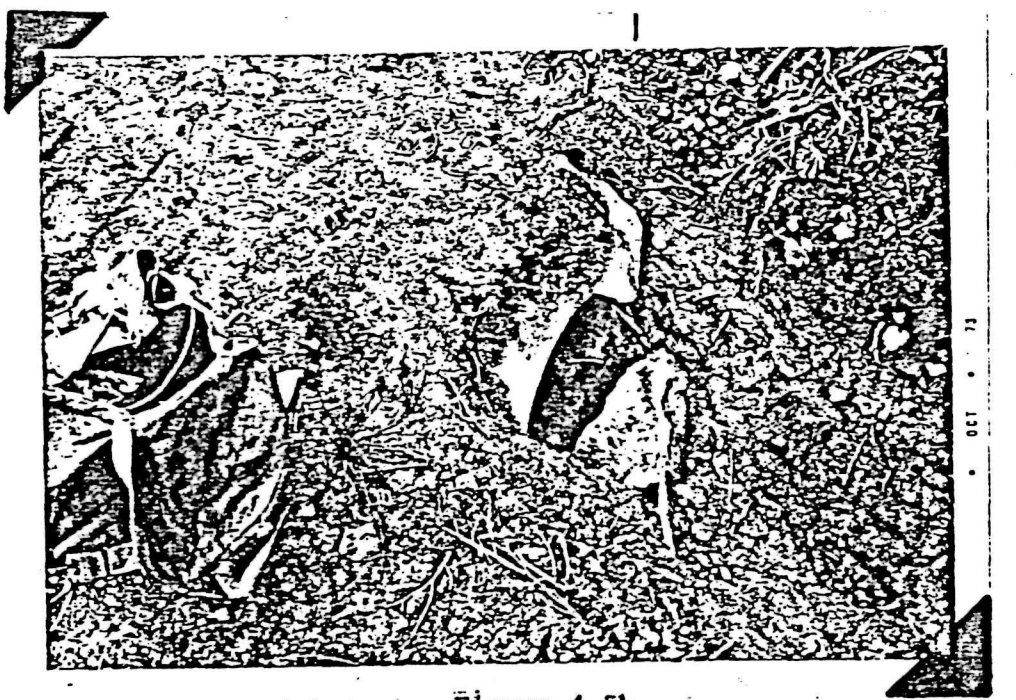


Figure 4.5b

Culvert end is exsposed because it was covered with rocks too small. Larger, flatter rocks would have been firmer. With rocks gone the soil over culvert will eventually be knocked and washed off. Fallen rock is partly blocking discharge end of culvert - this could cause damming and blockage of culvert. For small stream crossings like this, rock lined ditches may be more visual pleasing and require less upkeep.

Unit · 5 SNOW PROBLEMS

Contract Item ____

Description

This unit pertains to problems due to snow remaining on trails during the normal trail use season.

Methods

Cairns; Where extensive sections of trails are covered by snowfields which do not melt on the average until August or later, rock cairns may be erected. They will be located so that, on the average, they melt out by no later than July 15. A cairn may be erected for every 300 feet of continuous snowcover, except they may be closer where there are sharp bends in the trail or the trail goes over very broken terrain. Excess cairns will be removed and the rocks replaced as natural as possible. Rocks will not be painted without approval of the Resource Manggement coordinating Team. Cement will not be used.

Wands: where travelers trample vegetation or cause erosion because they are avoiding a long snow covered section of trail, wands with flagging attached can be placed to keep travelers on the snow. They should be set at least 18 inches in the snow. They will need to be checked and reset at least every 10 days or sooner. Wands should then be relocated as directly over the trail as possible so that as travelers tramp a defined trail in the snow it will eventually be worn and melted down to the maintained tread and not on vegetation. Wands will be removed and packed out as soon as each is not need. Flagging will not be tied to trees or bushes.

Other trail defining methods to be used where travelers are trampling vegetation or causing erosion because of a short section of snow cover:

1. Tramp trail in snow. This will require walking across the snow several times to adequately define a path.
2. Dirt from cleaning water drainage facilities can be thinly (1/16") broadcast over the snow. A thin layer will absorb heat from the sun and melt down, thicker layers insulate the snow. The dirt also attracts travelers to follow it.
3. Shovel a path or series of steps, especially on slopes where footing is poor and travelers may seek out vegetation for better footing.
4. Buried seismic wire - this will be used only on Class 1 and 2 trails and must be buried 12 inches unless bedrock or boulders prevent this. Wire should be buried in centerline of trail. Both ends of wire will be hidden from view and locations marked on a detailed map.

Figure 4.6e

Parallel trails on slope - trail on left is the original trail. Due to lack of drainage it eventually became deep and muddy so hikers began walking to the right and established a new trail (where hiker is). Eventually this trail too could become like original one and then hikers might start forming a third trail.

Solutions: (1) Reroute trail. (2) Gravel trail to reduce mud. (3) Build turnpike. (4) Build puncheon. (5) Drain water from trail on right into trail on left making left trail a parallel ditch.

Alternative (5) could be done by placing a series of dips or water bars on the trail on right to drain water into trail on left, making left trail a parallel drain ditch. A series of check dams should be installed in the parallel ditch to prevent further erosion of it. Wherever terrain permits water should be drained from parallel ditch by providing discharge points.

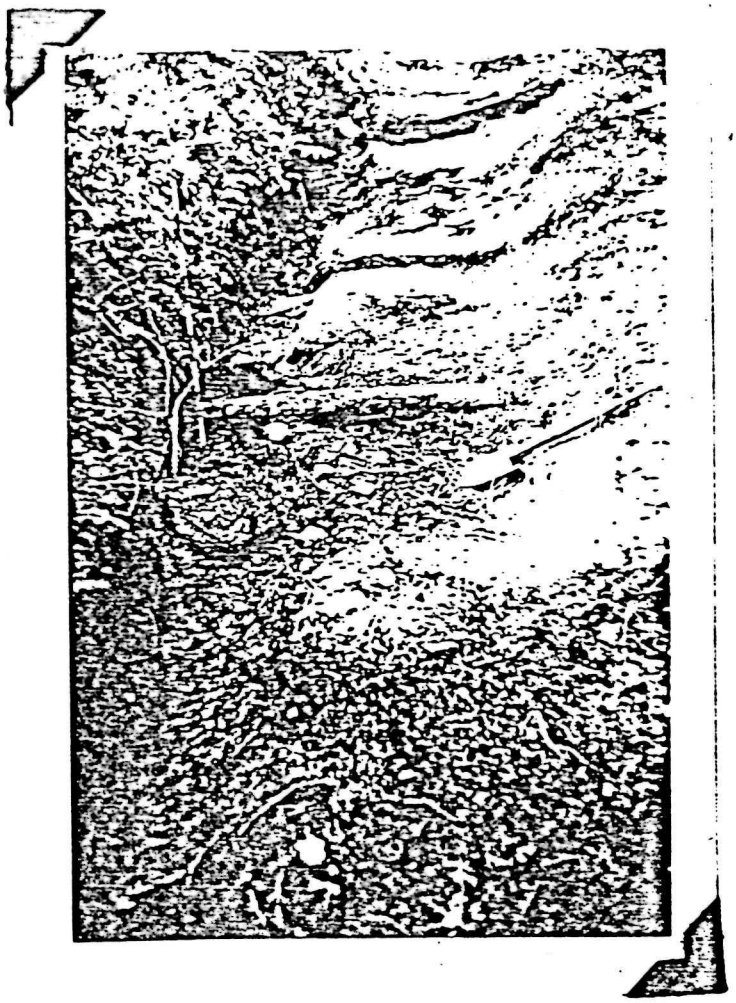


Fig. 4.6c

Ditches parallel to the trail are <u>not</u> desireable but sometimes are the only solution. This occurs usually where the trail is lower than both banks and sub-surface water flows out of the tubbanks and onto trail. If possible the ditch should be rock lined to halt deepening erosion, or add a series of check dams.

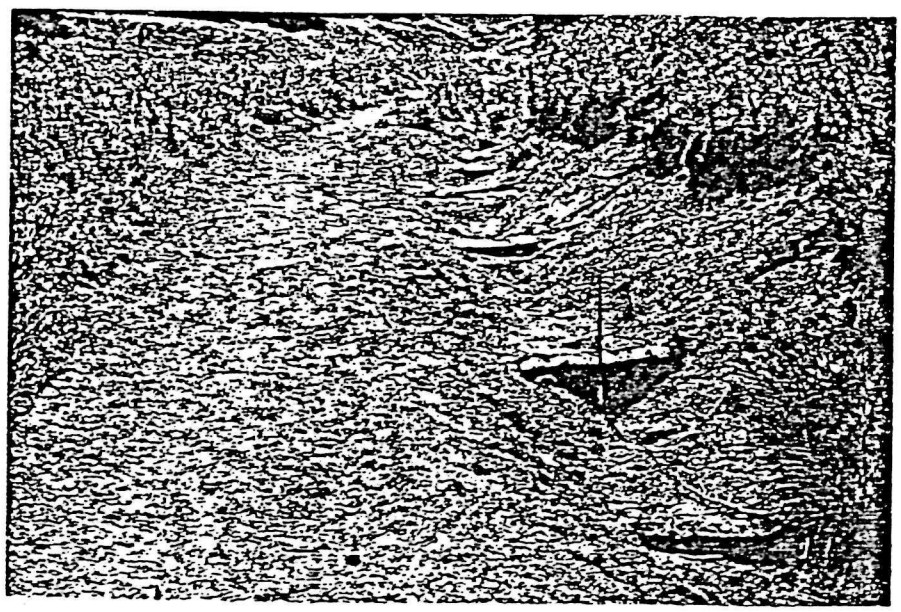


Figure 4.6d

Parallel ditch with check dams to retard erosion. Such dams should be set a few inches lower than trail, so water won't spill over them into trail. as in this picture

Figure 4.6a

Newly dug parallel (lateral) drain ditch. Used where subsurface water seeps into trail in many places and trail cannot be outsloped.

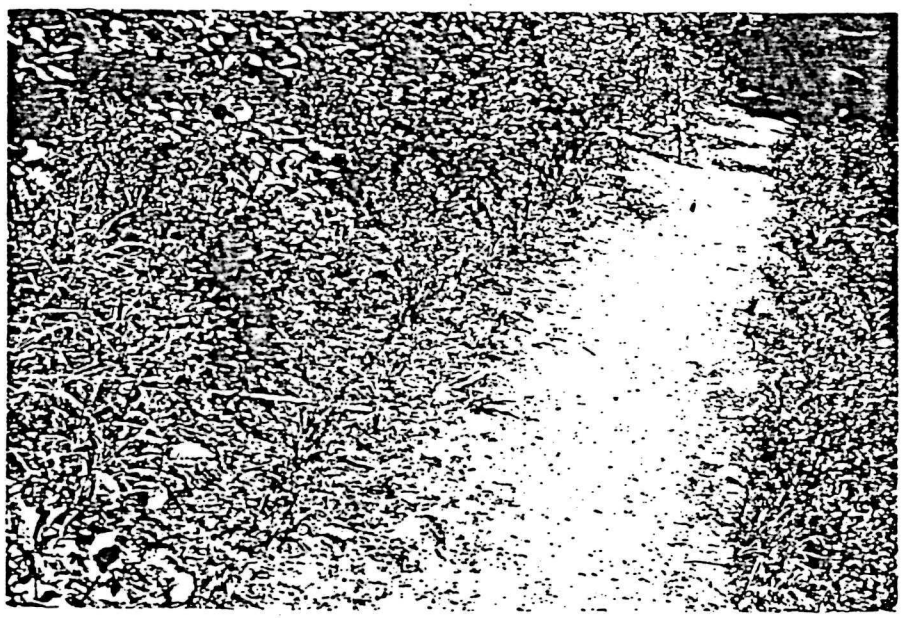


Figure 4.6b

Parallel ditch a few years after being dug. Note edge between it and trail has grown in nicely stabilizing soil dug from ditch and ditch bank and largely hiding ditch from hikers. Ditch must be kept cleaned but do not disturb plants <u>beside</u> ditch.

Unit 4.6 PARALLEL DITCHES

Contract Item ___

Description

This pertains to the maintenance and construction of parallel (lateral) drain ditches. (Contractor: the number of parallel ditches to be constructed is ____; total linear feet is _____. Location of each is staked at head and discharge points and are listed by station number on the attached location list.)

Methods

Maintenance of existing parallel ditches will be to the same specifications as for construction.

Construction of parallel ditches will consist of excavating a depression parallel to the trail tread wide enough to carry the anticipated volume of water and maintaining a ditch bank slope of 1:1. Cross ditches will be installed to drain the parallel ditches at approximately 25 foot intervals or as terrain permits. On Class 1 and 2 trails culverts will be used instead of cross ditches.

Where terrain and water flow permit parallel dithces will be constructed at least 1 foot from the trail tread margin and vegetation allowed to grow between the ditch and the tread margin.

Where the gradient or soil conditions may cause erosion of the ditch the ditch will be lined with rock or check dams will be placed. The check dams will be set so the top of the dam is below the trail tread so the anticipated volume of water will not overflow onto the trail tread. Check dams should be placed at least: no more than 25 feet apart on slopes of up to 20^{o}; no more than 15 feet apart on slopes of 20 to 30^{o}; no more than 10 feet apart on slopes in excess of 30^{o}.

Excess soil removed from constructing parallel ditches will be used to backfill eroded areas and/or outslope or restore tread.

SNOW PROBLEMS (continued)

No matter which method is used, if travelers have already created a path on the snow in the wrong place (not over the tread), this path will be blocked by shoveling snow on it, or at least on ends on a very long section.

Snow bridges: over stream crossings and gullies the snow may be melting from beneath creating a thin bridge. These will be knocked down and a path shoveled so that travelers will use the crossing structures and not damage stream banks.

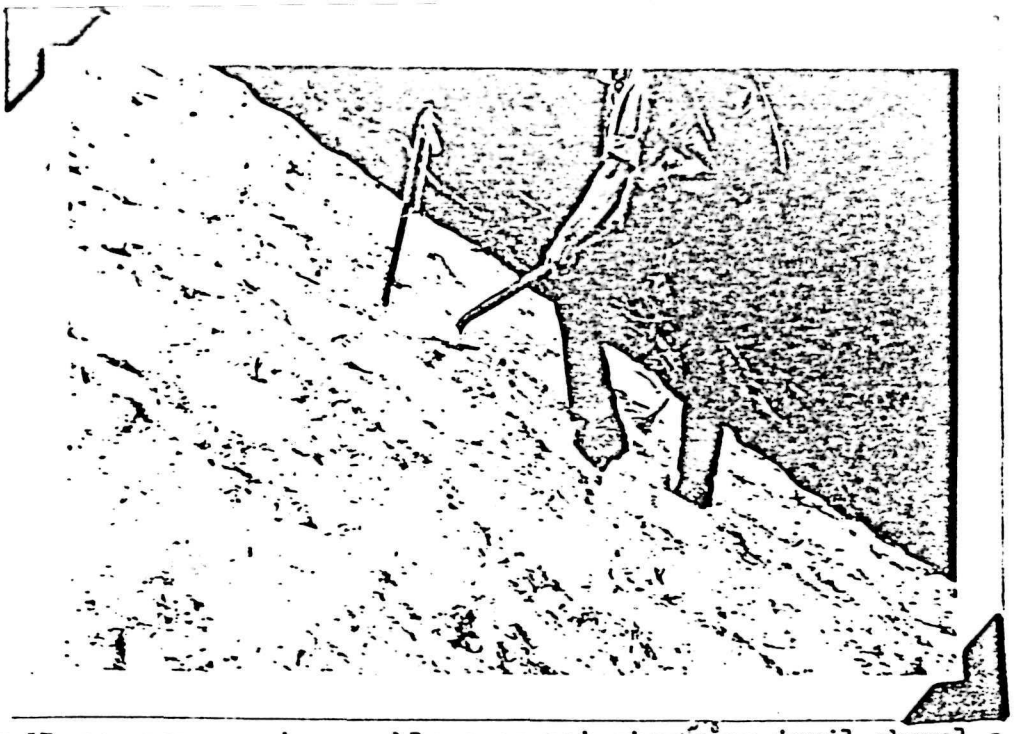


Fig. 5a Where snow creates problems on not stay over trail shovel a path, wand, tramp or spread a very thin coat of dirt over trail -if you are sure where trail is under snow.

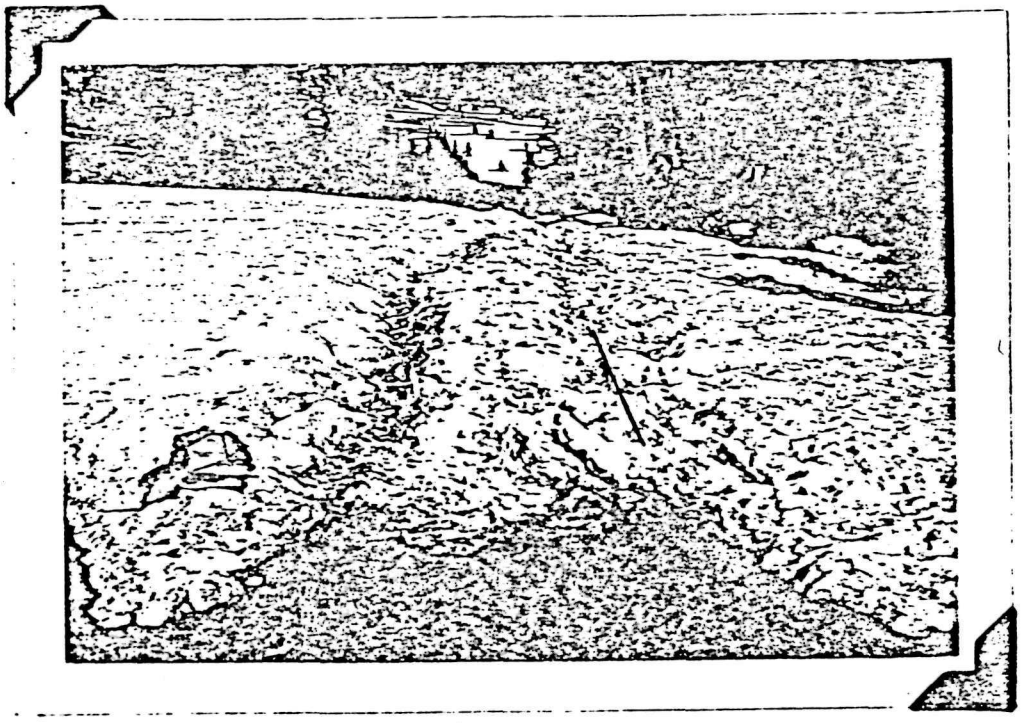


Fig. 5b Trail is under snow -dark area just below and to right of pack. Hikers were walking to right (by shovel handle) and thus off trail onto meadow. Snow was shovelled to block off both ends of this informal trail. A light coating of dirt from nearby water bar runoff was broadcast over correct location causing rapid melt of snow and defining trail. If not positive of trail location, check every few days and reshovel and redirt to coincide with proper location. Dirt must be broadcast lightly and evenly - just enough to still see snow beneath it.

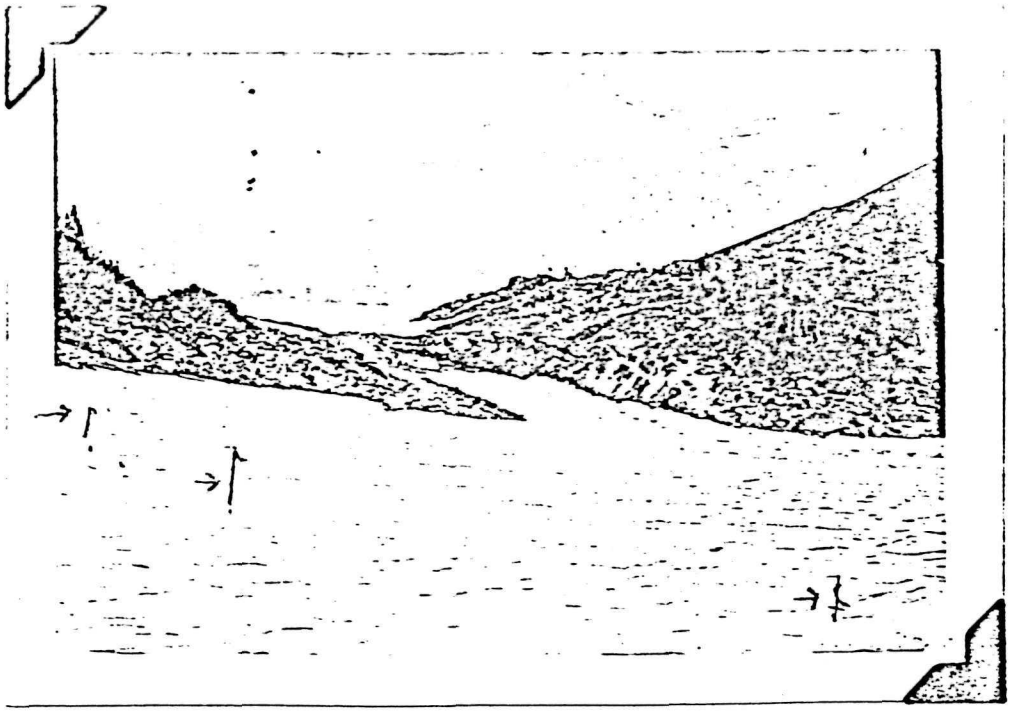


Fig. 5c Temporary wanding (red arrows) over proper trail is a good method to prevent damage. Note snowfree informal trail on steep bank in background where hikers go if not wanded. Wands should be set deep in snow and rechecked at least weekly during hot weather. As trail melts they can be reset into better locations over trail. Remove wands when path is well enough defined and they are no longer needed. In some cases ribbon may be tied to trees but it should be low enough so it can be reached as snow melts and removed. Wands and flagging should only be used to prevent resource damage.

