HELVETAS
ETHIOPIA

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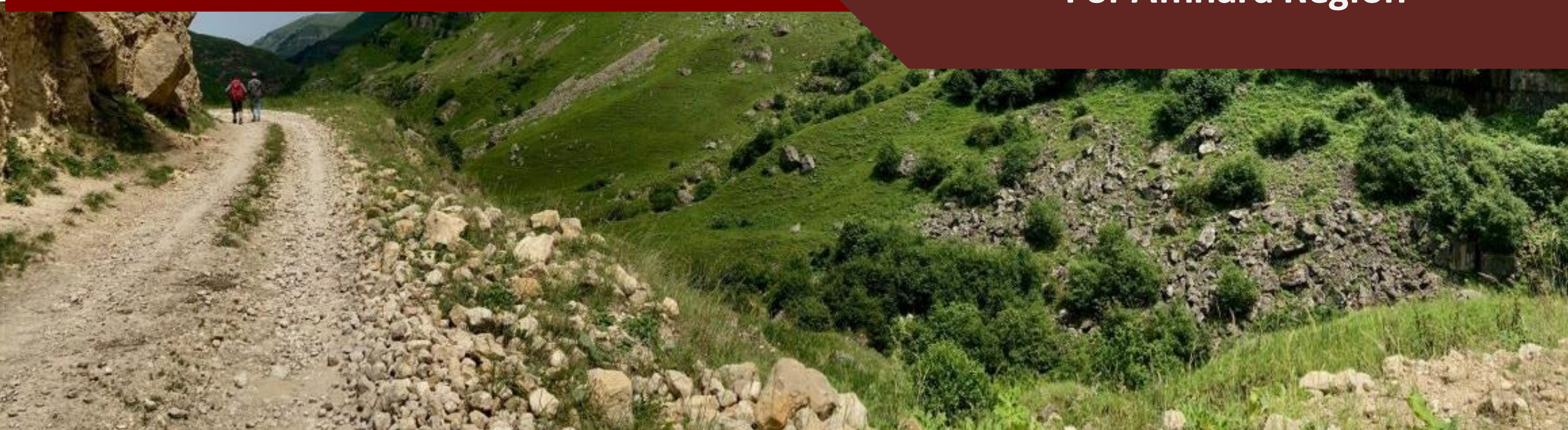
Foot Trail Development Manual

For Amhara Region



COMMUNITY-BASED FOOT TRAIL MANUAL

OPERATION MANUAL FOR PLANNING, CONSTRUCTION, AND MAINTENANCE OF PEDESTRIAN FOOT TRAILS IN AMHARA REGION

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Foreword

The most common means of travel in the rural areas of most developing countries such as Ethiopia is walking, using animals, and bicycles. Many farmers usually walk long distances that involve load carrying on the head or shoulders. Similarly, many, if not most, villages of rural Ethiopia do not have access to roads to improve the livelihood of the community. These rural communities and farmers are still dependent on the existing extensive network of pedestrian foot paths and tracks for access to agricultural fields, sources of water and firewood and to the main access road with towns and cities.

Rural paths and tracks have rarely been "constructed" but have evolved over a period of time through the passage of people, bicycles, garis', carts and animals. Generally, this evolution has resulted in a good alignment which balances the shortest distance with the least effort in terms of avoiding obstacles and minimizing hill climbing. Problems with natural foot trails do however arise, making them difficult and sometimes dangerous for travelers, and therefore inhibiting the movement of people and goods. Simple improvements to paths and tracks can often bring about substantial benefits to rural communities by making the paths safer and easier to use. Spot improvements on short sections of the path or tracks are usually the most effective.

For instance, in many cases of the Amhara National Regional State, these problems can be remedied by using simple techniques some of which are described in this manual. Sometimes measures have been taken by the local people themselves to improve these sections but often their resources are limited or they do not have the technical knowledge or skills to overcome the problems successfully.

This manual presents practical measures that can be taken to improve or upgrade traditional foot trails, particularly in the Amhara national regional state. These improvements are not only directed to making travel by foot easier but also cover the need to provide access for intermediate means of transport such as pack animals, gari's, and bicycles.

The manual includes guidelines on organizational issues; the appropriate standards of planning, design, construction and maintenance phases for foot trails for different uses; as well as specific technical solutions to problems which are commonly encountered on sections of pedestrian foot trails.