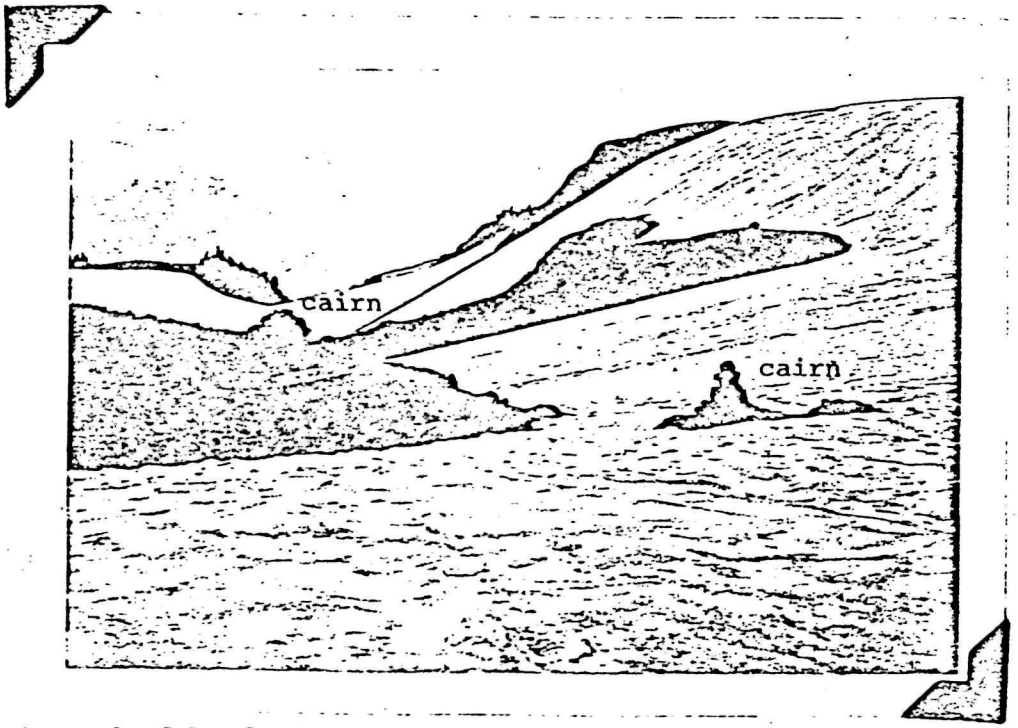


Fig. 5d Cairns should only be built with District Managers ok. Proliferation of improperly placed cairns causes resouce damage and impinges on backcountry experiences. Note there are two cairns - lower one melts out later than upper - result of poor planning. Before building cairns snowmelt patterns should be studied. Do not paint cairns or rocks.

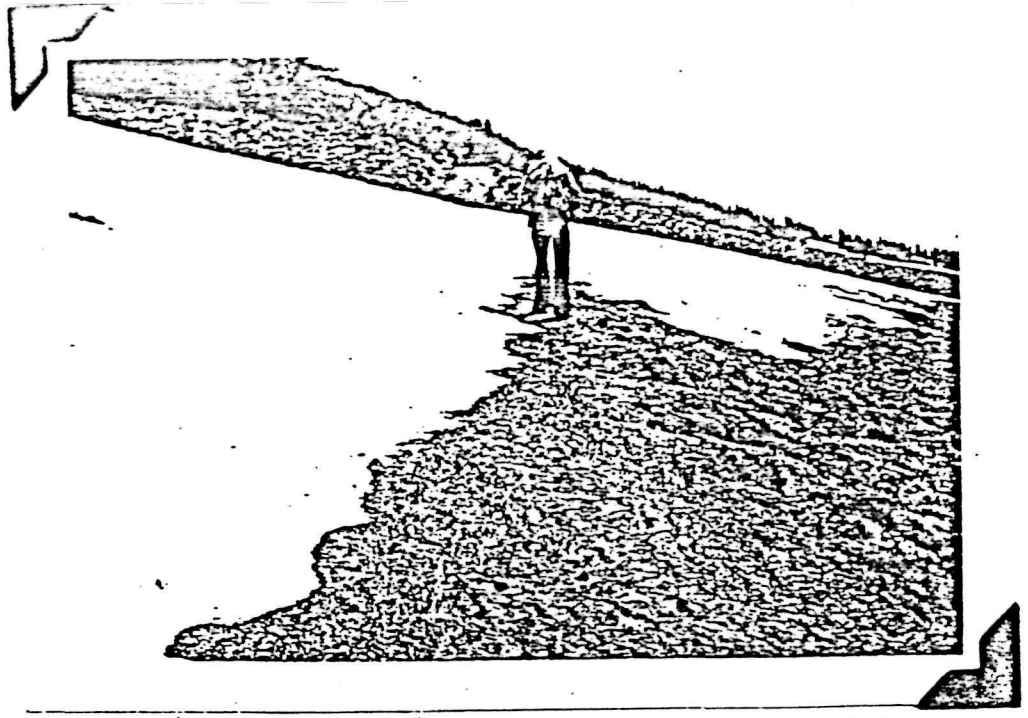


Fig. 5e Where snow is just melting from trail, or where patches cover trail, hikers may walk on edges of trail or on vegetation. Leads to trail widening and vegetation damage as in photo below.

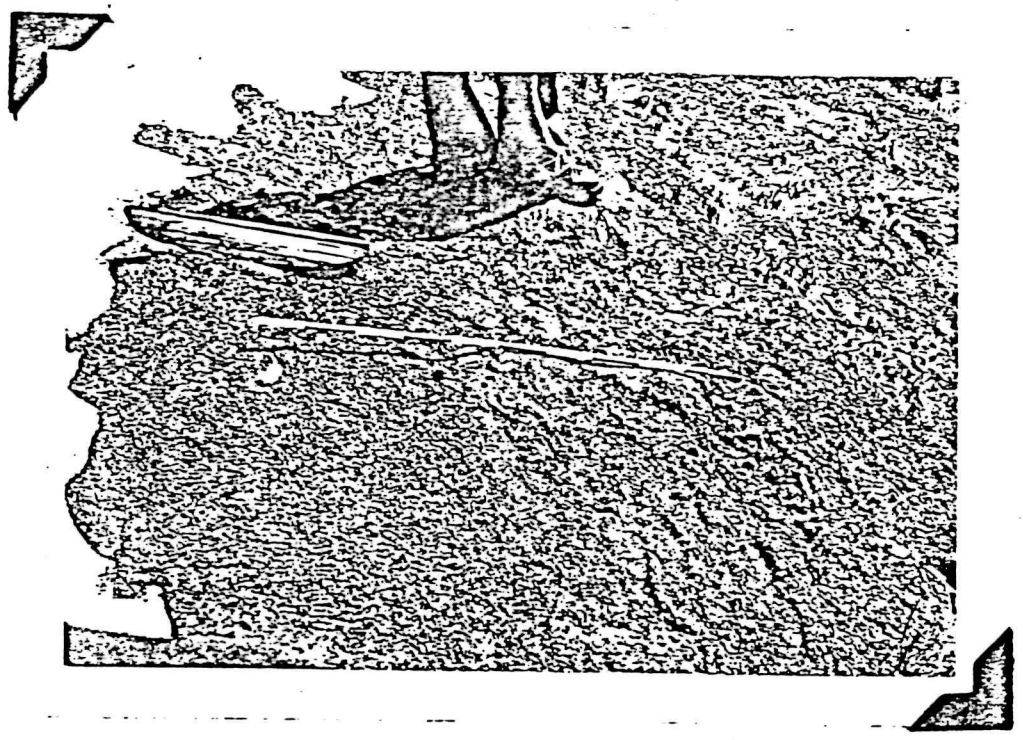


Fig. 5f Trail widening and vegetation damage from walking around late snow.

A trail should be marked by shoveling, tramping, wanding or dusting over the snow to keep hikers from walking on edge or below edge of trail.

Unit 6

RESTORATION

Contract Item ____

Description

This unit pertains to restoring to as near original natural conditions as possible any abandoned trail or closed section such as shortcuts and social trail, and other altered areas when so designated.

Methods

When a section of trail is abandoned steps will immediately be taken to restore it. For sections that have been abandoned in the past but not restored the trail supervisor will program restoration work for the earliest possible time.

Restoration work will include the following used in order of priority:

1. Correct source of any problems, such as source of water flowing into and down trail, or travelers taking shortcut into abandoned trail.
2. Where erosion has occured fill in. If fill material is not available (see Unit 7) install check dams to halt further erosion and allow backfilling to occur. Rock or log dams will be spaced as follows: no more than 25 feet apart on slopes of up to 20°; no more than 15 feet apart on slopes of 20 to 30°; no more than 10 feet apart on slopes in excess of 30°. Further stabilization may be accomplished by the placement of rocks in areas of sheet erosion, or use of jute net or other biodegradeable covering agents, such that the speed of water runoff is impeded and gullying and rilling inhibited.

3. Where trail was originally built on sideslope and sidecast was used as fill for outer edge of tread, this sidecast will be pulled back into cut. See figure 6a & b.

4. Once cuts and erosion have been filled plant growth needs to be established. Specific information on the best methods to use for the area conditions can be obtained from the Area Ranger, Area Resource Technician or Resource Management Specialist.

5. The areas being restored must be blocked from use and if possible from being seen. This can be accomplished by laying logs, limbs, brush and rocks on the area. Use of signs must have the concurrance of the District Ranger.

RESTOPATION, (continued)

Shortcuts and social trails: crews will be alert for these beginning to form and will immediately block and obscure them with logs, limbs, rock and brush.

Trail narrowing: where trails exceed width standards they will be narrowed to appropriate standard. There are two ways to do this depending on circumstances:

1. For trails cut on a sideslope, part of the sidecast can be pulled in. If plants are present they should first be removed with large root ball and replanted into the remaining sideslope.

2. For non cut and fill trails, block the appropriate width with natural debris such as down logs, limbs, brush, rocks and fill. Place material in a scattered or irregular pattern, so it does not look artifical. Rocks and logs should be partly buried and the weathered side up (side previously exposed to air). Compacted ground can be loosened to aid natural seeding or other methods for establish plants can be used.

Trail Narrowing Techniques

Berm removal

Move berm material (A) into trail or road cut (B).

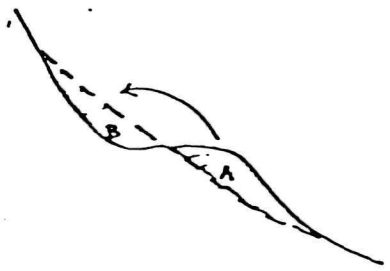


Figure 6a For complete trail eradication

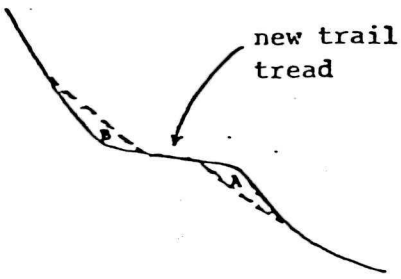
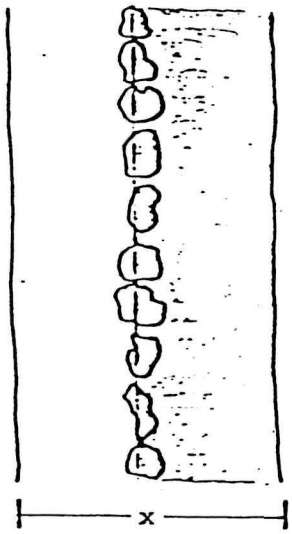


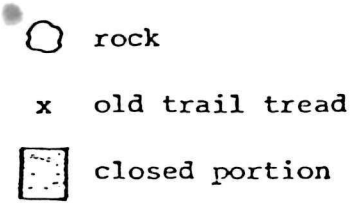
Figure 6b For a narrower trail tread

Partial trail blockage

Rocks, transplants or forest debris can be used to channel use into a narrower section.

Rocks





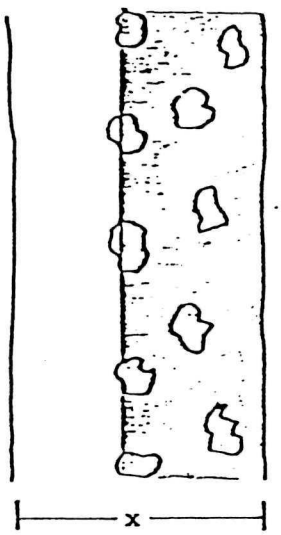


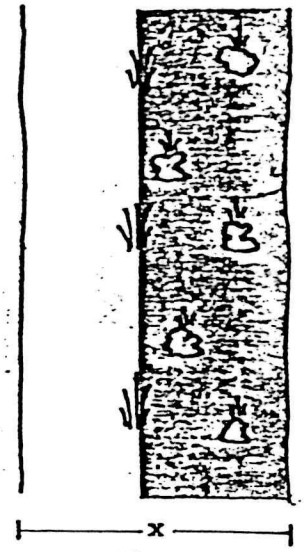
Figure 6c Rock border

Figure 6d Scattered rock

This technique is most effective.

Trail Narrowing Techniques

Large transplants



large transplants spaced 5 ft. apart

small transplants

rocks placed near transplants for protection

closed portion

x old trail width

Figure 6e Trail defined by scattered transplants

Forest trails

nursery log

rotten log

transplant

rock

closed portion

x old trail width

Figure 6f Trail defined by forest debris and transplants

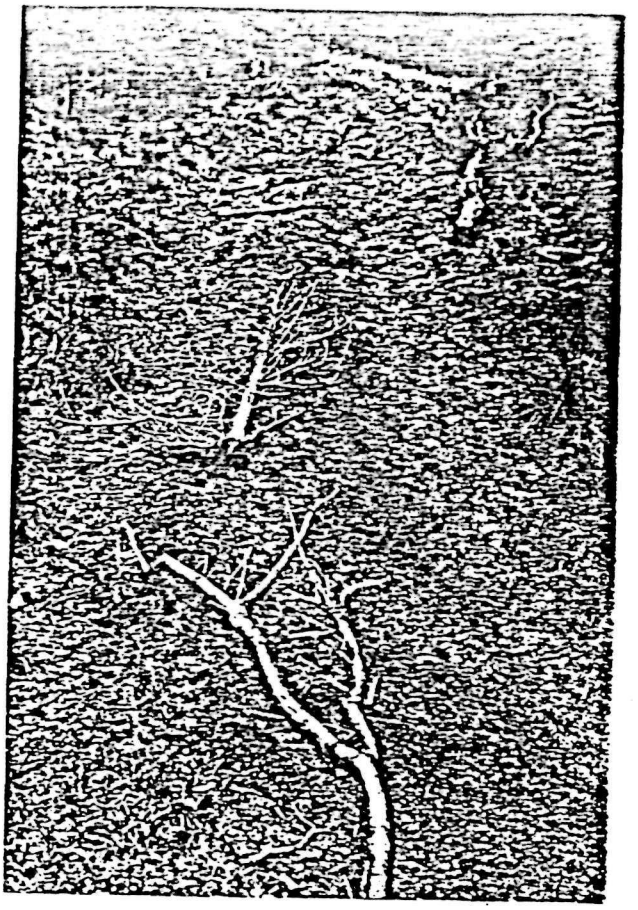


Figure 6g

Excessivley wide trails should be narrowed to park standards. Trails closed to stock use need only be 18" wide on the thread. These pictures show examples of laying limbs to discourage use so trail can grow in narrower.

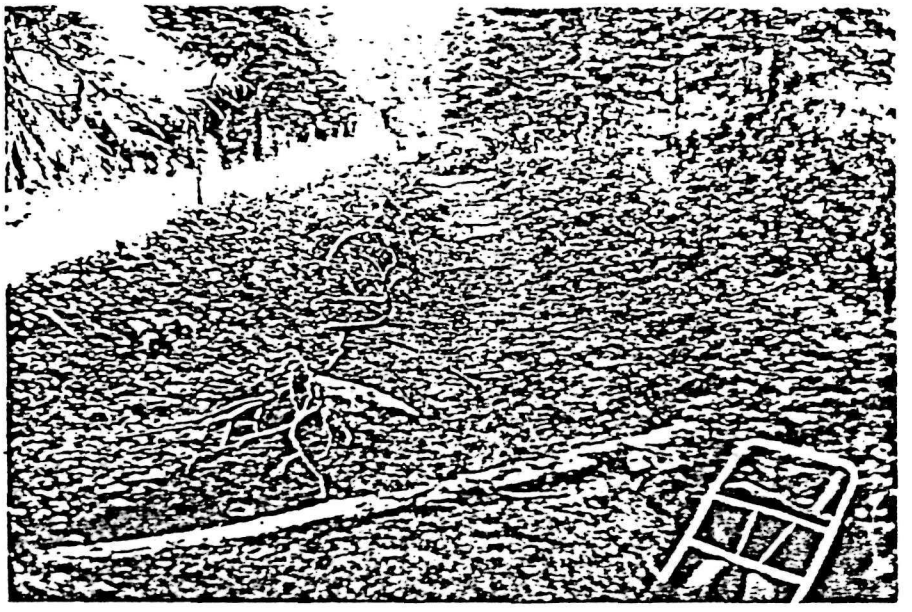


Figure 6h

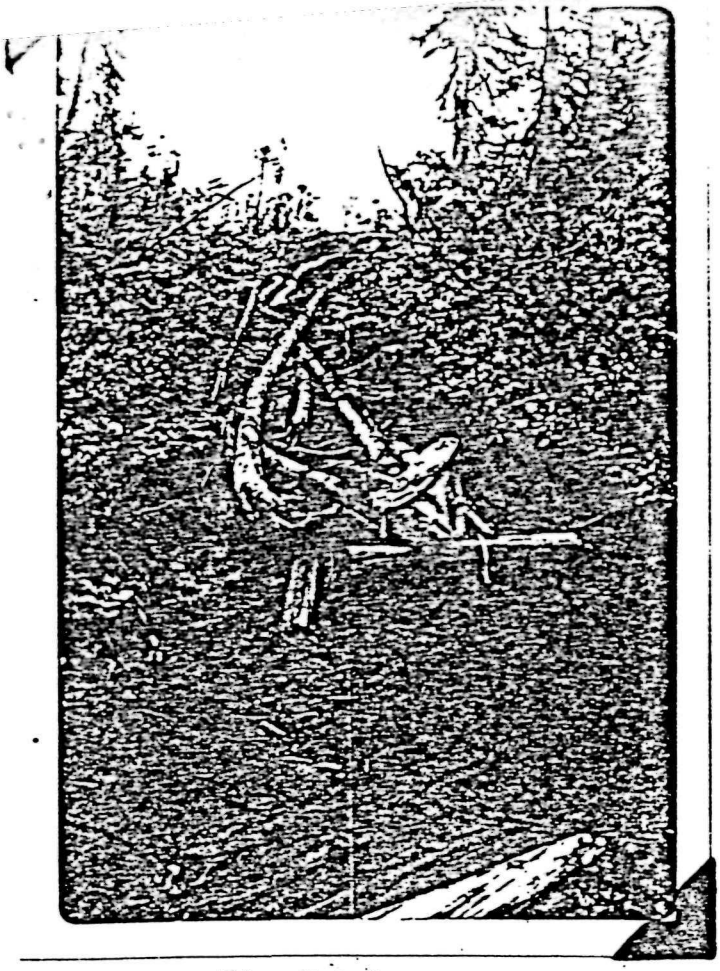


Fig. 6i

Switchback shortcut. Attempt to block - did not use enough material, people walking around.

Fig. 6j

An adequate amount of material in place. All this down wood was found within 20' of the shortcut and only took a short time to place.

Fig. 6k

A sharp switchback. To prevent shortcutting the trailcrew put plenty of large, windfall across.

Unit 7 ON SITE MATERIAL SOURCES

Contract Item ____

Description

This unit pertains to the priorities for selecting materials on site (that is, not hauled in) for maintenance and construction.

Methods

Rock: sources of rock in amounts up to approximately 1 cubic yard from the same general location may be used in the following priorities:

1. Rock removed from clearing and cleaning tread, travelway and ditches and from restoring designated backslopes.
2. Talus slope rock (fist size or larger).
3. Streams or rivers where the bed is approximately 50% or more rock covered; except not within 200 feet of inlets or outlets.
4. Scree slopes (rock smaller than fist size).
5. Streams or rivers where bed in under 50% rock covered; except not within 200 feet of inlets or outlets.
6. Rocks on forest floor.

Use of more than 1 cubic yard of rock or any rock from subalpine or alpine meadows must have the approval of the Resource Management Coordinating Team.

Wood: sources of wood will be used in the following priorities:

1. Trees cut when clearing travelway or left from unneeded structures.
2. Down tree.
3. Standing trees, cut as flush to ground as possible.

Soil: sources of soil will be used in the following priorities up to 1 cu. yard:

1. Sluffs on trail; silt runoff from drainage facilities; excavated soil from cleaning or construction facilities; soil from restoring backslopes or berms.
2. Silt from streams or rivers where vegetation is not disturbed and not from within 200 feet of inlets and outlets.
3. Borrow pits in forest and out of sight of trail.

Use of more than 1 cubic yard of soil from numbers 2 and 3 must have the permission of the Resources Management Coordinating Team.

Every effort will be made to restore and blend in source area with its surroundings and mask area from view.

(Contractor - onsite material will be flagged).

Unit 8 STREAM AND RIVER CROSSINGS

Contract Item ___

Description

Stream and river crossings maintenance will consist of the inspection, repair and/or replacement of crossing facilities.

Methods

At the beginning of each seasons trail work the first priority, as snow melt permits, will be to check the condition of crossing facilities. Stringers, sills, walls, cribbing, decking, cables, anchors and railings will be examined for evidence of rot, cracks, breaks, looseness and displacement. Cables will be checked for deformity and change in the lay of strands. Debris damming on facilities or supports will be removed.

Hazardous facilities will be immediately posted closed to use and the backcountry office will be immediately notified to advise travelers. The trail supervisor will make arrangements for temporary alternative crossings and for repair or replacement of the hazardous facility.

Minor problems, but not constituting a hazard to users, will be corrected at time of inspection if feasible, or as part of Schedule 3 work.

The selection of new or replacement crossing facilities will be based on the following order of priorities:

Class 1 and 2 trails:
1. Fiberglass culverts
2. Puncheon bridges for spans not over 12 feet
3. Three solid stringer bridges for over 12' spans
4. Metal bridges,with Superintendent's approval

Class 3 trails:
1. Fords
2. Step stones
3. Rock or wood culverts
4. Footlog(foot trails); puncheon bridges, 12' or less spans (All purpose trails)
5. Solid stringer bridges for spans over 12 feet.
6. Metal bridges, with Superintendent's approval

Priorities will be determined by considering: (1) Degree of hazard to users. (2) Need to protect natural resources. On Class 3 trails facilities will not be placed or rebuilt solely for the convenience of users.

Where bridges have been washed downstream their materials should be reused if possible. Where not possible and safety permits, they should be dismantled and wood removed out of stream beds and out of sight. Metal will be packed out.

Where bridges have a history of being washed out, they should be cable anchored at one end so they are not washed away. Their materials can be reused for rebuilding.

Wherever stream conditions allow, footlogs and bridges should have center supports to prevent damage due to unusually heavy snow loads.

Unit 8.1 STREAM FORDS

Contract Item ___

Description

This pertains to the restoration or construction of stream fords. (Contractor: each ford location has been staked and is listed by station number on the attached location list. The total number of fords to be restored is ___; total linear feet is ___. The total number of fords to be constructed is ___; total linear feet is ___.)

Methods - Class 3 trails

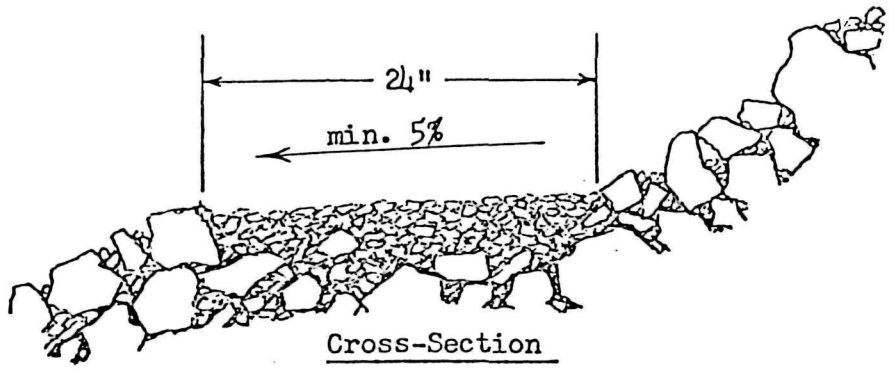
The trail tread will be considered as existing on the stream bed at the location of crossing. Rock in excess of 4 inches in diameter, and all logs, limbs, stumps and other debris will be removed from the tread by pick-and-bar or blasting; such material will also be removed from the travelway in the ford to provide a minimum clearance of 4 feet on each side of tread centerline 24 inches above the stream bed. All woody material removed from the ford will be deposited downstream and not closer than 20 feet to the ford, and in no case will be allowed to form an obstruction to the free flow of the stream.

Where the stream bed at the ford has a downstream gradient in excess of 10%, large rock will be placed and firmly anchored along the lower side of the tread and the tread will be backfilled with rock not more than 2 inches in diameter to achieve a downstream gradient of 5%. The tread in the ford will have a minimum width of 24 inches. Where large rock is not available, a log will be placed at the lower side of the tread, lying parallel to the tread, and will be anchored by backfilling with rock as specified above and by burying the log ends in the stream bank at least 24 inches. Logs used for this purpose will be sound, peeled, and will be single solid logs large enough to allow achievement of the specified 5% downstream gradient. Log ends buried in banks will be backfilled with rock and mineral soil and solidly tamped to prevent washing out.

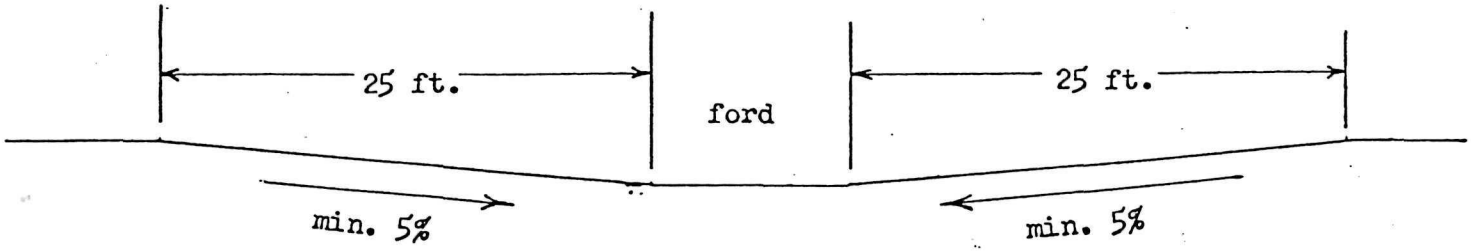
All eddy holes and pockets in the tread of the ford will be backfilled with small rock.

The trail tread approaching the ford will dip to the ford on a minimum 5%, maximum 15% down-grade for a linear distance of at least 25 feet (see Figure 8.1). The trail tread will approach the ford at an angle rather than perpendicular to the direction of stream flow, and will enter the ford flush with the ford tread or no more than 12 inches above the ford tread if conditions of stream current and volume make flush entry impossible.

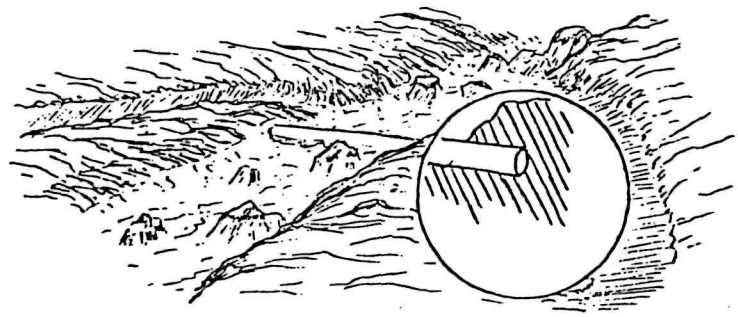
STREAM FORDS



Cross-Section



Trail Gradient Profile



Emplacement of Ford Log

Figure 8.1

Unit 8.2 STEP STONES

Contract Item ___

Description

This pertains to the maintenance and installation of step stone stream crossings. (Contractor: the number of step stones to be placed is ____. Locations are by station number on the attached location list.

Methods - Class 3 Trails

Maintenance of step stones will consist of inspecting stones for movement or rocking when in use, levelness of tread, spacing and clearance above high water during normal use season. Step stones will be maintained according to the installation specifications.

Installation of step stones will consist of seating stones firmly in stream bed so they will not wash out or be undercut by water flow or move or rock when walked on. Stones used will not be subject to shearing or crumbling under normal use. Stone tread surface will be at least 12 inches in diameter and will slope no more than 2%. The step stones will be located no more than 12 inches apart nor more than 12 inches from stream bank trail tread. The stones will have tread surface above the normal high water level during the normal use season.

Figure 8.2

Step stones, Class 3 trail. Where stream is shallow, large rock is available and there is a need for a crossing structure to stop resource damage, the effort of moving and placing stones should be done, instead of building footlogs or bridges.

Where stream banks are high and damage will result from hikers going down to the step stones, a footlog should be used instead.

Unit 8.3 PUNCHEON BRIDGE

Contract Item ___

Description

This pertains to the construction of puncheon bridges.(Contractor: each puncheon bridge location has been staked and is listed by station number on the attached location list. The total number of bridges to be constructed is____; the total linear feet is ____.)

Methods - Class 1 and 2 trails and Class 3 All purpose trails

Construction of the span will consist of placing two sound peeled 14 inch minimum diameter sill logs, 4 feet long, buried to 2/3 their diameter, which will be spanned by 3 sound peeled stringers and decked as show on detail drawing. For stringer diameters see Wood Stringer Chart, appendix A . Each sill to sill span will not exceed 12 feet. Stringers will be fixed to the sill logs with 5/8 inch drift pins or notched and spiked. Decking will be installed with 8 inch spikes, 4 per plank at least. Bull or curb rails, 3 inch minimum diameter will be placed directly over the stringers and fastended in place with spikes or drift pins on 24 inch centers. Stringers and rails will be placed to allow a deck treadway between rails of at least 30 inches. Decking material should be 4 feet long and at least 4 inches thick. Each end of the bridge will have an end dam spiked on to prevent soil or fill from eroding out. This will consist of a plank at least 4 inches thick.

Trail tread is to approach each end of the puncheon bridge level and flush with the walking surface. All brush and debris will be removed from the drainage on both sides of the bridge and out of sight. Stumps will be cut as close to the ground as possible and limbs, bark and other debris will be scattered out of sight. Any major marks from cutting or moving materials will be restored as nearly as possible to the original state.

(Contractor: on site native material will be flagged by the government.)

Methods - Class 3 Foot trails

All methods and specifications applying to Class 1 and 2 trails and Class 3 All purpose trails will apply with the following exceptions:

Two stringers will be used and sill logs and deck planking will be shorter to accomodate a 24 inch treadway between bull rails.

PUNCHEON

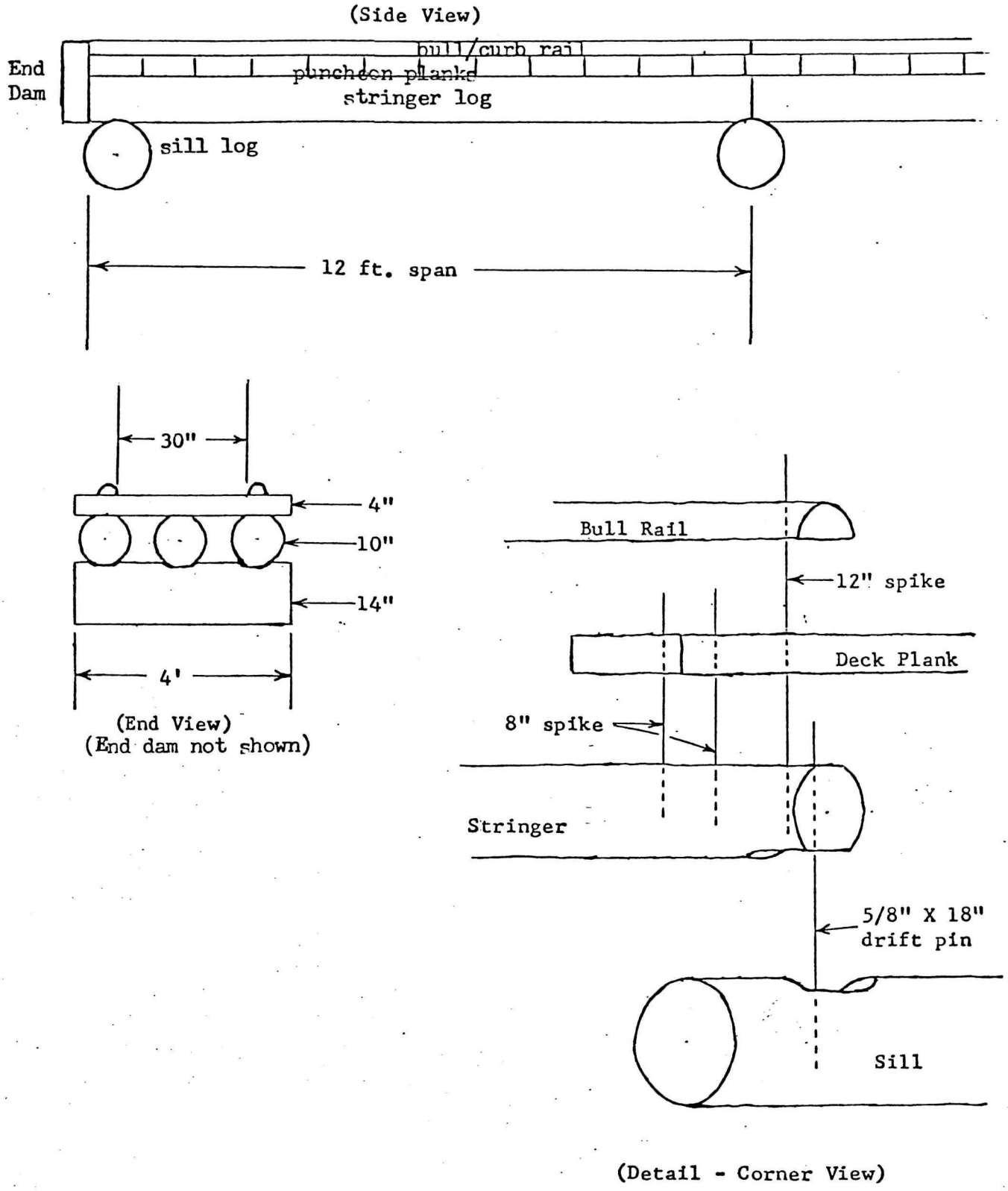


Figure 8.3

PUNCHEON BRIDGE

(For Spans of 12 Feet or Less)

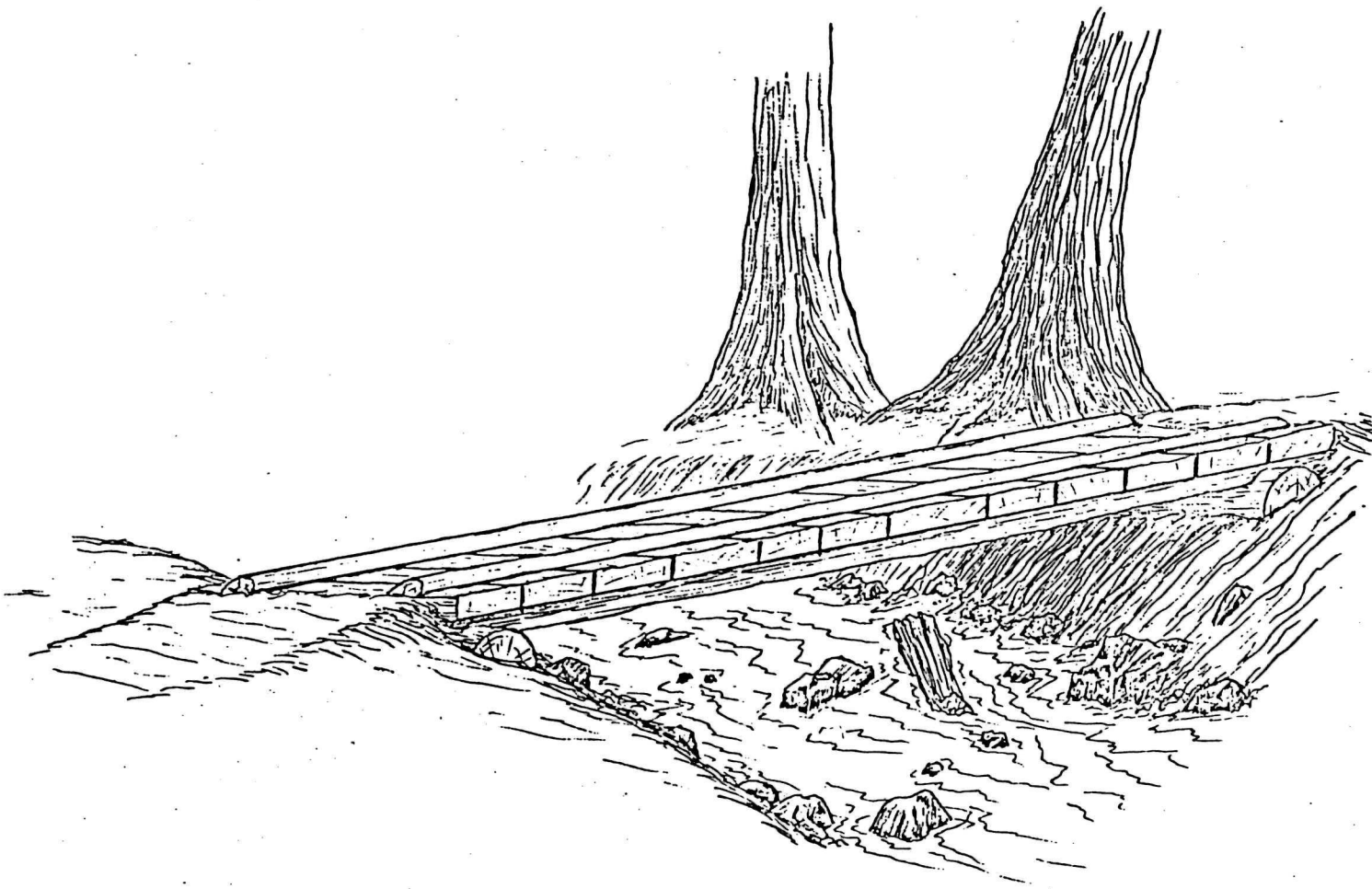


Figure 8.3a

Unit 8.4 BRIDGES (SOLID STRINGER)

Contract Item ___

Description

This pertains to the construction of solid stringer bridges. (Contractor: each bridge location has been staked and is listed by station number on the attached location list. The total number of bridges to be constructed is ___; total linear feet is ___.)

Methods - All purpose trails and Class 1 and 2 Foot trails

Construction of the span will consist of placing two sound, peeled, 24 inch diameter sill logs, 10 feet long, buried to 2/3 their diameter (unless some other type of footing is specified), which will be spanned by three sound peeled stringers and decked as shown on detail drawing (Figure 8.4). Sill-to-sill span will not exceed 50 feet. Stringers will be fixed to sill logs with 5/8 inch drift pins or notched and cabled. Decking will be installed with 8 inch spikes, 4 spikes per decking plank minimum.