Part A

General

A. INTRODUCTION

In Ethiopia, the construction and maintenance of foot trails is usually considered the responsibility of the communities that use them. Financial resources are rarely available to construct and maintain this vital level of infrastructure. Local communities who wish to improve these paths will often be required to provide their own resources which will usually be in the form of free labour.

A.1 Forms of Community Organizations for Foot Trail Development

The coordination of improvement or maintenance of paths and tracks will usually be undertaken by a formal or informal community organization or group. These groups can take a number of different forms based on either the government administrative setup or common social and cultural gatherings of the society.

Organizations based on administration setups can be formed at the lowest level of local government administration, also known as Woredas' operating at a village level. In remote areas where the community is not fully mobilized by the government administration units (Gots and Kebeles), the organizations can also be formed following the traditional leadership structure.

Another and perhaps more effective approach depending on particular existing situations is to organize the community based on common social and cultural gatherings. These groups are defined by the members themselves and reflect the prevailing social and economic characteristics in the rural population. Examples of these groups may be farmers unions, Edir and Ekub associations.

The manual gives guidelines on providing technical assistance to these groups.

A.2 Supports That Can Be Provided to Local Organizations

The community organizations formed to construct a footpath will usually need technical support in order to improve a footpath and particularly to overcome specific problems along the path. The technical support required will depend on the difficulty of the local terrain. This manual aims to provide the technical background that is required to provide the support to the community group. This support may be provided, for instance by a technician from the local woreda or kebele officials or by a field worker from a NGO, or the community.

The manual provides the technical background required through the use of simple diagrams and text to enable a technician to provide the necessary support to the community group. It is envisaged that the person providing technical support will make use of the diagrams in the manual when explaining issues and tasks to be undertaken by the community group.

A.3 Role of the User Community

As is the common practice in Amhara Region, normally, community members are responsible for funding and construction of foot trails. Technical support should be sought from the local governmental offices and or other stakeholders so that critical parts of the foot trail will lack proper technical planning and construction methods. The drainage systems should be checked and properly executed, and maintained. Ensuring the proper planning and construction of critical parts of the foot trail eliminates the causes of multiple problems including safety problems for pedestrians and animals.

Figure A-1: A sample foot trail in Bahir Dar Zuria Woreda

Figure A-2: Poorly planned and constructed foot trail, failing due to lack of a cross drainage structure

A.4 Trail Classification and Specifications

For clarity of communications, it is good to first understand the classes of trails and what each grade entails as a specification. There are four general categories of trails depending on their grades. The minimum specifications for each trail grade can be expanded as follows as per Trail Design Standards & Specifications, 2006.

A.4.1 Grade 1

- A minimum width of 2.5 m allowing for side-by-side riding and walking. This makes passing and overtaking easy, and provides sufficient width for novice riders to feel secure. The minimum width may be reduced to protect historic features, or for environmental or visual amenity reasons. Width also caters for 4wd vehicle access for maintenance purposes.
- Maximum prolonged gradient of 2 degrees (28:1). Maximum gradient of 4 degrees (14:1)
- Maximum out-slope cross fall of 3% for straight sections of track.
- Corners shall have a minimum inner radius of 6.0 m and in-slope gradient or cross-fall of 6- 8% except hair pins which must not exceed of 2.5 m
- Minimum structure width of 2.0 m clear. Clear means between the closest parts of the barriers.

- clearly sign-posted, well-defined trail from beginning to end so visitors can easily find their way in both directions and during inclement weather
- A compacted, well bound smooth riding surface with suitable camber to provide a pleasurable and easy riding experience. Riders should never feel they are going to slide off the trail. Minimum compacted aggregate depth of 75 mm, with 10 mm compacted crusher dust top layer
- All water courses to be culverted or bridged
- All areas of fall hazard within 1.5 m of track (exposure) shall be protected with barriers that meet the building code.
- No stiles are to be used. All fences are to be crossed using cattle stops/bollards
- Sight lines – a minimum of 15 m clear sight distance is to be achieved around all corners