Handrails will be constructed by spiking an upright post to both the decking and to either a bull rail or a mid rail (at 24 inches above decking) and to upright post (at 24 inches above decking). Such uprights and braces to be spaced not more than 10 feet apart (see Figure 8.4). The uprights will be spanned by a 6 to 8 inch diameter handrail, fixed to the uprights with 12 inch spikes. The top of the finished handrail will be 4 feet above the level of the bridge deck.

All diameters are minimal for the small end of each log used. Minimum stringer diameters will be specified in the Wood Stringer Chart, appendix A .

If bull rails are used they will be made from a sound peeled log, not less than 10 inches in diameter, ripped down the center. If a mid rail is used instead it will be made from a sound peeled log not less than 6 inches in diameter. Stringers and rails will be placed to allow a deck treadway between rails of 60 inches. Decking material will be 6 feet long and not less than 4 inches thick, except that decking placed at points where handrail posts and braces will be set 10 feet long. Handrail upright posts and braces will be at least 8 inches in diameter.

Trail tread is to approach each end of the bridge level and flush with the walking surface. The bridge deck will be level and uniform, with all knots and protruding edges hewn flat.

Stumps will be cut as close to the ground as possible and limbs, bark and other debris will be scattered out of sight. Any major marks from cutting or moving materials will be restored as nearly as possible to the original state. (Contractor: on site material will be flagged by the government).

BRIDGES (SOLID STRINGER) (continued)

Methods- Class 3 Foot trails

All methods which apply to All purpose trails will apply also to Class 3 foot trails with the following exceptions:

Two stringers will be used and all sills and decking will be shorter to accomodate a treadway between rails of 24 inches.

Footlog bridge- Class 3 foot trails- construction will consist of placing two sound, peeled sill logs at least 12 inches in diameter and buried 2/3 their diameter and spanning these with 1 or 2 logs (see Wood Stringer Chart, Appendix A). The top 1/3 of the footlog(s) will be hewn flat so that a tread surface of at least 12 inches results. The tread surface will be hewn slightly rough so there is not a smooth or slick surface which could cause slipping. The footlog(s) will be level and uniform. Trail tread is to approach each end of the footlog flush with the walking surface.

Center supports will be installed wherever feasible. Handrail will be installed where the height of the footlog above the stream or the volume and velocity of stream flow constitute a clear safety hazard.

Where center supports are not feasible or high spring water may wash footlog away the footlog should be cabled to the sill logs so the footlog can be removed in the fall and reinstalled in the summer.

BRIDGE (SOLID-STRINGER)

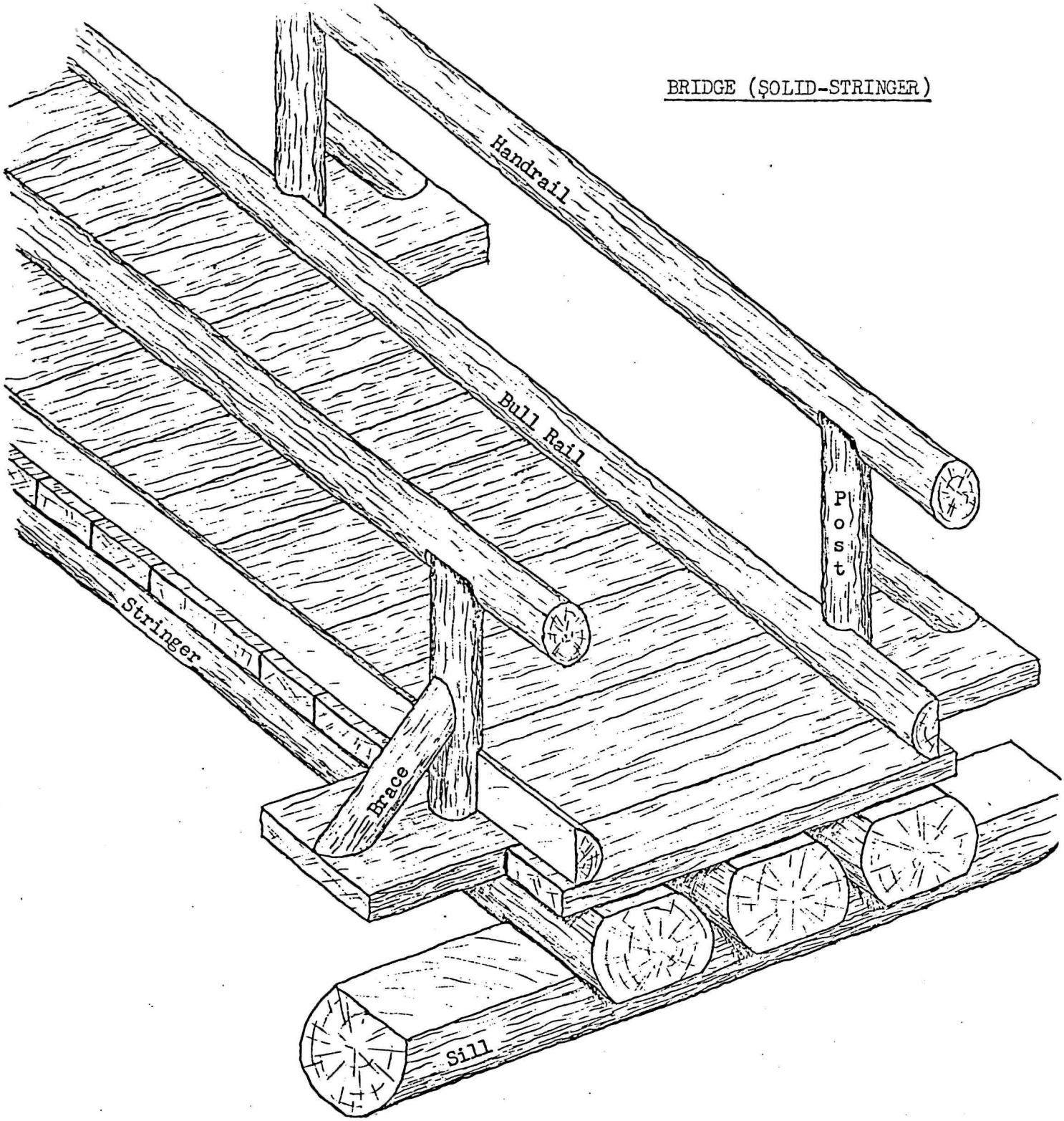


Figure 8.4

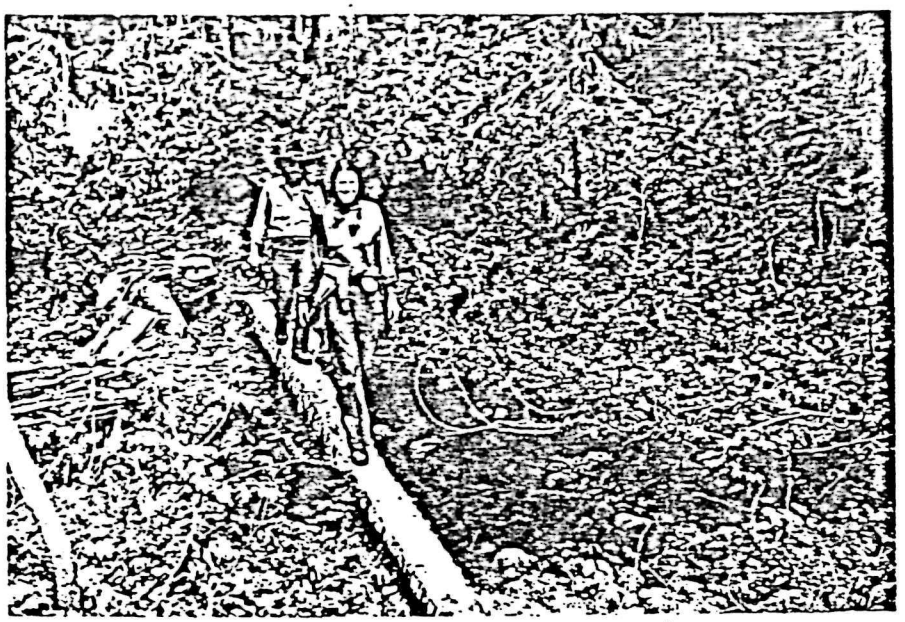


Figure 8.4a

A good footlog across a shallow stream. Large enough rocks were not available here to use step stones instead of a footlog. If this was a stock trail the footlog would still be sufficient since the stream banks are low, the stream shallow and a horse ford would suffice.

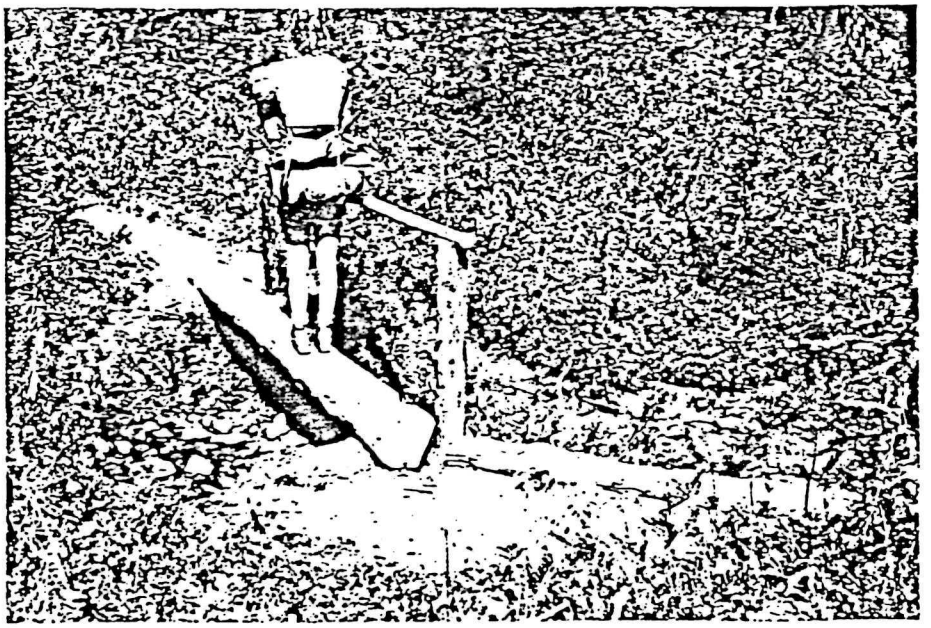


Figure 8.4b

Footlog is not flush with trail tread. Handrail not needed since this is not a hazardous crossing.

In both pictures footlogs were used to prevent resource damage- the streams could be safey forded but hikers tended to walk along the banks seeking other crossings and caused damage. The footlogs were not needed for safety reasons nor were they installed for hikers convenience.

Unit 8.5 BRIDGE -OVERHEAD TRUSS

Contract Item ___

Description

This unit pertains to the construction of solid-stringer trail bridges over spans of 40 feet or more where overhead trusses are to be included in the structure, and includes furnishing and installing specified metal parts such as bolts, hanger rods and gussets. Each bridge location has been staked and is listed by station number on the attached location list. The total linear feet of overhead truss bridges to be constructed is _____.

Construction Methods

The bridge span will be constructed in accordance with the attached specifications for solid-stringer bridges, except that decking other than those planks supporting handrail posts will be 8 feet long, and stringers will be spaced to accomodate the specifications for bull rail and truss placement given below. Minimum stringer diameter will be 24 inches unless otherwise specified.

Construction of the supporting truss will consist of placing two truss timbers on each side of the bridge such that they form a triangular support on each side of the bridge with truss ends joined at the midpoint of the span (see Figure 8.5). A cradle timber having a minimum end dimension of 12 inches will be suspended under the bridge at span center by steel hanger rods depending from the truss peaks and passing through the exterior stringers, and the cradle timber will be drawn up securely against the bridge bottom by tightening of the hanger rods. A brace timber will be fastened at each end of the cradle timber and will extend to and be fastened at the truss peak. See Figures 8.5 and 8.5a.

The joint between the truss and the stringer (called the heel joint) will be a squared and mortised joint providing a level bearing surface, and will be such that the angle between the stringer and the truss is 30° (see detail drawings). The heel joints will be fastened by one-inch diameter steel bolts passing completely through the truss and the stringer at a right angle to the long line of the truss, and by steel clamping-plate timber connectors placed between truss and stringer. In addition, the heel joint will be bolted to the bull rail with 3/4-inch bolts through gusset plates, and the bull rail will be bolted through the stringer with one-inch diameter bolts on 24-inch centers for a linear distance of 6 feet toward span center from the heel joint (see detail drawings). The inside truss edge will rest directly over the centerline of the exterior stringer, and stringers will be spaced to allow a minimum distance of 60 inches between the bull rails of the completed bridge.

Braces will be fastened at the truss peak joint by 3/4-inch bolts passed through the brace and a plate of 1/4-inch thick steel measuring 8 inches by 20 inches which is bolted through the peak gusset plates (see Figure 8.5b). The brace-to-cradle heel joint will be at least 4 linear feet beyond the exterior stringer and will be fastened by a 3/4-inch bolt passed at an angle through the brace and cradle. Malleable iron bridge washers having a minimum outside diameter of 2-1/2 inches will be used under the bolt head and/or the securing nut at any point where a steel plate is not specified as part of the structure.

Bridges (Overhead Truss) (Continued)

Trusses and braces may be either round logs or square-split timbers; minimum end dimensions for structural members will apply to all squared joints. Trusses will have a minimum end dimension equal to 50% of the stringer diameter. Braces will have a minimum end dimension equal to 66% of the truss diameter. The cradle timber will have a minimum end dimension of 12 inches, and will be long enough to provide the specified 4 feet of clearance between stringers and brace joints. All wooden members will be sound, peeled fir or cedar.

All joints will be squared for flush fitting. Gusset plates will be used on both sides of truss peak and heel joints as shown in drawings, and the peak joints will have a cap plate having a width equal to the truss width plus 1/2-inch and a length equal to at least three times the truss width. Bolts 1/2-inch in diameter will be used through the peak joint and heel joint gusset plates. All flat steel parts, such as gussets and cap plate, will have a minimum thickness of 1/4-inch.

The hanger rods will pass through the cap plate center, and a 12-inch by 12-inch steel plate on the bottom of the cradle timber. Hanger rods will be high-strength steel having a minimum diameter as specified in the table below, and will be secured by steel nuts over malleable iron bridge washers.

	Total Span Length			
	40 ft.	50 ft.	60 ft.	60+ ft.
Minimum Rod Diameter	1"	1-1/8"	1-1/4"	1-1/2"

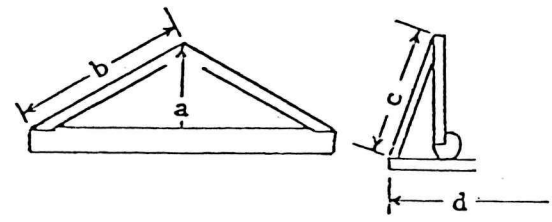
Flat-plate metal parts such as gussets will be self-rusting type corrosion resistant steel requiring no painting. All threaded steel parts such as bolts and nuts, and including the hanger rods, will be galvanized. Wire-rope cable will not be accepted as substitution for hanger rods.

The following table indicates the planned truss length, truss rise, and brace length for various span lengths. This table will not be considered as a substitute for actual field measurements during construction of the bridge, and is included only as a general reference.

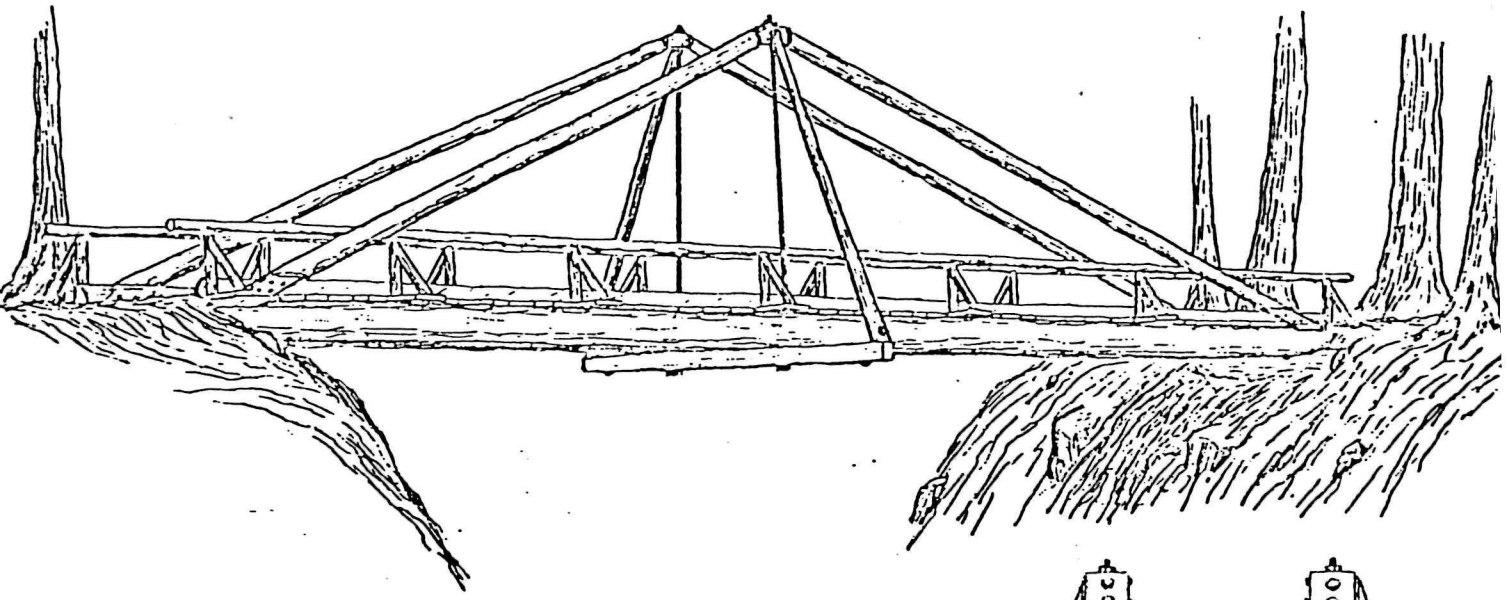
	Total Span Length				
	40 ft.	45 ft.	50 ft.	55 ft.	60 ft.
Truss Rise (a)	11'7"	13'1"	14'5"	15'11"	17'5"
Truss Length (b)	24'4"	27'1"	30'0"	32'10"	35'9"
*Brace Length (c)	13'8"	15'2"	16'6"	17'11"	19'5"
**Hanger Rod Length	16'0"	17'6"	19'0"	20'6"	22'0"

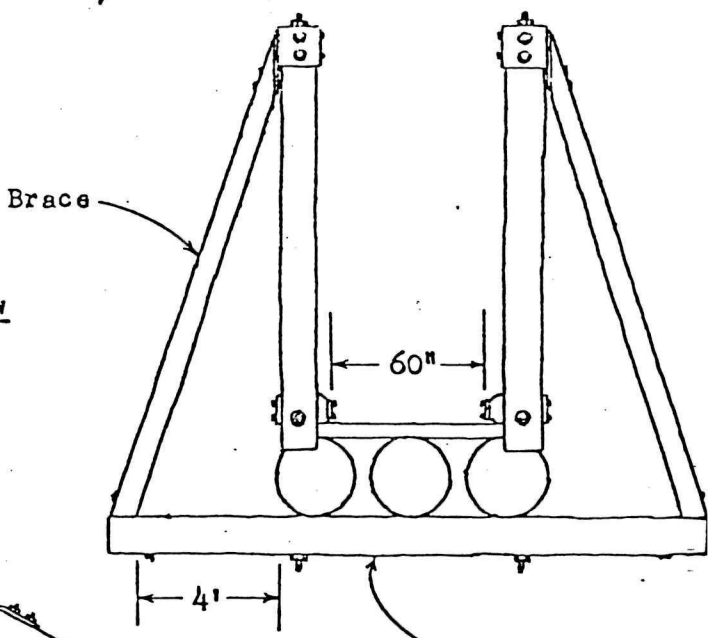
*For Cradle Length (d) of 16 ft. and Stringer Diameter of 24 inches.