A.4.2 Grade 2

- A minimum width of 2.2 m but generally 2.5 m wide allowing for side-by-side riding and walking. This makes passing and overtaking easy, and provides sufficient width for novice riders to feel secure. The minimum width may be reduced to protect historic features, or for environmental or visual amenity reasons. Width also caters for 4wd vehicle access for maintenance purposes.
- Maximum prolonged gradient of 4 degrees (14:1) but where length >100m it must be broken with flat recovery sections 10m long minimum at 50-75m spacing's. Maximum gradient of 6 degrees (10:1) for no more than 30m without a flatter recovery section of equal or greater length
- Maximum out-slope cross fall of 3% for straight sections of track.
- Corners shall have a minimum inner radius of 4.0m and in-slope gradient or cross-fall of minimum 5-10% (to be suited to the trail geometry to ensure slip free riding at design speed) except hair pins which must not exceed of 2.0 m
- Minimum structure width of 2.0 m clear. Clear means between the closest parts of the barriers.
- A clearly sign posted, well defined trail from beginning to end so visitors can easily find their way in both directions and during inclement weather
- A compacted, well bound smooth riding surface with suitable camber to provide a pleasurable and easy riding experience. Riders should never feel they are going to slide off the trail. Minimum compacted aggregate depth of 75 mm, with 10 mm compacted crusher dust top layer
- All water courses to be culverted or bridged
- Areas of significant fall hazard that could result in death or serious harm within 1.5 m of the trail edge shall be protected with barriers that meet the building code. Areas of

exposure where there is not a significant hazard may be protected with fencing, bunding, vegetation or signage

- No stiles are to be used. All fences are to be crossed using cattle stops/bollards
- A minimum of 10m clear sight distance is to be achieved around corners, or additional warning/speed calming measures may be required to avoid user conflict.

A.4.3 Grade 3

- A minimum width of 0.9 m wide allowing for comfortable single file riding and walking only. The minimum width may be reduced to protect historic features, or for environmental or visual amenity reasons over short (50 m) sections. Width caters for quad bike access for maintenance purposes.
- Maximum prolonged gradient of 6 degrees (10:1) for sections not longer than 100 m with flat sections of minimum 25 m length between. Maximum gradient of 8 degrees for no more than 30 m without a flat recovery section of equal or greater length
- Maximum out-slope cross fall of 3-6% for straight sections of track.
- Corners shall have a minimum inner radius of 3m and in-slope gradient or cross-fall of minimum 8-15% (to be suited to the corner, speed and trail geometry) except hair pins which must not exceed of 1.2 m
- Minimum structure width of 1.0 m clear. Clear means between the closest parts of the barriers to ensure quad bike access.
- A clearly sign posted, well defined trail from beginning to end so visitors can easily find their way in both directions and during inclement weather
- A compacted riding surface of either appropriate in situ gravels or imported gravel to provide an all- weather surface. Minimum depths to suit ground conditions
- Trail cross fall to provide an enjoyable riding experience for intermediate riders. Riders should never feel they are going to slide off the trail due to incorrect cross slope.
- Water courses may be crossed with fords or be culverted or bridged if required. Any areas of soft or boggy ground shall be made all weather to prevent mud and damage to the trail surface
- Areas of significant fall hazard shall be protected with barriers that meet the building code. Areas of exposure within 1.5 m of the trail edge where there is not a significant fall hazard may be protected with fencing, bunding, vegetation or signage
- Stiles may be used but preference should be given to using Cattle stops for convenience and maintenance purposes. Where a stile is used, a gate is required adjoining for maintenance use.
- A minimum of 5m clear sight distance is to be achieved around corners, or additional speed

- calming measures (trail alignment, sag, etc.) are required to avoid user conflict.

A.4.4 Grade 4: Natural Walking/Cycling Tracks

- A minimum width of 0.3 m wide.
- Percentage of track gradient between 15 – 20 degrees (must not be more than 10% of total track length)
- Maximum out-slope cross fall of 3-6% for straight sections of track.
- Corners shall have a minimum inner radius of 3 m and in-slope gradient or cross-fall
- Minimum structure width of 1.0 m clear.
- A clearly sign posted, well defined trail from beginning to end so visitors can easily find their way in both directions and during inclement weather
- Natural ground maybe used but a preferred surface of 50 mm compacted AP20 at lease 50% broken faces with portion of fines, 10 mm crusher dust on top
- Water courses may be crossed with fords or be culverted or bridged if required. Any areas of soft or boggy ground shall be made all weather to prevent mud and damage to the trail surface
- Areas of significant fall hazard shall be protected with barriers that meet the building code. Areas of exposure within 1.5 m of the trail edge where there is not a significant fall hazard may be protected with fencing, bunding, vegetation or signage

A.5 How to Use This Manual

The manual is divided into six parts each of which covering a different aspect of the construction /improvement of foot trails.