** 12 inches threaded on each end.



OVERHEAD TRUSS BRIDGE





End View

Side View

(Gusset plates and braces not shown)

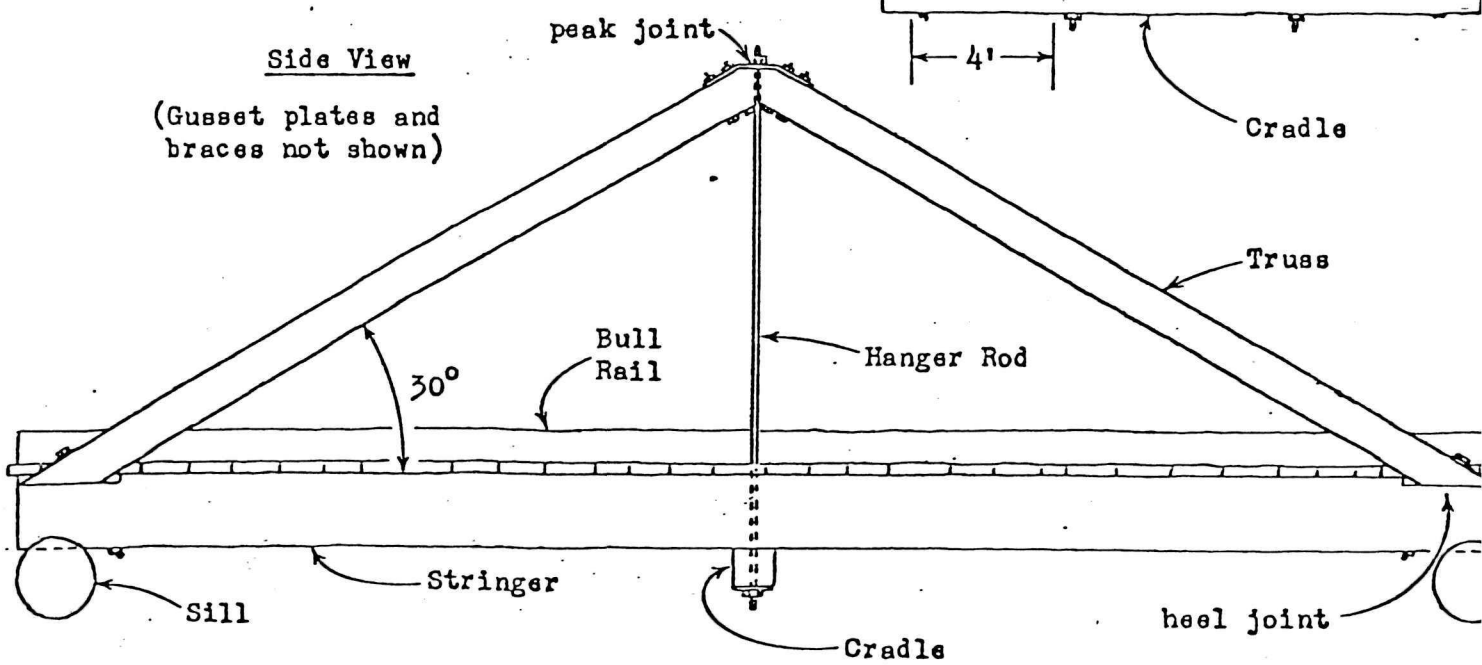


Figure 8.5

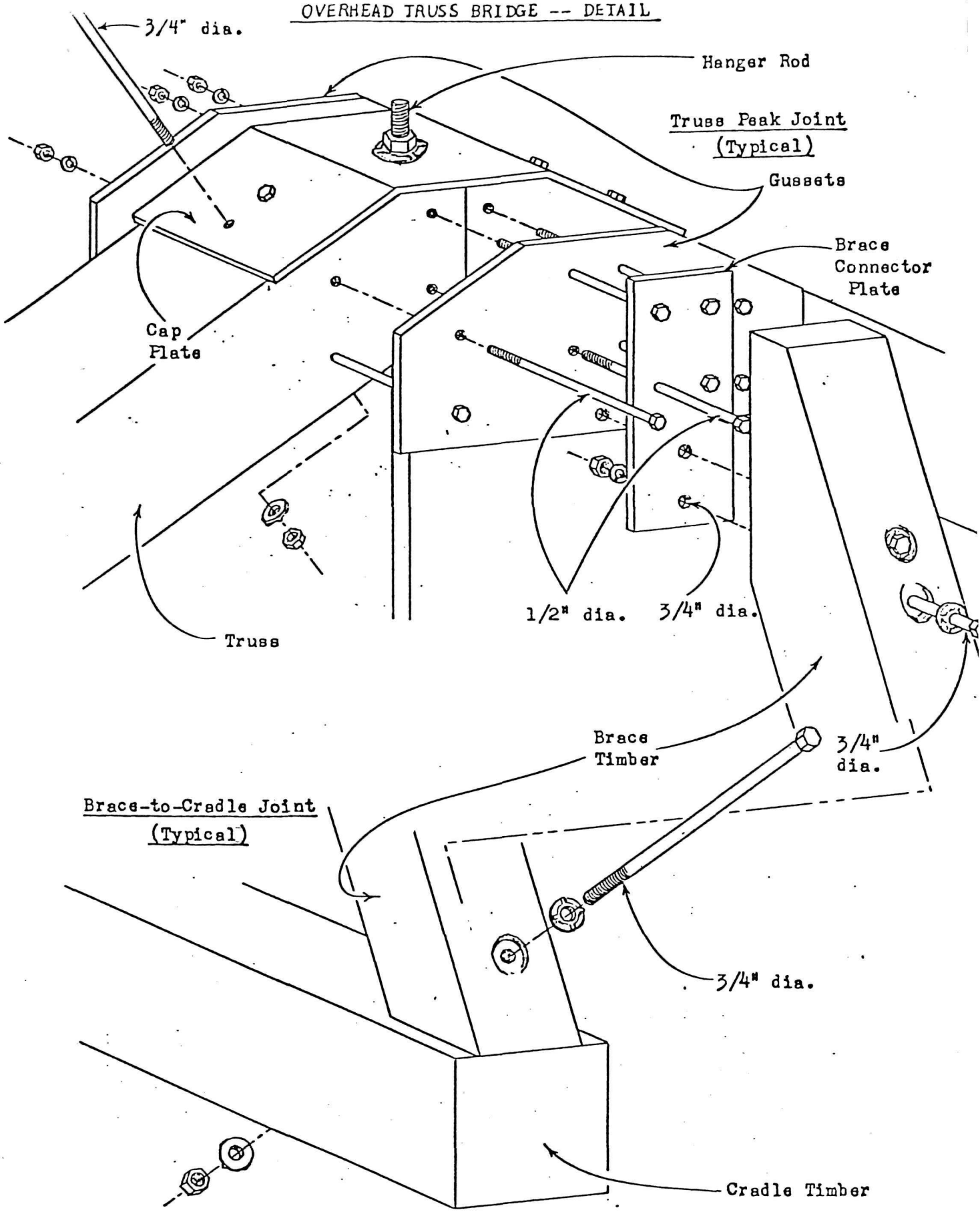

OVERHEAD TRUSS BRIDGE -- DETAIL
3/4" dia.
Hanger Rod
Truss Peak Joint
(Typical)
Gussets
Brace
Connector
Plate
Cap
Plate
1/2" dia.
3/4" dia.
Truss
Brace
Timber
3/4"
dia.
Brace-to-Cradle Joint
(Typical)
3/4" dia.
Cradle Timber

Figure 8.5a

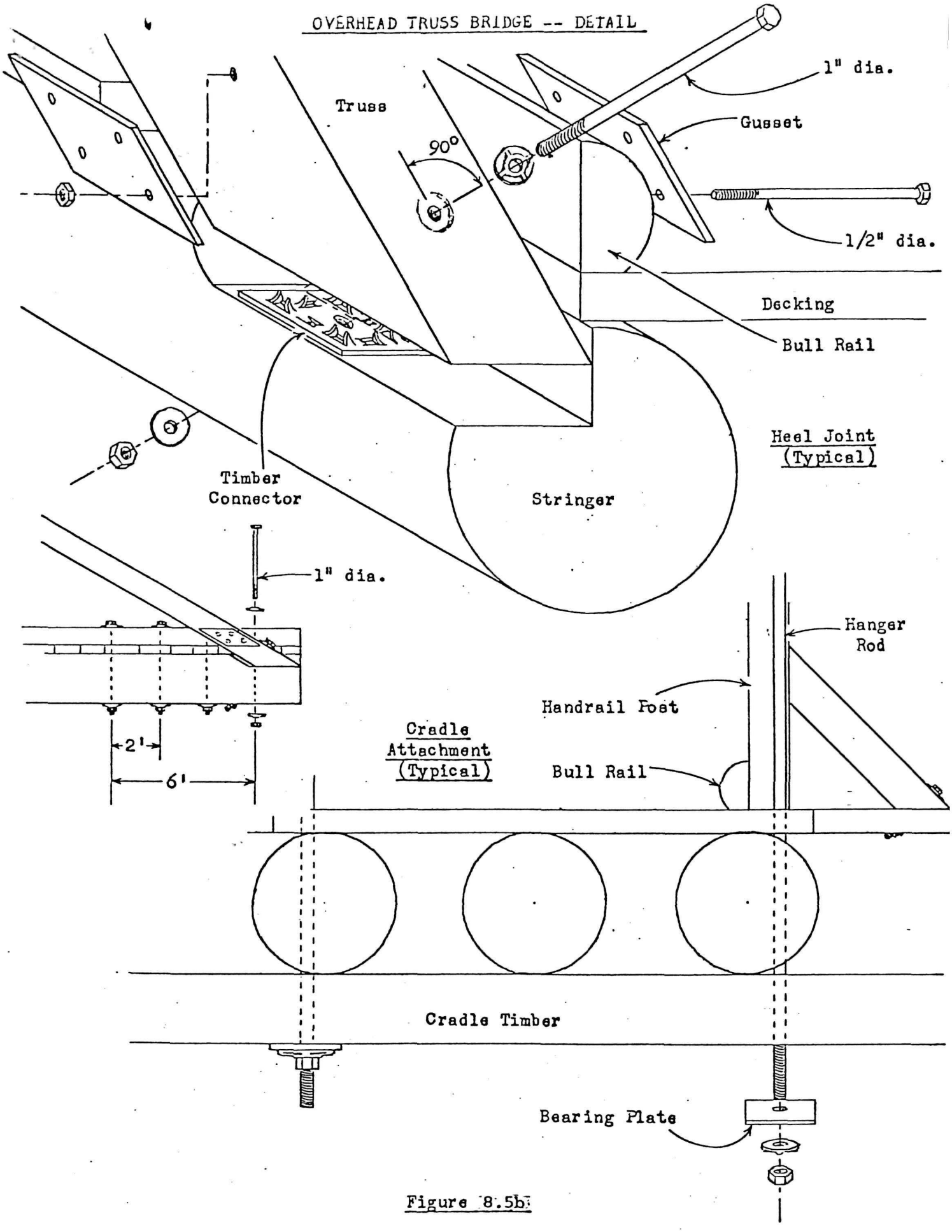

OVERHEAD TRUSS BRIDGE -- DETAIL
1" dia.
Truss
Gusset
90°
1/2" dia.
Decking
Bull Rail
Heel Joint
(Typical)
Timber
Connector
Stringer
1" dia.
Hanger
Rod
Handrail Post
Cradle
Attachment
(Typical)
Bull Rail
2'
6'
Cradle Timber
Bearing Plate

Figure 8.5b

Unit 8.6 BRIDGE - HIP TRUSS

Contract Item ___

Description

This unit pertains to the construction of solid-stringer trail bridges over spans of 40 feet or more where hip trusses are to be included in the structure, and includes furnishing and installing specified metal parts such as bolts and gussets. Each bridge location has been staked and is listed by station number on the attached location list. The total linear feet of hip truss bridges to be constructed is _____.

Construction Methods

The bridge span will be constructed in accordance with the attached specifications for solid-stringer bridges. Minimum stringer diameter will be 24 inches.

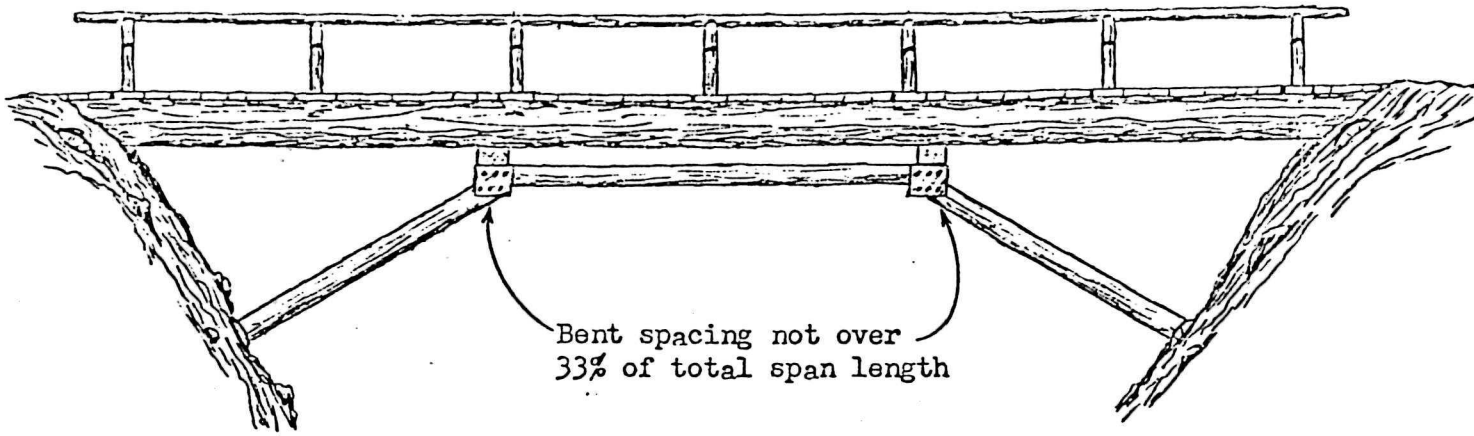
Construction of the supporting truss will consist of placing two cradle timbers having a minimum end dimension of 12 inches under the bridge such that all three stringers are supported, and fastening a knee-braced hip truss under each side of the bridge such that the bent (knee-brace to truss joint) is directly beneath the cradle timber and the centerline of the exterior stringer. Distance from bridge end to bent will not exceed 33% of total span length, and bents will be joined with bolted iron or steel gusset plates (see Figure 8.6). The angle between the bridge stringer and the knee-brace will be not less than 30°.

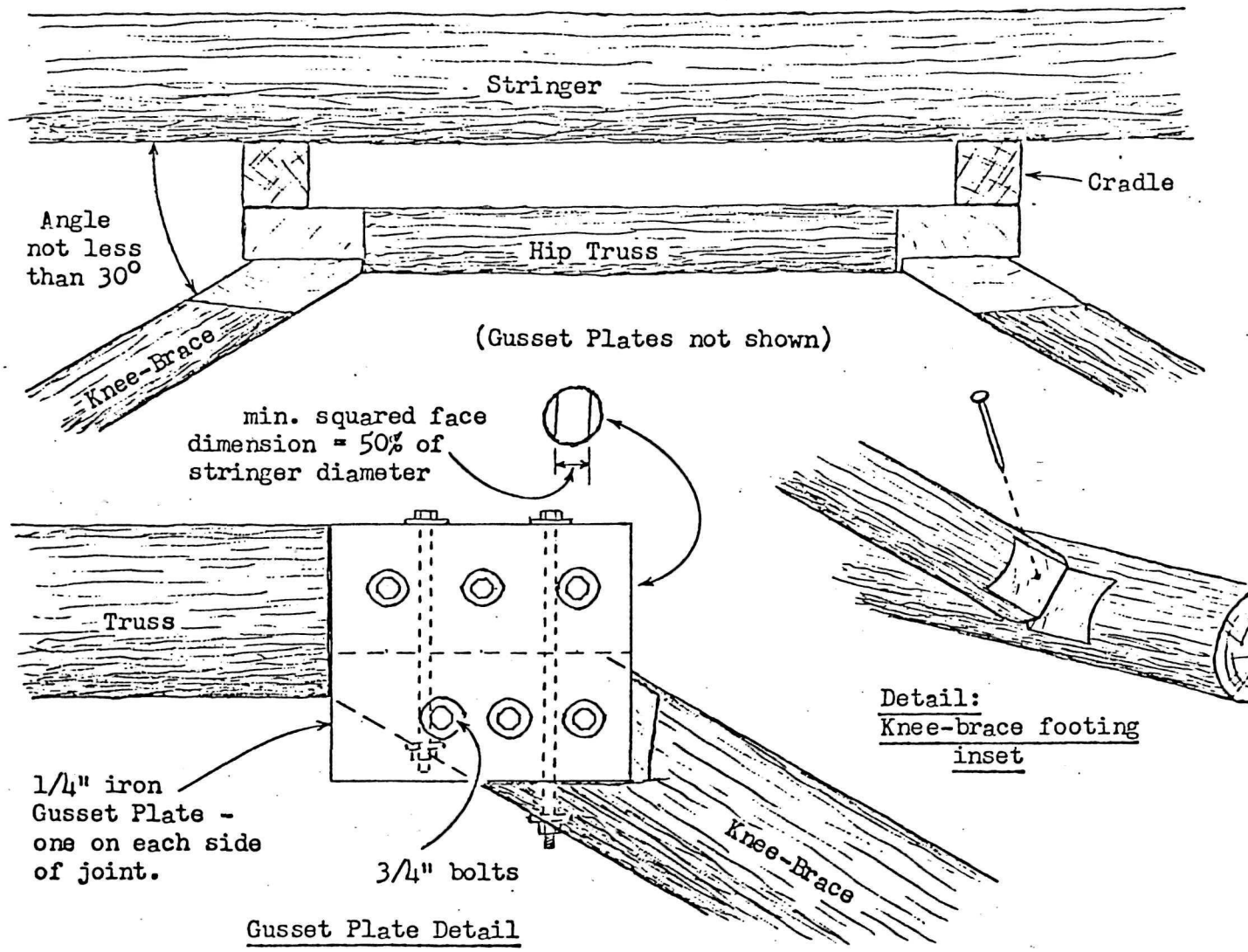
Hip truss and knee-brace timbers will be squared at bents to assure flush fitting of the gusset plates, and will have a minimum end dimension equal to 50% of the stringer diameter. Gusset plates will be of 1/4-inch thick iron or steel, cut to fully cover the bearing surface at the bent, and will be bolted with 3/4-inch diameter steel bolts and nuts with large steel flat washers or bridge washers (see detail drawing). The knee-brace will be bolted to the hip truss with 3/4-inch diameter bolts as shown in the detail drawing.

Where firm rock footings are not encountered, even load distribution at bents and knee-brace footings will be provided by emplacement of a footing log, buried to 3/4 its diameter, upon which the knee-braces will rest. The footing log will have a minimum diameter not less than 1.5 times the diameter of the brace, and will be long enough to extend 24 inches beyond the braces on each side of the bridge. The joint between the brace and footing log will be squared at right angles to the linear angle of the brace, and the brace will be spiked to the log with 12-inch spikes driven into pre-bored guide holes (see Figure 8.6). The knee-brace footings will not be set lower than two feet above any discernible high-water mark.

Flat-plate metal parts such as gussets will be self-rusting type corrosion resistant steel requiring no painting. All threaded steel parts such as bolts and nuts will be galvanized. Washers will be of malleable iron.

HIP TRUSS BRIDGE





Gusset Plate Detail

Figure 8.6

Unit 8.7 LOG CRIBBED APPROACH RAMPS

Contract Item ___

Description

This unit pertains to the construction of log cribbing in ramps as approaches to bridge ends. The number of ramps to be constructed is _____.

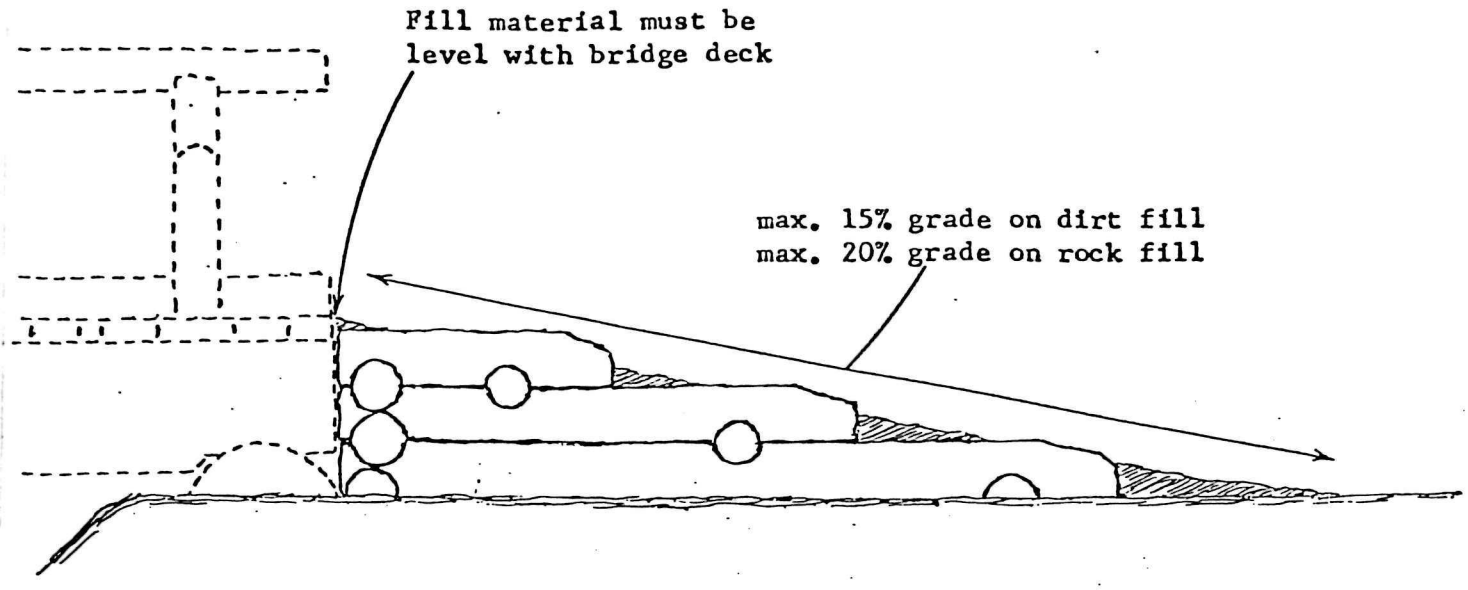
Construction Methods

The cribbing will be constructed of logs having a minimum diameter of 10 inches for rails, and 8 inches for ties. All logs are to be cedar or fir, peeled, and notched to assure a tight fit and no loss of fill material (see Figure 8.7). The cribbing logs will be fastened together with drift pins or 12-inch spikes. Cribbing will be constructed to a minimum width of 5 feet (or to allow at least 3 feet of soil tread width), and to a length assuring a fill grade not exceeding 15% on dirt fill, or 20% on rock fill. The height of the crib will be sufficient to assure that fill material rises to the level of the bridge deck surface.

Fill material will be rock and/or mineral soil, the final 4 inches of fill being mineral soil and/or rock not larger than 2 inches. All voids will be filled and fill material will be thoroughly tamped and compacted.

On-site native materials to be used and borrow areas will be marked by the C.O.R. or his representative. Stumps will be cut flush with the ground, and limbs, bark and other debris will be scattered out of sight. Any major marks from construction activities, and all borrow areas will be restored as nearly as possible to the original state. Excavation of the existing stream bank to obtain fill material will not be allowed.

CRIBBED RAMPS



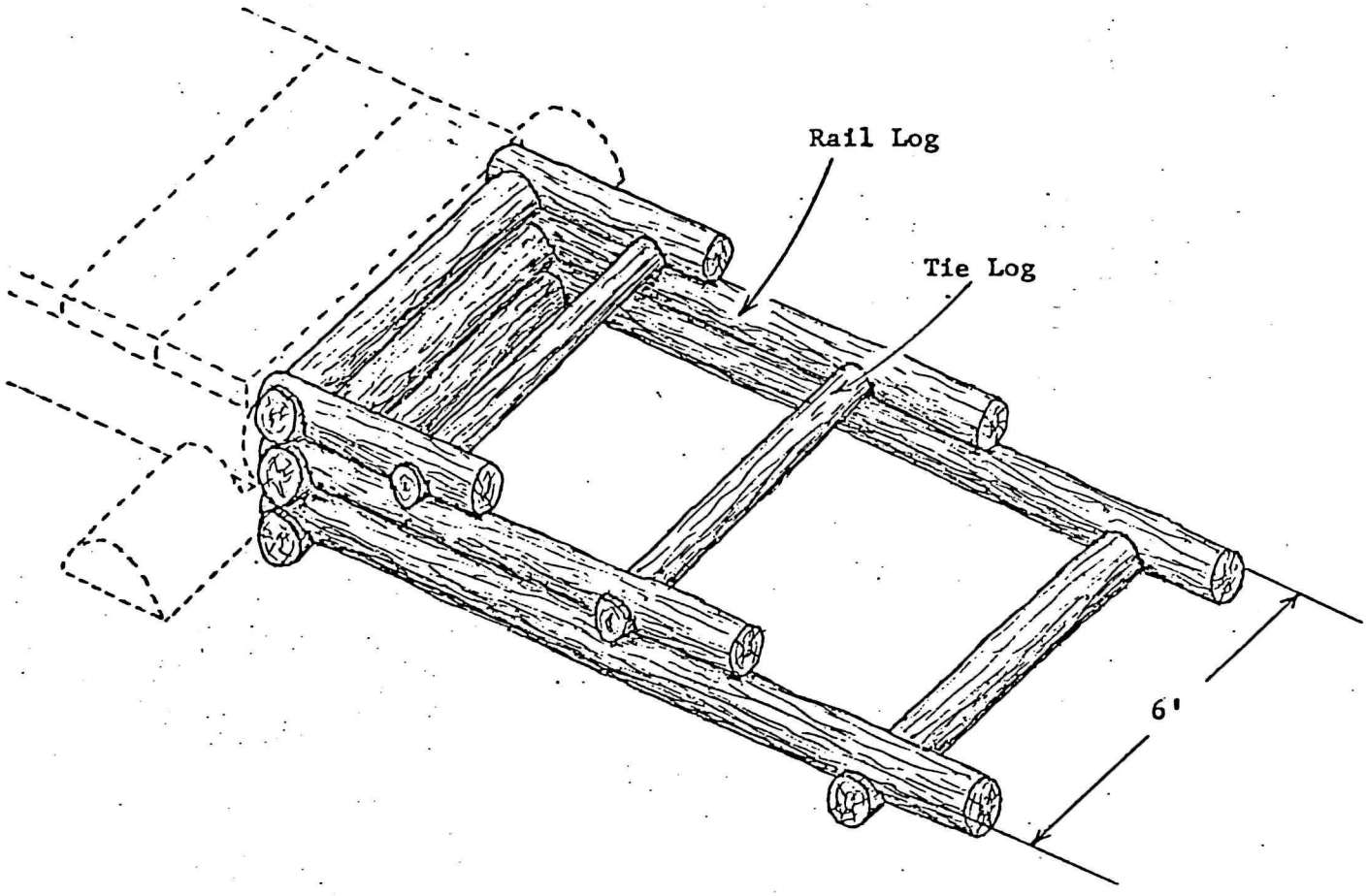


Figure 8.7

Unit 8.8 LOG CRIBBED ABUTTMENTS (FOOTINGS)

Contract Item ___

Description

This unit pertains to the construction of rock-filled log cribbing to be used as abuttment footings for trail bridges. Each bridge location has been staked and is listed by station number on the attached location list, which specifies which bridges require construction of abuttments and the linear distance the abuttment will extend into the stream. The total number of abuttments to be constructed is ____.

Construction Methods

Abuttments will consist of log cribbing filled with rock large enough to prevent washing away of material by water action between the cribbing logs. All fill will be compacted to minimize voids.

An excavation will be made such that the bottom log of each cribbed wall will lie at least 12 inches below the level of the stream bed to prevent washing out of the structure. The face wall of the abuttment will be laid parallel with the stream at the distance from the stream bank specified for the particular location. The upstream wing wall (shear leg) will be laid at an angle of not more than 45° from the line of stream current flow. The downstream wing wall (heel leg) will be laid at an angle of not more than 60° from the line of current flow (see Figure 8.8). Wing walls will be excavated not less than 24 inches into the stream bank to prevent washing action around the wall end at the bank. All abuttments will be constructed to a minimum height of at least 4 feet above high water level.

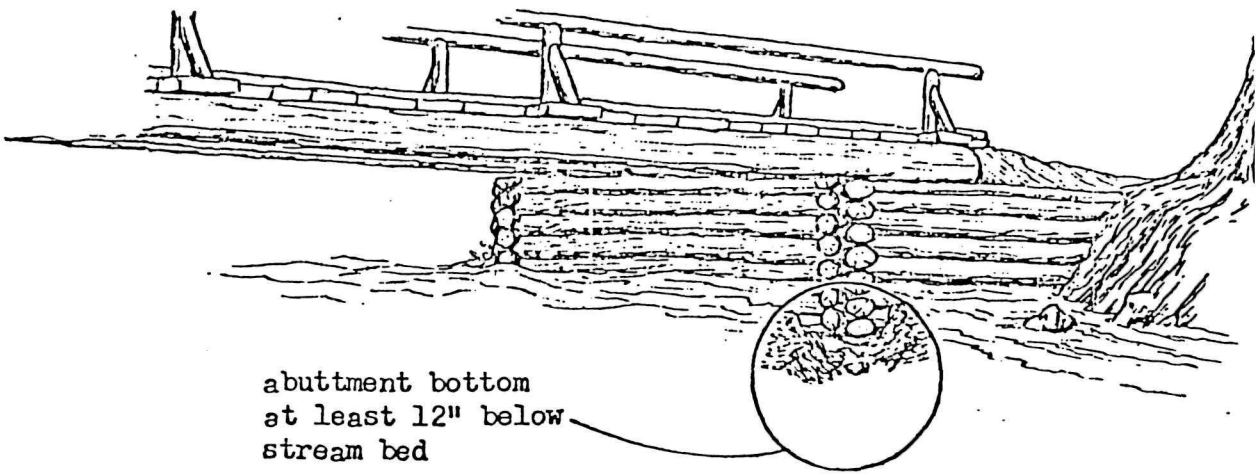
Cribbing will be constructed of sound, peeled, cedar or fir round logs or square-split timbers. Minimum end dimensions for cribbing timbers will meet or exceed specifications detailed in the table below.

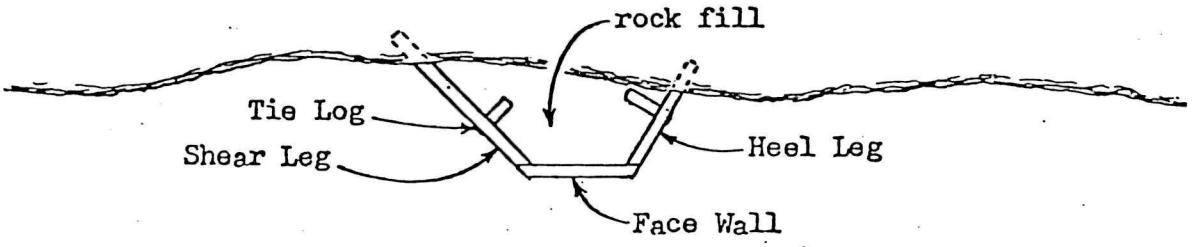
	Length of Cribbing Wall		
	10' to 12'	14' to 16'	18' to 20'
Rail Log Dia.	8"	10"	12"
Tie Log Dia.	6"	8"	10"
Drift Pin Size	3/8"X10"	3/8"X12"	1/2"X14"

All wall logs will be notched or squared at joints and fastened with drift pins meeting minimum specifications from table above. Tie logs will be placed into wing walls at 8 foot horizontal intervals and for each 2 feet of rise above stream bottom, and will have a minimum length of 3 feet (see detail drawing). All log ends will be cut flush with the walls to prevent catchment of floating debris.

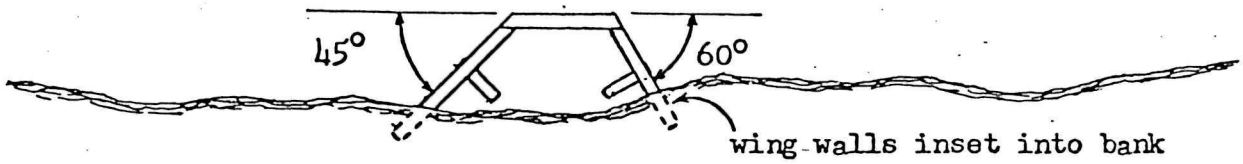
On-site native materials to be used and borrow areas will be marked by the C.O.R. or his representative. Stumps will be cut flush with the ground, and limbs, bark and other debris will be scattered out of sight. Any major marks from construction activities, and all borrow areas will be restored as nearly as possible to the original state. Excavation of the existing stream bank to obtain fill material will not be allowed.

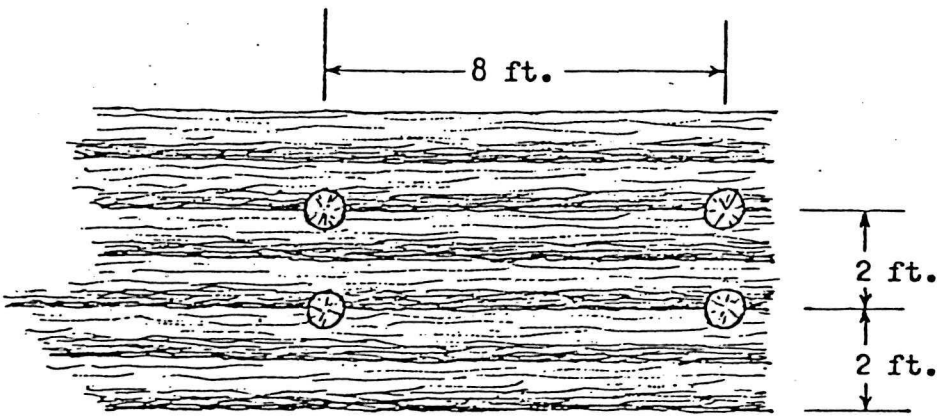
CRIBBED ABUTTMENTS





Stream
direction of flow





Tie Log Placement

Figure 8.8

Unit 8.9

CRIBBED PIERS

Contract Item ___

Description

This unit pertains to the construction of rock-filled log cribbing to be used as mid-stream support piers for trail bridges. Each bridge location has been staked and is listed by station number on the attached location list, which specifies which bridges require construction of piers and the number of piers per bridge. The total number of piers to be constructed is _____.

Construction Methods

Piers will consist of log cribbing filled with rock large enough to prevent washing away of material by water action between the cribbing logs. All fill will be compacted to minimize voids. Piers will be either rectangular or triangular in shape as specified for the particular location.

An excavation will be made such that the bottom log of each cribbed wall will lie at least 12 inches below the level of the stream bed to prevent washing out of the structure. The pier will rest on a foundation of stable rock; in no case will piers be placed on sand, clay or silt without further excavation and filling with large rock to a depth of at least 24 inches below the pier base. All piers will be constructed to a height assuring a firm fit against the bottom of the bridge stringers.

Cribbing will be constructed of sound, peeled, cedar or fir round logs or square-split timbers having a minimum end dimension of 8 inches. All corners will be squared or notched for secure fit, and will be fastened with 3/8"X12" drift pins. All log ends will be cut flush with the walls to prevent catchment of floating debris.

Rectangular piers will be constructed 6 feet wide and 10 feet long, and triangular piers will be constructed 12 feet long on each side, unless specified otherwise on the location list (see Figure 8.9).

On-site native materials to be used and borrow areas will be marked by the C.O.R. or his representative. Stumps will be cut flush with the ground and limbs, bark and other debris will be scattered out of sight. Any major marks from construction activities, and all borrow areas will be restored as nearly as possible to the original state. Excavation of the existing stream bank to obtain fill material will not be allowed.

CRIBBED PIERS

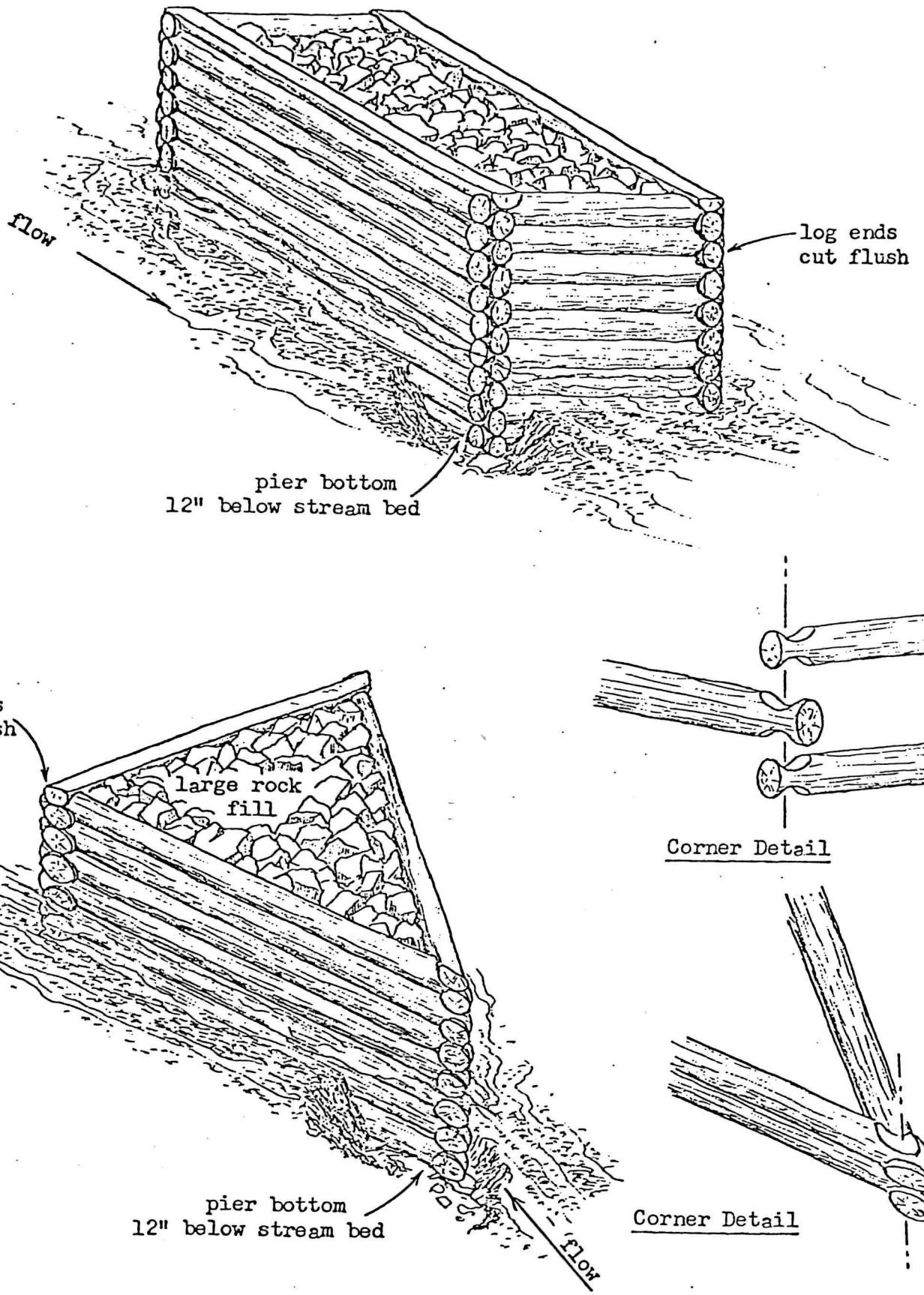


Figure 8.9

Unit 9 ROCK FOOTWALL

Contract Item ___

Description

This unit pertains to the construction of mortarless rock footwall, also called Drywall. Each footwall location is staked on the ground and listed by station number on the attached location list. Footwalls will be constructed to the length and height specified at each location.

Construction Methods

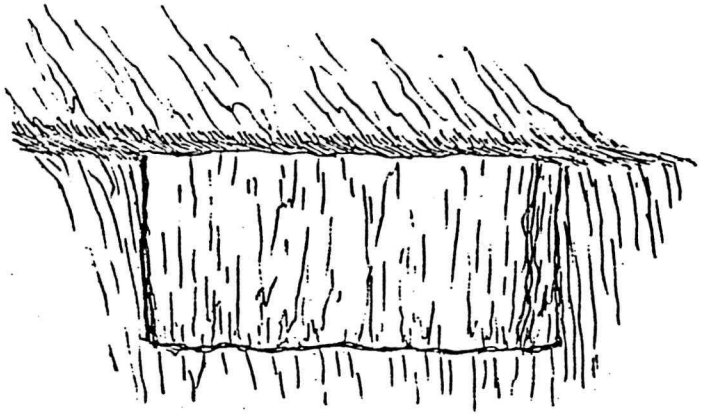
Construction materials will consist of large angular or flat rocks having at least two major bearing surfaces. No round rock, or soft rock prone to crumbling or shearing will be used. Voids in the wall will be filled with small rock and/or mineral soil, and compacted, to produce a firm stable wall.