Part A: General

This section covers the current community – based foot trail construction practice in the Amhara region. It consists of qualitative analysis of the case studies including a SWOT analysis conducted using multiple data collection tools.

Part B: Planning

This section covers four issues. The first section is about need assessment and community mobilization approaches. The second part covers community engagement and institutional planning techniques. The third part deals with the technical aspects of the planning process. And finally, resource mobilization and fund-raising guidelines are provided.

Part C: Design

This section provides the central source of technical information on the design of footpaths and on the methods for dealing with the main problems found along footpaths. There are subsections on: Alignment and setting out, Improving the path surface, Drainage, Paths on steep slopes, crossing marshy ground, and Simple water crossing such as stepping stones, drifts and culverts

Part D: Foot Trail Construction

This chapter covers the foot trail construction techniques and requirements, including standards, testing, and unique methodologies for parts of the foot trail that need a due care; such as cross drainages.

Part E: Foot Trail Maintenance

More so, regular maintenance of footpaths is essential to sustain the work put into improving the paths and the improvements achieved. This section provides guidelines on maintenance to be carried out and how that can be organized.

Part F: Appendices

Finally, in the appendices are larger tables, forms, checklists and flow charts which will be important for technicians that will help the community in each phase of the foot trail development.

Part B

Foot Trail Planning

and

Community Mobilization

B. FOOT TRAIL PLANNING

This section provides principles of trail planning in Amhara Region and more technical guidelines about project proposal preparation; conducting feasibility study of an initiated trail project; ways to raise funds to fill financial gaps in the initial capital cost; and ways to mobilize and engage the community towards the construction and latter for the management of the project.