A firm and stable footing will be dug for the wall, at least 12 inches deep for walls up to 2 feet high, and at least 24 inches deep for walls more than 2 feet high, and will be sloped into the bank 3% (see Figure 9) The footing will be at least as wide as the wall is long.

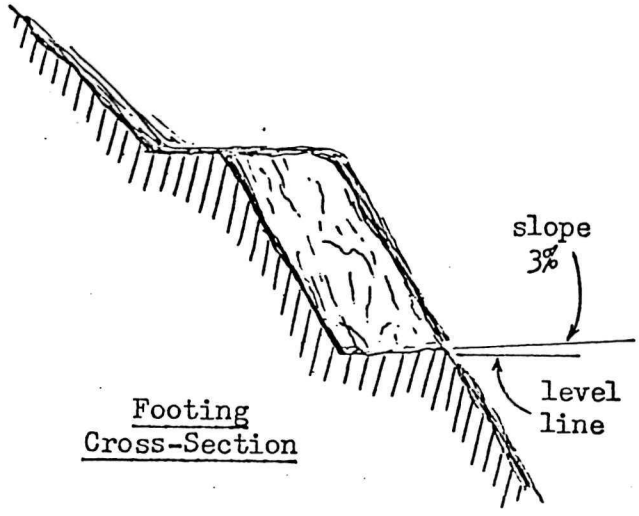
Rocks will be laid in tiers, such that each ascending tier overlaps and locks the lower tier in place. The wall will be sloped inward 25% to prevent caving and collapse. The topmost tier will end at a point which allows a covering of 4 inches of mineral soil to reach tread level on-grade.

To assure uniform bearing of the wall on the footing, rocks in the bottom tier shall be laid such that the long axis of the rock is perpendicular to the centerline of the trail.

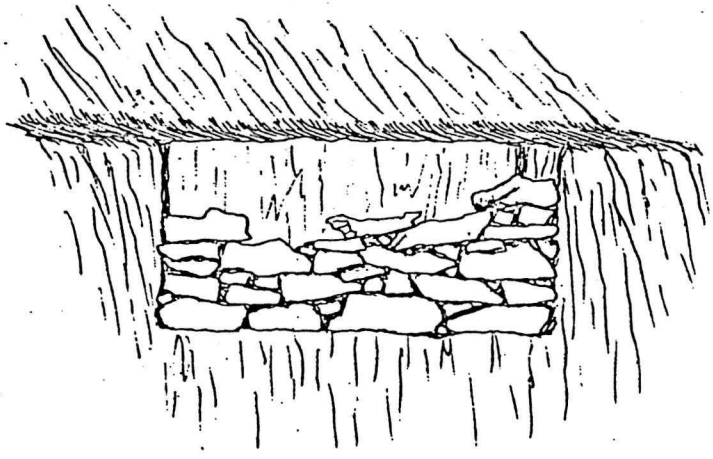
ROCK FOOTWALL

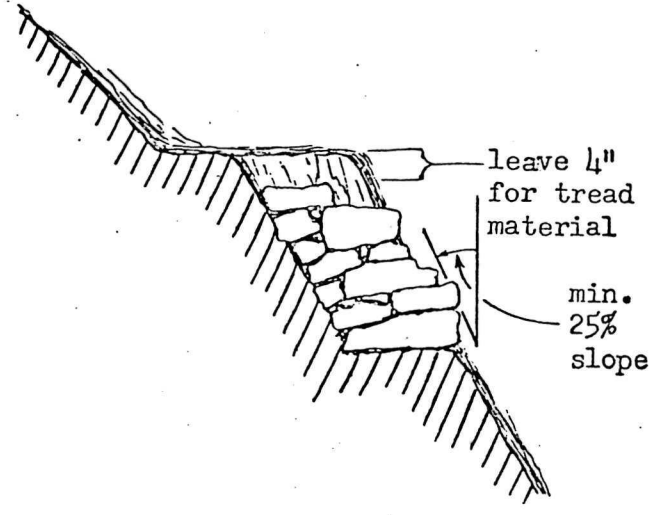


Dug Footing

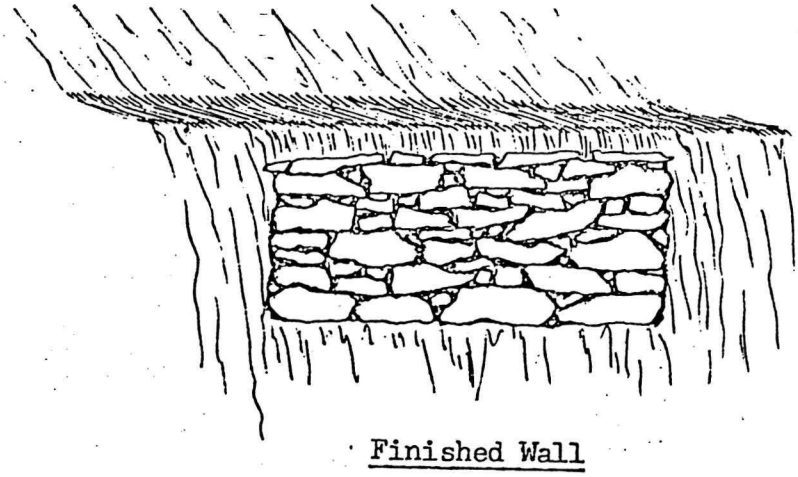


Footing
Cross-Section





Laying Wall



Finished Wall

Figure 9

Unit- 10

LOG CRIBBING

Contract Item ___

Description

This unit pertains to the construction of log cribbing. Each cribbing location is staked on the ground and listed by station number on the attached location list. Cribbing will be constructed to the length and height specified at each location.

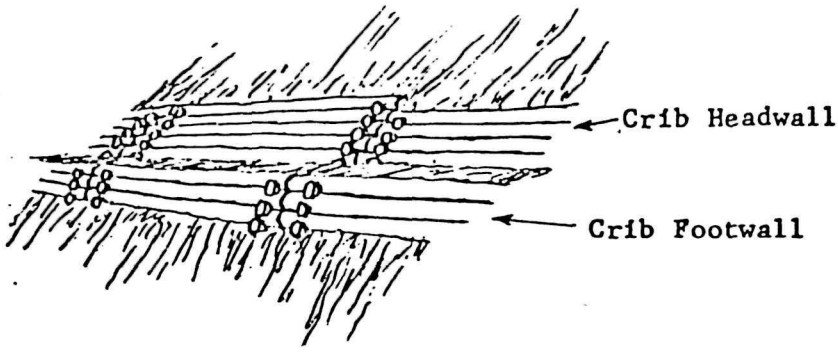
Construction Methods

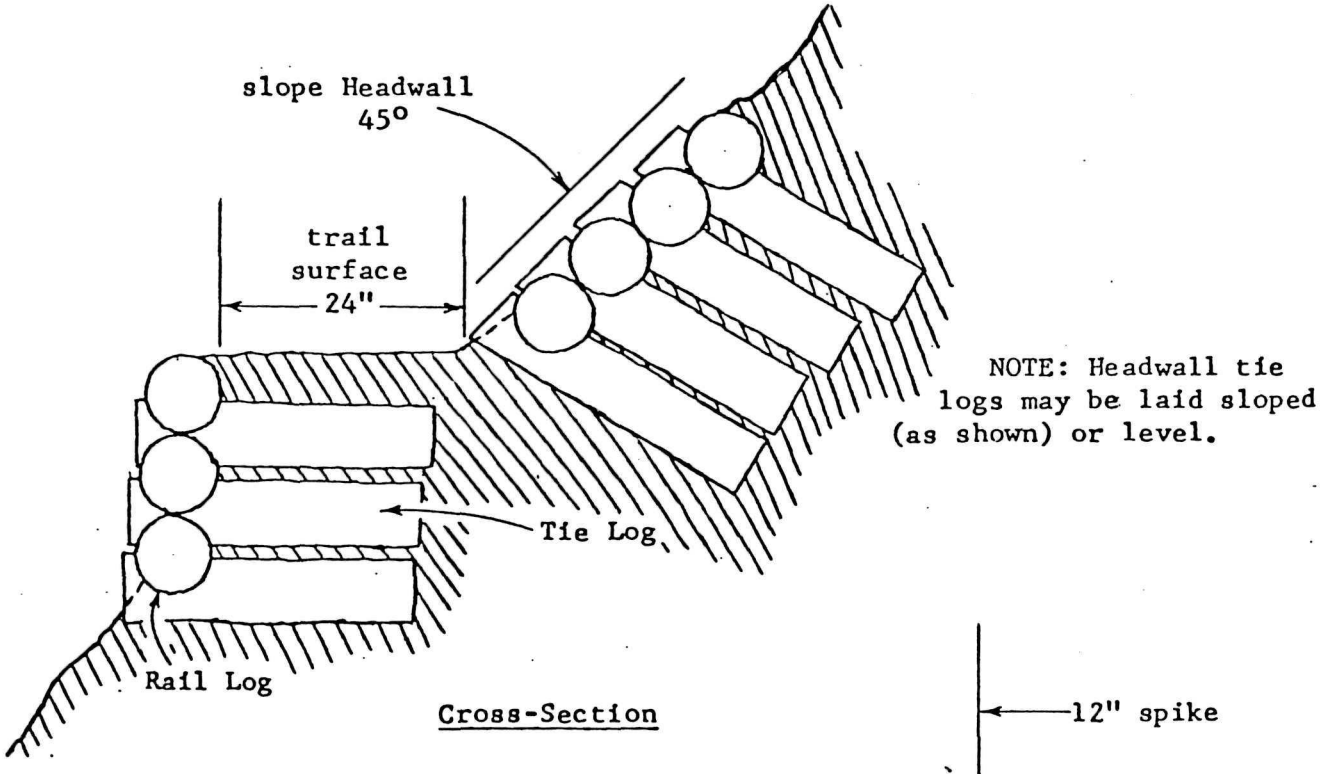
All rail logs and tie logs will be peeled, and will be 8 inches minimum diameter at the small end. Tie logs will be spaced not more than 12 feet apart, and will be at least 30 inches long (see Figure 10) Logs will be notched and fastened with 12-inch spikes or drift pins. Rail logs will be tightly fitted in such a manner that the backfill material will not sift out. Cribbing backfill will be tamped, and no rocks larger than 2 inches will be used within 12 inches of the crib wall or 4 inches of the trail surface.

Tie logs will be laid by either digging a trench to the necessary depth and length for the log or, if conditions permit, sharpening one end and driving the log into position. Tie logs in place must be level and firmly seated.

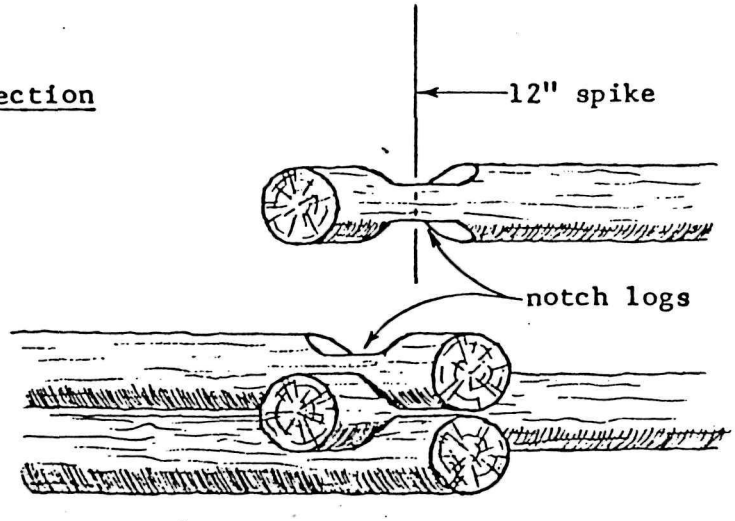
On-site native materials to be used will be flagged by the C.O.R. or his representative. Stumps will be cut flush with the ground and limbs, bark and other debris will be scattered out of sight. Any major marks from cutting or moving materials will be restored as nearly as possible to the original state.

LOG CRIBBING





Cross-Section



Corner Detail

Figure 10

Unit 11 REROUTING, SURFACING, NEW TRAILS

Contract Item ___

Description

This pertains to the rerouting or relocating and surfacing of sections of trail to avoid major damage or problem areas which have rendered routine maintenance ineffective; and to the construction of new trails where presently no trails exist.

Methods

New trails: new trails will be constructed only with the permission of the superintendent and he will approve class and purpose and location.

Rerouting: sections of trails destroyed or damaged by natural events: trail crew leaders may reroute up to 100 feet of trail where it is not feasible to rebuild original section. Longer sections must have the approval of the Resource Management Coordinating Team.

Sections of trail where safety problems or major resource damage is occuring and routine maintenance is ineffective: must have approval of Resource Management Coordinating Team for all sections.

Surfacing: consists of surfacing by such means as gravel, turnpike, puncheon and paving, where these do not exist and routine maintenance is ineffective in dealing with resource damage. All paving of Class 1 trails must have approval of Resource Management Coordinating Team. For trail sections up to 25 feet long, trail supervisor can approve gravelling, turnpike or puncheon, in that order of priority. Longer sections must have the approval of the Resource Management Coordinating Team.

For those projects requiring approval of the Superintendent or Resource Management Coordinating Team, the Trail Supervisor will notify the District Ranger prior to submitting recommendations.

Unit 11.1 GRAVEL TRAIL SURFACING

Contract Item ___

Description

This unit pertains to the placement of gravel as a surfacing material on and in the trail tread. Such gravel surfacing will extend over the full width of the trail tread, and over the full length of trail staked by the government. The finished surface will be outsloped 2% to 3% to facilitate water runoff, and will be firm and of uniform cross-section. The total length of trail to be surfaced with gravel is _____ linear feet.

Methods

Material to be used will be crushed, creek-run or pit-run 3/4"-minus gravel of a rock type acceptable to the government (COR), free of duff, sticks or other organic material, or soil or sand. The Contractor will furnish samples of the material to the COR for inspection upon request of the COR or his representative. If on-site borrow areas or stockpile areas are to be used, they will be marked and designated by the COR or his representative.

The tread surface will be scarified to produce a soil mix base at least 3 inches deep. Gravel will be spread uniformly over the tread to a minimum depth of 4 inches, and will be thoroughly mixed with tread soil and thoroughly compacted to form 4 to 6 inches of gravel and soil mix. The finished surface will be firm, with no soft or loose spots or ravelling segments.

Crusher sites, stockpile areas and borrow areas will be restored to a natural contour and appearance to the greatest degree possible.

Unit 11.2 DITCHLESS TURNPIKE

Contract Item ___

Description

This unit pertains to the construction of specialized rock or log turnpike (as specified) to be placed on the surface of the ground in areas where ground disturbance is undesireable. The location of each such turnpike section has been staked and is listed by station number on the attached location list. The total linear feet of such turnpike to be constructed is _____.

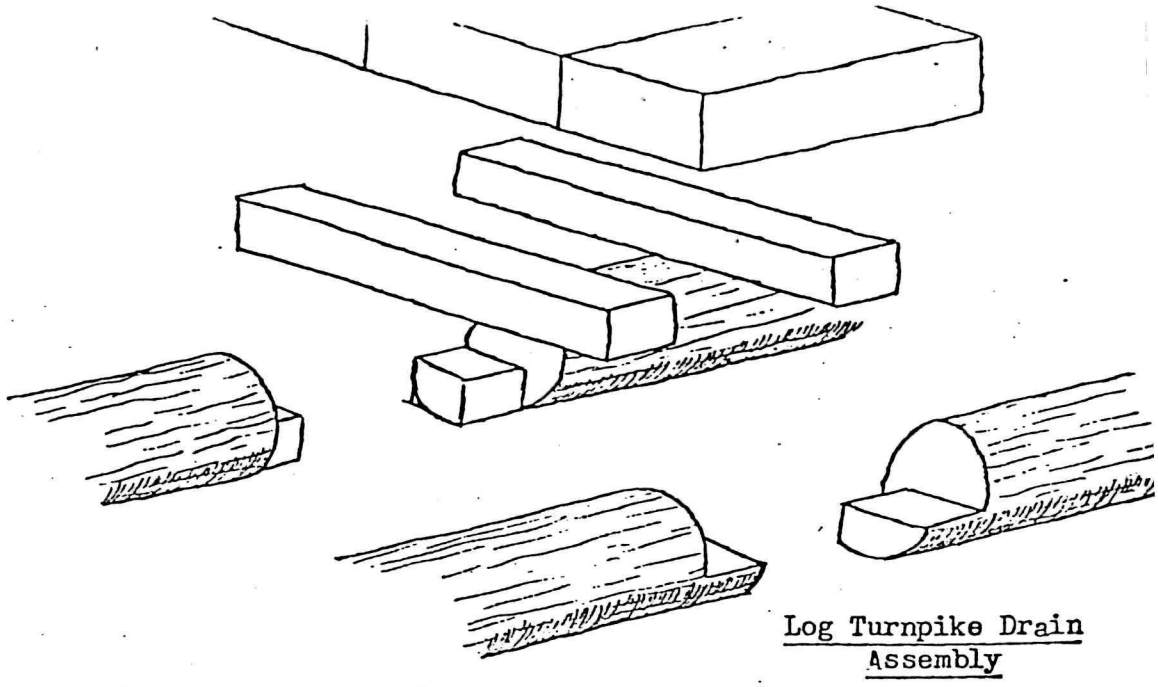
Construction Methods - All trail classes

Log or rock turnpike will be constructed in accordance with the attached specifications for each, Unit11.3 and/or Unit11.4 , except that no drainage ditches will be constructed. The turnpike will rest on top of the undisturbed ground, and fill material will be taken from areas marked by the government.

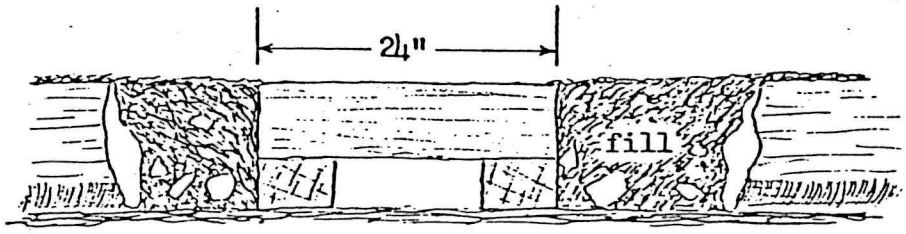
Drainage in log turnpike will be provided by insetting split or sawn planks 6 inches thick over a linear distance of 12 inches on each side of the staked drain location. Such planking will be installed and spiked to the turnpike logs as shown in Figure 11.2 to form an unfloored wooden culvert.

Drainage in rock turnpike will be provided by restricting the turnpike fill material to large angular rock covered with 4 inches of rock 2 inches in diameter over a linear tread distance of 24 inches on each side of the staked drain location. No mineral soil or rock less than one inch in diameter will be use as fill in the drain section (see Figure11.2). The bottom rocks of the turnpike walls in the drain section will be placed to allow a drainage gap of 2 inches to 4 inches between the rocks.

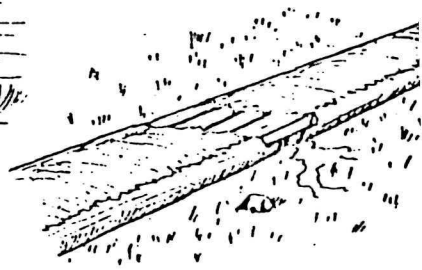
DITCHLESS
TURNPIKE
DRAINS



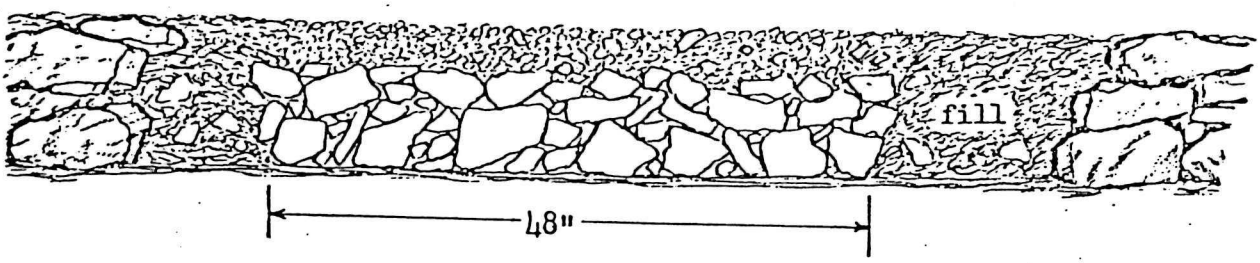
Log Turnpike Drain
Assembly



Log Turnpike
Cut-Away Cross-Section



Ditchless Log Turnpike



Rock Turnpike Drain Section
Cut-Away Cross-Section

Figure 11.2

Unit 11.3 DITCHED ROCK TURNPIKE

Contract Item ___

Description

This unit pertains to the construction of ditched rock turnpike. The location of each turnpike section has been staked and is listed by station number on the attached location list. The total linear feet of rock turnpike to be constructed is_____. The total number of turnpike culverts to be installed is_____.