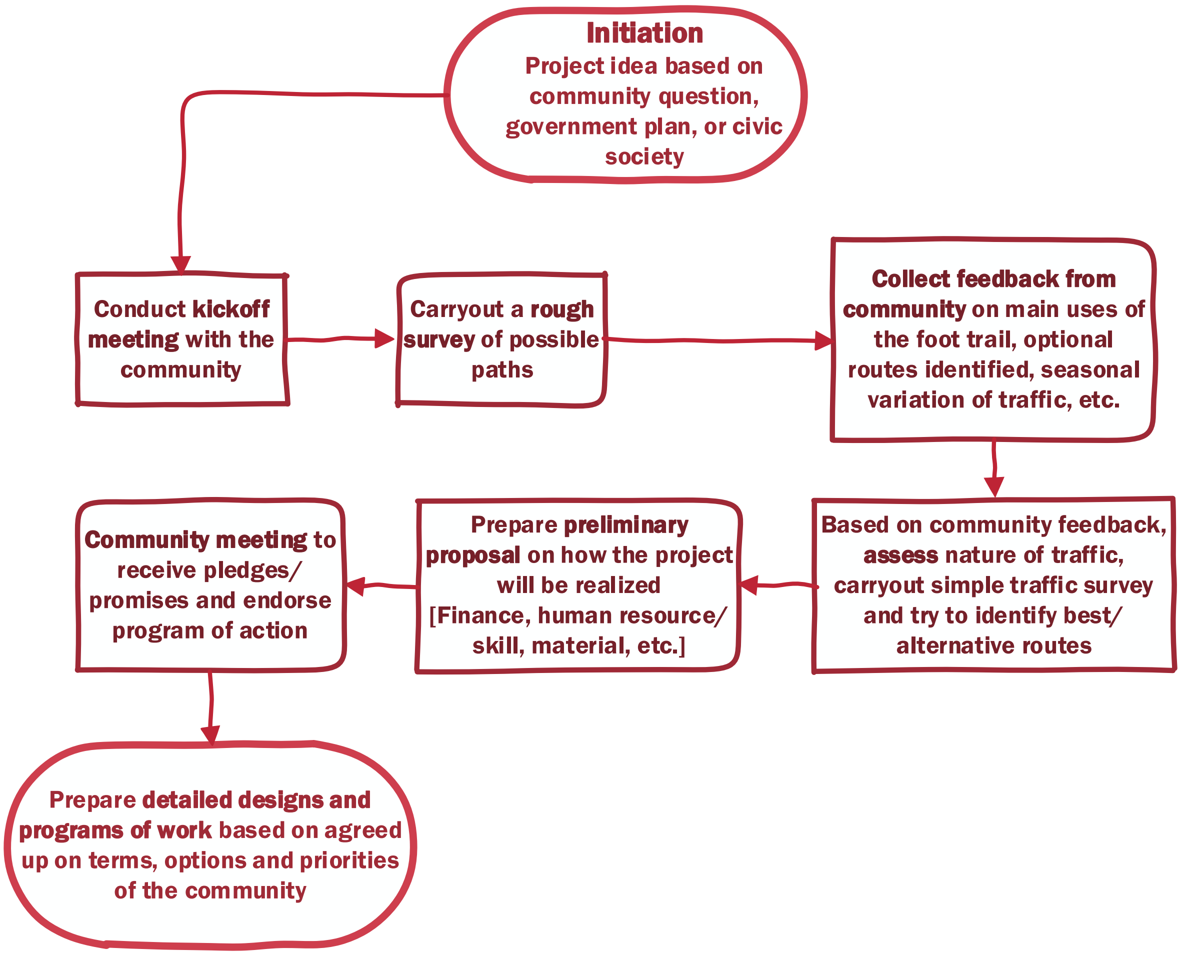


Figure B-1: General flow chart of a community-based foot trail planning

B.1 Planning Principles

Trails in Amhara Region are normally used as initial means of access infrastructure to connect rural societies to main road infrastructures. There are also trails constructed in reserved areas like natural parks and monasteries, where noise and accidents from motorized transport are not tolerated. Planning of such trails may involve recreational and cultural elements in addition to construction standards. In this manual, however, we will focus on trails purposed as IMTs for subsistent rural communities.

In principle, the trails should be cost-effective, sustainable, and accessible.

i. Cost-effective

Cost refers to both capitals raised either in the form of fundraising and investment or direct money, labour, and material commitment from the community members. Considering the resource strains of the societies leading a subsistence lifestyle, the trails should be planned to be constructed from locally available construction materials, tools, and skills. The relevant question that should be asked here is “how to make the trail affordable without significantly compromising its quality?” The answer to this question should depend on prior assessment of funding organizations’ viability, community commitment, and resource availability.

ii. Sustainable

Sustainability refers to a broad set of ideas including social, economic, and environmental compatibility of the project as well as longevity of the structural elements of the trail itself.

Social sustainability of the trail depends on the societal integration role it can play by providing opportunities - for relatives living in different kebeles to come together to feast or to mourn; for different communities to celebrate cultural and religious holidays together, for farming unions to assemble and discuss on the management of shared natural resources (for instance irrigation water use) etc.

Economic sustainability on the other hand refers to the long-term resource and finance-based affordability of the trail. Economic sustainability largely depends on community engagement to ensure timely maintenance of key elements of the trail such as drainage and river crossings before absolute failure. The availability of viable agencies (governmental or non-governmental) and viable civic societies also play a vital role to make the project economically sustainable.

Environmental sustainability should be ensured by conservation and enhancement of natural areas, protection of biodiversity, and raising environmental awareness in the community. The location of the trail should be laid out in a way that it will not disturb wildlife habitats, avoid land degradation, soil erosion, and gully formation. In general principle, the trail layout and design should incorporate means that will minimize environmental impacts and when possible, play a positive role (for example wooden guardrails can function as fences to prevent open grazing in reserved areas).

The durability of structural elements is one variable of sustainability. High-quality construction materials, good design, and the fact that whether the landscape supports trails or not determines its longevity. Provided that appropriate design and management is applied, structural elements being more durable implies high quality of construction materials and hence higher initial capital and less intensive ongoing maintenance. So, it is a tradeoff between affordability and quality. In this regard, a good judgment should be made by the technician in terms of selecting construction materials and appropriate skills to construct parts of the trail, especially the key components.

iii. Accessible

Accessibility is as important as sustainability and it refers to the usability of the trail by all members of the communities. Accessibility can be achieved by incorporating the seven Principles of Universal Design (look table below).

Table 1: the 7 principles of universal design[1]

The purpose of the 7 Principles is to guide the design of environments, products, and communications. According to the Center for Universal Design in NCSU, the Principles "may be applied to evaluate existing designs, guide the design process and educate both designers and consumers about the characteristics of more usable products and environments." The seven principles are:

Principle 1: Equitable Use

Principle 2: Flexibility in Use

Principle 3: Simple and Intuitive Use

Principle 4: Perceptible Information

Principle 5: Tolerance for Error

Principle 6: Low Physical Effort

Principle 7: Size and Space for Approach and Use

Principle 1: Equitable Use
The design is useful and needed by people with diverse abilities.

***Guidelines*:**

- ☞ Provide the same means of use for all users: identical whenever possible; equivalent when not. For example; the design of slopes in approach sections to trail bridges and stepping stones in cross drainages should not be adventurous for the youth group, usable by the elderly and disabled.
- ☞ Avoid segregating or stigmatizing any users.

[1] Adapted from The Centre for Excellence in Universal Design (CEUD): https://universaldesign.ie/What-is-Universal-Design/The-7-Principles/#p1

- ☞ Make the design accessible to all users (refer to the design standards in the trail design and construction section).

Principle 2: Flexibility in Use

The design accommodates a wide range of individual preferences and abilities.

***Guidelines*:**

- ☞ Provide choice in methods of use (ramps as alternatives to steps for the disabled people with wheelchairs).
- ☞ Accommodate right- or left-handed access and use (this for example refers to guardrails in slippery segments of the trail).

Principle 3: Simple and Intuitive Use

The use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.

***Guidelines*:**

- ☞ Eliminate unnecessary complexity (intended construction methods and equipment should, for example, be by local skills and available tools).
- ☞ Be consistent with user expectations and intuition.
- ☞ Accommodate a wide range of literacy and language skills.
- ☞ Arrange information consistent with its importance.
- ☞ Provide effective prompting and feedback during and after task completion.

Principle 4: Perceptible Information

The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.

***Guidelines*:**

- ☞ Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.
- ☞ Provide adequate contrast between essential information and its surroundings.
- ☞ Maximize the "legibility" of essential information.
- ☞ Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions).
- ☞ Provide compatibility with a variety of techniques or devices used by people with sensory limitations.

Principle 5: Tolerance for Error

The design minimizes hazards and the adverse consequences of accidental or unintended actions.

Guidelines*:*

- Arrange elements to minimize hazards and errors: hinges in approach ramps to trail bridges should be well connected, and contingency plans (such as filling the space underneath the ramp with loose material) should be considered for the risk of failure.
- Provide warnings of hazards and errors.
- Provide fail-safe features.
- Discourage unconscious action in tasks that require vigilance.

Principle 6: Low Physical Effort

The design can be used efficiently and comfortably and with a minimum of fatigue.

Guidelines**:**

- Allow the user to maintain a neutral body position (this has much to do with path slopes).
- Use reasonable operating forces (especially when the trail is supposed to be used for non-motorized means of transport such as animal pulled carts and bikes). Again, this principle also has much to do with appropriating the path slope and the surface finish quality.
- Minimize repetitive actions.
- Minimize sustained physical effort.

Principle 7: Size and Space for Approach and Use

Appropriate size and space are provided for approach, reach, manipulation, and use regardless of the user's body size, posture, or mobility.

Guidelines**:**

- Provide a clear line of sight to important elements and enough right of way for any walking user (for instance, consider women carrying firewood which requires a significant lateral clearance).
- Make reach to all components comfortable for any user.
- Accommodate variations in hand and grip size (especially while designing guardrails).
- Provide adequate space for the use of assistive devices or personal assistance (such as wheelchairs).

Principles addressed in Table 1 are meant to ensure the usability of the trail by all members of the community. In terms of networking, however, the accessibility of the trail shall be judged in terms of the following criteria

- The proximity of the path to villages (*Menders* or *Gotts* in the Amhara region context).
- Proximity to rural service providers, farm unions, open market places, water sources, etc.

- Linkages to other trails and availability of trail bridges in case of large river crossings.
- Security of the area in which the path will pass through. The trail layout should avoid unsafe places habituated by dangerous wild animals or places with possible hiding locations for robbers.

B.2 Preparing a Project Proposal

It is explained in the Planning Principles section that a trail to be realized has to be environmentally, economically, and socially sustainable. The right way to demonstrate that to the land managers (for approval) is through a comprehensive trail project plan.

Section 10 subsection 2 of the Rural Land Administration and Land Use Proclamation of Ethiopia[2] states "the holder shall have the obligation to allow the construction of irrigation lines and other infrastructures if they cross his landholding."

As trials will take only a smaller fraction of private lands and can be, in most parts, designed to coincide with the property borders, land use issues are less likely to be trouble. It is expected that they demand the trail services and let the path pass through their lands. Yet that may not be always the case and authorities will need to settle legal issues. In case of refusal by a few individuals, the regional land managers may have to provide the landholders with a means of compensation for letting their land for shared use or settle their case legally. For all that to happen the authorities and the community will have to be convinced by the feasibility and possible benefits of the project.