Construction Methods

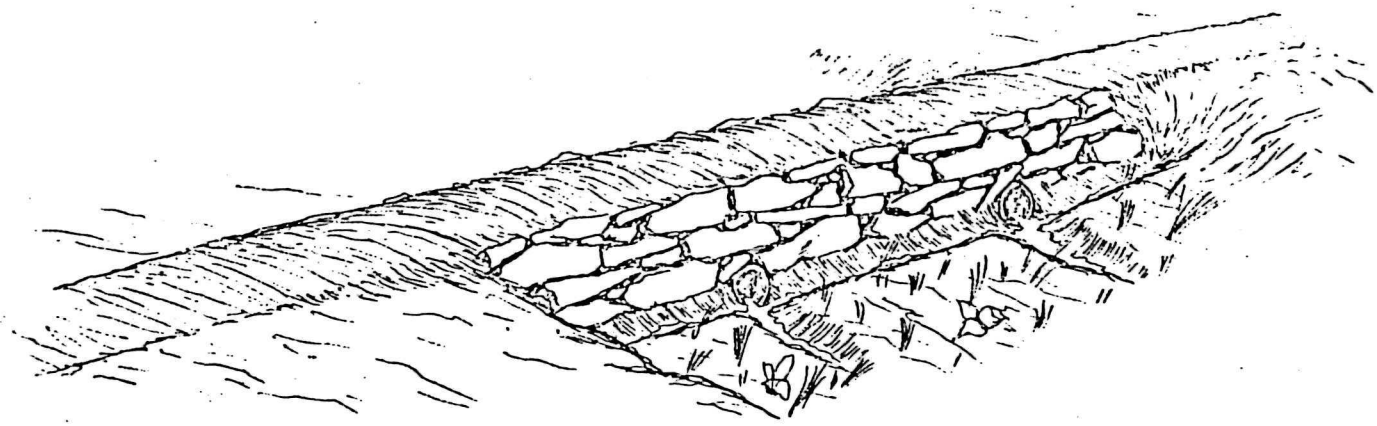
All Class 1 and 2 trails:using large flat or angular rock, build two parallel walls on a firm base. The walls will be 12 inches high and 48 inches apart at their base. They will slope inward to 36 inches apart at their top.

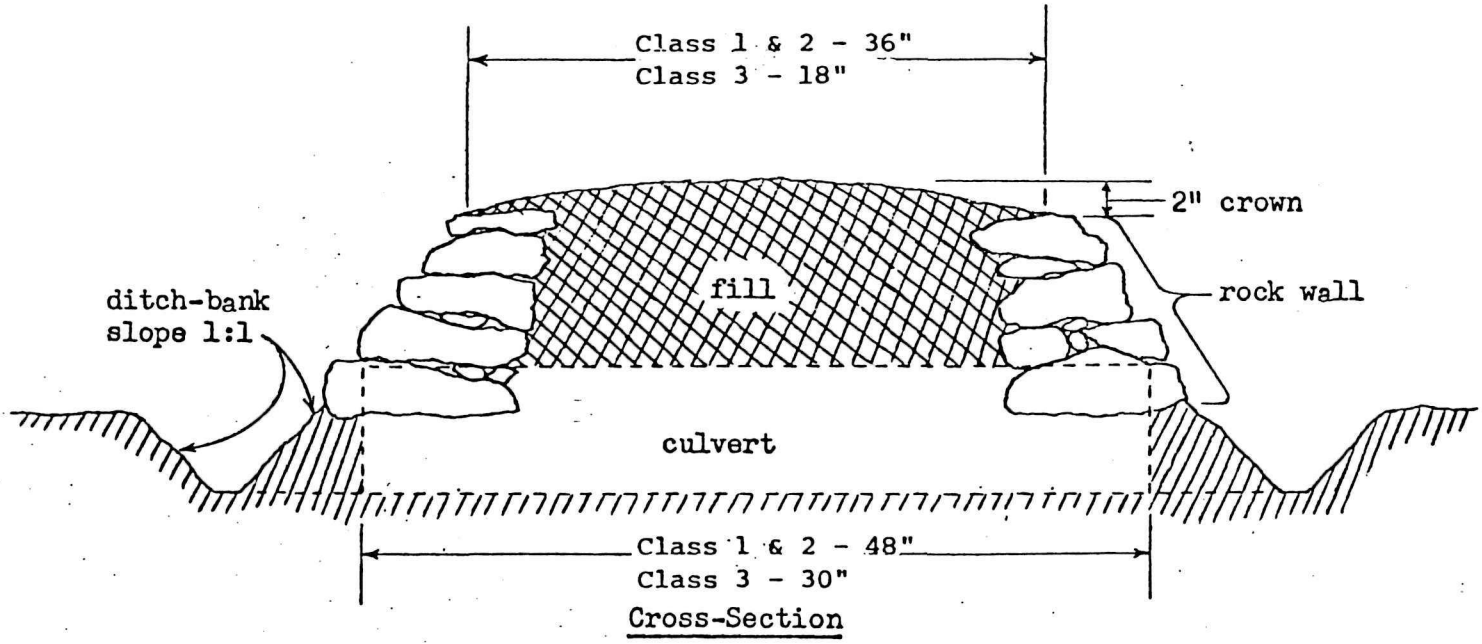
All Class 3 trails: using large flat or angular rocks, build two parallel walls on a firm base. The walls will be 12 inches high and 30 inches apart at their base. They will slope inward to 18 inches apart at their top.

The space between the walls will be filled with material removed from drainage ditches constructed on both sides of the turnpike section (see Figure 11.3), and other designated fill as needed. Soil ,except clays, and rock will be placed and compacted in layers not greater than 6 inches deep until the fill is crowned 2 inches higher than the top of the rock walls. The final 4 inch layer of fill will contain no rocks larger than 2 inches.

Adequate drainage will be provided by installation of culverts (see Figure 11.3).Culverts will be installed in accordance with the specifications of Unit 4.4 ,Culverts. The number and size of culverts for each turnpike section is shown on the attached location list.

ROCK TURNPIKE





Cross-Section

Figure 11.3

Unit 11.4 DITCHED LOG TURNPIKE

Contract Item ___

Description

This unit pertains to the construction of ditched log turnpike. The location of each turnpike section has been staked and is listed by station number on the attached location list. The total linear feet of turnpike to be constructed is_____. The total number of turnpike culverts to be installed is_____.

Construction Methods

All Class 1 and 2 trails: place two sound, peeled 10 inch diameter logs 36 inches apart.

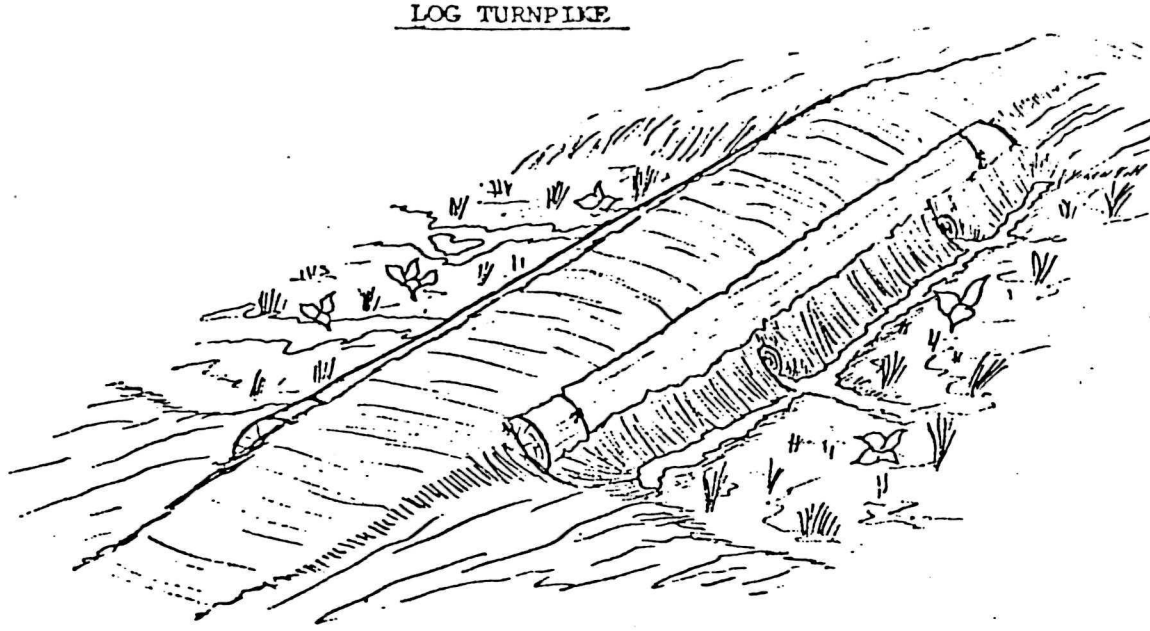
All Class 3 trails: place two sound, peeled 10 inch diameter logs 18 inches apart.

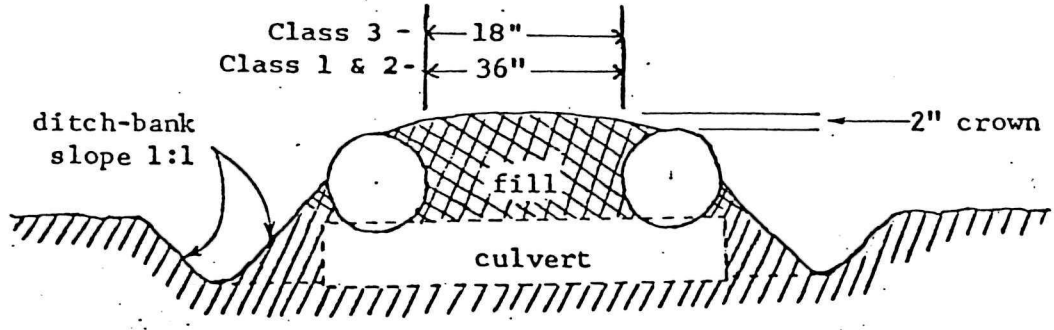
Log diameter specification is minimal for the small end of the log. Logs will be securely staked, or tied together with No. 9 wire or equivalent, so they cannot spread apart when fill material is compacted. Where wire ties are used, a twist or cable clamp will be placed next to each log so that the wire will not be higher than the center of each log.

Fill material, except clay soils, consisting of rock and soil, will be placed and compacted in layers not greater than 6 inches deep until the fill is crowned 2 inches higher than the top of the turnpike logs. The final 4 inch layer of fill will contain no rocks larger than 2 inches. Drainage ditches will be dug on both sides of the turnpike section (see Figure 11.4) and this material can be used as turnpike fill, along with rocks.

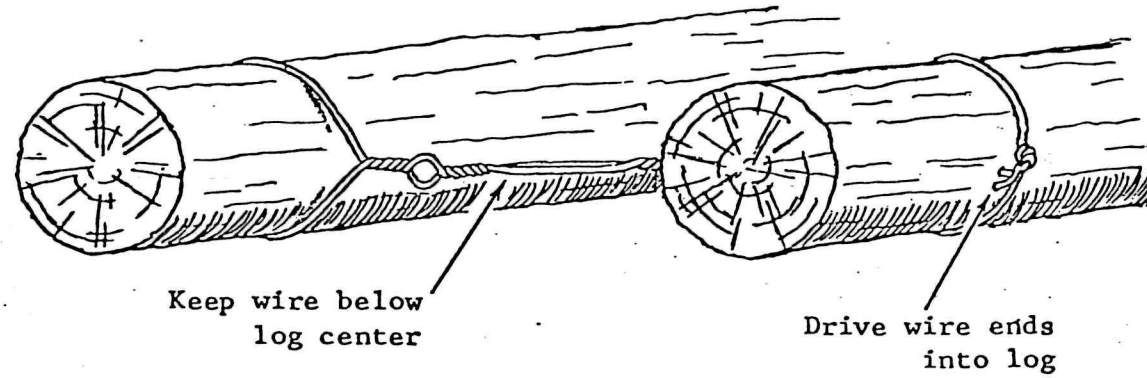
Adequate drainage will be provided by installation of culverts (see Figure 11.4) Culverts will be installed in accordance with the specifications of Unit 4.4, Culverts. The number and size of culverts for each turnpike section is shown on the attached location list.

LOG TURNPIKE





Cross-Section



Wire Tie Detail

Figure 11.4

Unit 12

HANDRAILS

Contract Item ___

Description

This pertains to the construction of handrails on trails in approaches to bridges, along cliff areas, or elsewhere as specified. Location of handrails must have the approval of the Roads and Trails General Foreman and the District Ranger. (Contractor: the total linear feet of handrail to be constructed is ____).

Methods

Class 3 trails: handrails will be constructed by emplacement in the ground of upright posts, 8 inches in diameter minimum, set in the ground a minimum of 30 inches, set 8 feet apart, and spanned by 2 rail logs. The top of the completed handrail will be 42 inches above trail tread level. On all-purpose trails handrails will not be placed closer than 36 inches to the tread margin (48 inches from tread centerline to handrail).

Rail logs will be a minimum of 6 inches in diameter. The top rail will be fixed to the upright posts with 10 inch spikes. The mid-rail will be notched for firm fit against the upright posts, and fastened to the posts with ½ x 8 inch lag screws; holes for lag screws and spikes will be pre-bored in the rail logs. Splices in rail logs will be made at an upright post to assure a firm splice.

All logs are to be of sound, peeled cedar or Douglas-fir when cedar is not available. On site native material will be flagged by the government. Stumps will be cut as close to the ground as possible and limbs, bark and other debris will be scattered out of sight.

Class 1 and 2 trails: all methods for Class 3 trails will apply with the exception that split cedar may be used instead of logs when the superintendent approves.

HANDRAILS

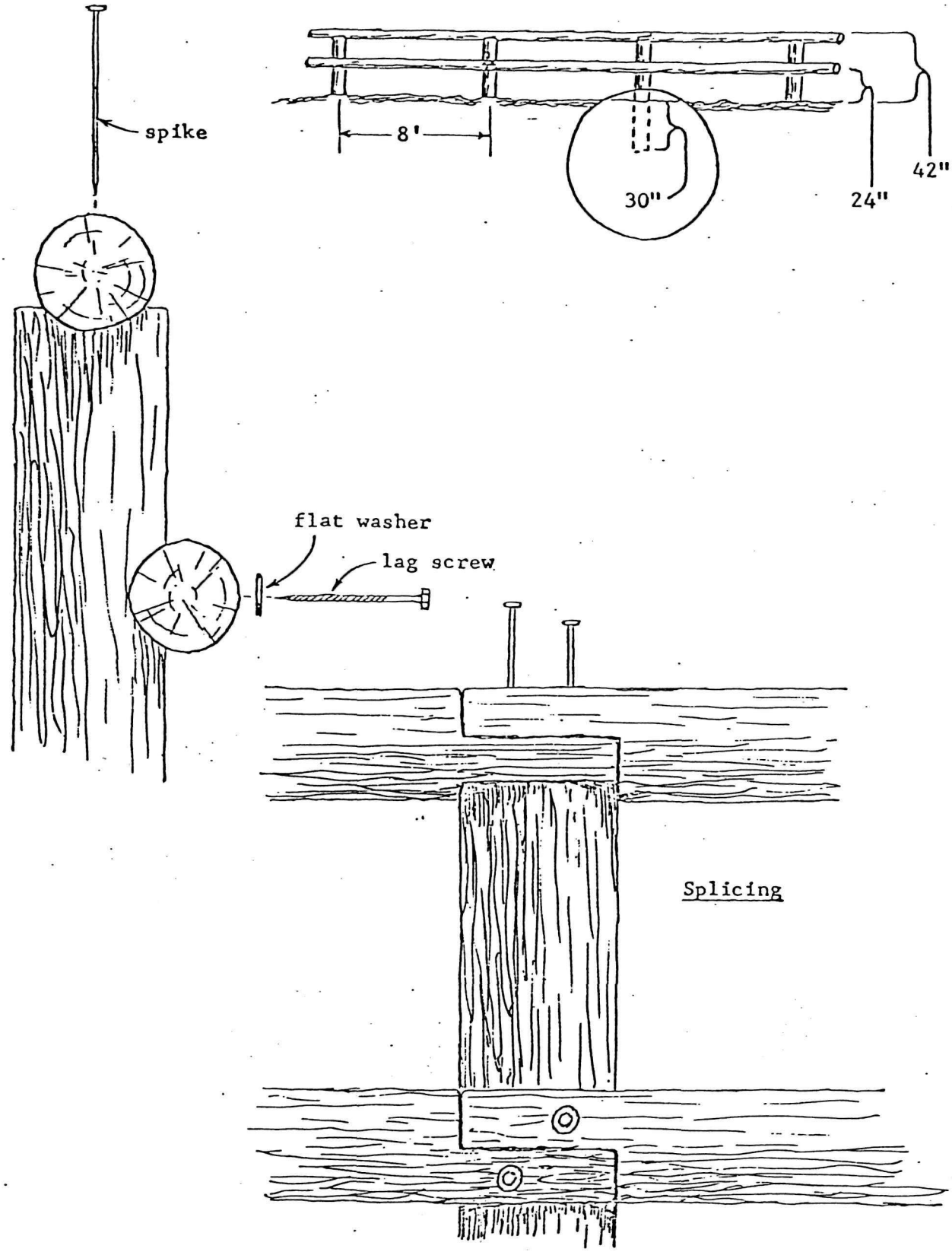


Figure 12

WOOD STRINGER CHART

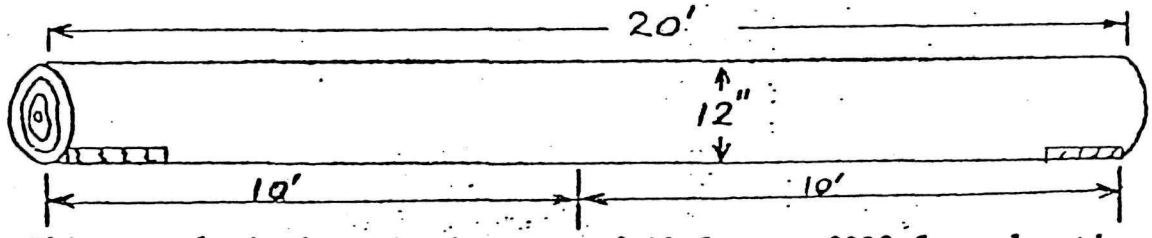
Note: This chart is for three (3) stringers only.

Get elevations from Mount Rainier National Park Contour Map.

The following diameters are for the center of the stringers.

The span is in feet and the diameter in inches.

Elevations	2000 Dia.	3000 Dia.	4000 Dia.	5000 Dia.
Length of span:				
4 ft.	6"	6"	6½"	7½"
5 ft.	6"	6½"	7"	8"
6 ft.	6½"	7"	9"	9½"
7 ft.	7"	7½"	9½"	10"
8 ft.	7½"	8"	10"	10½"
10 ft.	8"	10"	11"	12½"
12 ft.	9"	10½"	12½"	13"
14 ft.	9½"	12"	14"	15"
16 ft.	10½"	13"	15"	17"
18 ft.	11"	15"	16½"	18"
☆ 20 ft.	12"	15½"	17½"	19"
22 ft.	13"	17"	19½"	20"
24 ft.	14"	17½"	20"	22"
26 ft.	15"	18½"	22"	23½"
28 ft.	16"	20"	23"	24"
30 ft.	16½"	20½"	23½"	24½"
32 ft.	17"	21"	24"	25"
34 ft.	17½"	21½"	24½"	26½"
36 ft.	18"	22"	25"	28"
38 ft.	18½"	23"	26½"	29"
40 ft.	19"	24"	27"	30"
42 ft.	19½"	24½"	28"	31"
44 ft.	20"	25"	29"	32"
46 ft.	20½"	26"	30"	32½"
48 ft.	21"	27"	31"	33"
50 ft.	21½"	27½"	31½"	33½"
52 ft.	22"	28"	32"	34"
54 ft.	22½"	28½"	32½"	34½"
56 ft.	23"	29"	33"	35"
58 ft.	23½"	29½"	33½"	35½"
60 ft.	24"	30"	34"	36"



This example is for a bridge span of 20 feet at 2000 feet elevation and the diameter would be 12" at center of stringer. (Use 3 stringers).