Any particular trail project plan should identify the burning issue of the specific project and give more emphasis to that. Nonetheless, the project proposal should address the following areas.

1) An introduction section covering the location and description of the proposed trail, background of the community as well as the intended user groups (dictated by the type and standard of the trail) and perceived need for the trail.
2) A summary of the separate feasibility study and availability of funding options (see section B.3, and section B.4 of this manual).
3) Community engagement and mobilization to enable the construction and ongoing management of the trail (see section B.5 for more information).
4) Availability of viable social organizations, an agency (government or private sector) to facilitate the development of the trail and engage the community to organize and commit resources (see section B.6 of this manual). The roles and responsibilities of organizations

[2] Proclamation No. 456/2005, Federal Democratic Republic of Ethiopia Rural Land Administration and Land Use Proclamation, Addis Ababa - 15th July, 2005.

involved in the project and project governance arrangements should also be addressed in the proposal.

5) The estimated cost, timing, and staging of the development of the trail (see section B.7 and section **Error! Reference source not found.** for more information). This part is vital t o convince the land managers and get a formal endorsement from the Kebele and Woreda authorities.

B.3 Feasibility Study

The feasibility study should aim to determine whether or not the project is technically and economically possible. While testing the plan's operability the feasibility study should address both short term (construction) and long-term (ongoing management and maintenance) challenges should be considered.

The feasibility study can be conducted by an experienced expert from the enabling organization. Depending on local settings the study document can have different outlines and can give more emphasis to particular pressing issues. The following headlines followed by thought provoking and framing questions are provided to assist the professional conduct the study without missing a critical component.

1) Project Overview:

   Questions to be addressed in this section are: Where is the geographic location of the project? How was the project initiated? Did the community request for the project or it still needs mobilization? Who are the intended users of the proposed trail?

2) Need Assessment:

   Is there a demonstrable need for the particular trail? Are there other similar trails in the *Woreda* where lessons can be learned from? Are there other trails in the vicinity of the proposed location which can be upgraded at a lesser cost?

   How is the project integrated with the woreda development plans in terms of, strengthening community ownership of rural infrastructure (Foot trails and Trail bridges), improving access to social and basic services as well as economic resources and opportunities of the rural settlements in Amhara.

3) Planning Endorsements:

   Has the project been already identified as a priority in the Amhara Rural Road Authority's plan or any other local/ woreda/ regional strategic plan? Has the local Community and/or *Woreda* land manager given their endorsement for the project? What approvals are necessary? Have they been granted or are there barriers that may complicate the approval process?

4) Network Improvement:

How will the project provide linkages between kebeles, woredas, towns or community facilities, open markets, service centres other trails or main receiving road infrastructure? How will the project enhance the lifestyle of the communities by serving as an initial means of access in the wider transportation infrastructure network? How will the project increase productivity by enabling agricultural agency professionals to ride to farms and spend more time with farmers for more guidance and follow-ups?

5) Management and maintenance planning:

How will the trail be managed and maintained and what is the management model for the trail as outlined in Chapter 4? How will the community-based foot trail management strategy work? How will the community raise capital and commit resources to undertake and pay for ongoing operation and maintenance costs? Are there other viable grant providers? How will the trail be monitored to measure benefits?

6) Community mobilization and engagement:

Was the trail project initiated by the local community itself? Is the community mobilized? Can the project demonstrate that it has support from the local community, trail user groups, community leaders, service organizations, the Woreda Transport Bureau, schools, commercial tourism businesses and other non-Government groups? What methods have been used to gain knowledge of this support?

Does the project accommodate a range of trail users (e.g., walking, cycling, horse riding, people with mobility impairments and educational purposes)? How will the different users share the trail?

7) Concept design:

What are the physical specifications of the trail: length, width, surface materials, drainage, trailheads, interpretive signage, safety elements and trail markers? What are the required standards of construction?

8) Environmental and Socioeconomic Impact Assessment:

How will the project protect and improve areas of environmental significance? How will it contribute to improved knowledge of the environment and what interpretive material will the project provide?

9) Anticipated challenges and remedies:

What does the preliminary SWOT analysis (See section …) of the 'on ground' conditions say? Have constraints and opportunities been identified? Was the trail layout proposed based on the sustainable trail design principles outlined in section B.1?

10) Cost Estimates and Staging of the Work:

What are the work items and what is the expected capital cost for the construction of the trail project? To what extent the landscape supports the desired standard of the trail? Will it require select material in a significant quantity? Who will pay for select materials and external skills, if required in certain locations where the specification of the work necessitates as such? How will the construction of the trail be funded?

11) Funding Opportunities:

Can the community cover all the costs including cross-drainage structures, guard rails and select fill material supplies when mandatory? If not, what funding opportunities are available? Can ‘in-kind’ support be provided by community organizations? Does the project satisfy the requirements of the funding organizations? It is important to show that the project can be cascaded to be developed segment by segment in different periods. That will increase the project’s chance to win a grant as the one-time amount requested from agencies will be reduced.

12) Conclusion:

Elaborate the occasion in context with the Amhara Region’s strategy to provide access to rural communities and integrate rural land? Explain the Exigency & Kairos, which is why now is the right time to develop the trail and why it should not wait. Why should the project proceed? What are the strengths and weaknesses of the project? What is required for the project to proceed?

B.4 Funding (Financial) Sources and Options

The ownership of trails is rarely defined. Usually, they are considered the responsibility of the communities that use them. Because of that, financial resources are seldom available to construct and maintain this vital level of infrastructure.

Local communities who wish to improve these paths and tracks will often be required to provide their resources, usually in the form of free labour. A formal or informal community organization or group will usually undertake the coordination of improvement or maintenance of paths and tracks. There can be some resources or skills the community cannot afford. Construction materials such as select fills in wet areas and water crossing structures cannot be constructed by in situ soil and stones. In such cases fundraising is important.

The group together with the enabling/assisting organization should explore a wide range of funding opportunities to ensure a continuous supply of resources for ongoing maintenances. Consider diverse funding sources including foundation grants, gifts from individual donors, especially from those who grew up with the community, and in-kind donations from organizations and businesses in the area. Focus on local resources whenever possible.

Consider drafting a standard fundraising language that can be used for a variety of “asks.” Make sure to include the best argument for why the foot trail is important as well as your mission, goals, objectives, strategies, and plans for evaluation. Don’t forget to add specific information about the community from the need assessment that will increase the likelihood of people to fund.

B.5 Community Mobilization

In ideal cases, the community is expected to recognize the access constraints and mobilize itself through available administrative and civic arrangements, and request help for the realization of foot trail development projects. If that is not the case, the initiation can also come from enabling organizations (the NGO) depending on the possible, and so far, unforeseen improvements, the foot trail development can bring upon the livelihood of the community. Such assisting organizations may discover shortcuts that will enable local farmers to sell their products in a nearby market, or reduce the workload of women by providing easy access to utilities and services such as water sources and grain mills. Hence this part addresses steps to mobilize the community when the initiation comes from assisting bodies such as NGOs, Civic societies, or the government.

The objective of the community mobilization is to create awareness so that the community will understand the need and become the owner of the project. Sense of ownership is vital as that will ensure the possibility of continuous maintenance and willingness to mobilize resources by the community itself.

Step 1: Initiation

A rough need assessment should be conducted especially if the project is about developing a new footpath instead of improving an existing one. The following questions can be asked to determine the importance of foot trail developments.

- How much traffic will the route have?
- Will the new path reduce the travel time of the assumed users?
- Does it solve seasonal access constraints?
- Will the new route (or improvements on the existing route) improve the livelihood of the users or noticeably ease their problems?

Once the answers to these questions are known and assessed, the enabling organization can start preparing a simple community mobilization strategy.

Table B-2: A simple need assessment form

Criteria	**Weight [W]**	**Score [S]**	**Weighted Score [W*S]**
Expected number of users on a market day or a holiday: 6) Score 1; if the amount of traffic per day is less than 50	5		

7) Score 2; if the number is between 50 and 500 8) Score 3; if the number of users per day is more than 500			
Travel time reduction 9) Score 0 if there is an alternative route with more or less equal distance from the origin to the destination 10) Score 1 if there is an alternative means of access, but the proposed route reduces the travel time slightly 11) Score 2 if there is an alternative means of access, but the proposed route reduces the travel time by at least 2/3 12) Score 3 if there are no alternative means of access at all	4		
Seasonal functionality 13) If the soil is black cotton or loamy, the footpath will not be functional in wet seasons unless the surface is treated with gravel. Give it a score of 1 if the soil condition is as such and select surface material cannot be found nearby 14) Give a score of 2 if the route is in a mountainous slippery topography that travelling in winter seasons is possible but likely to involve danger 15) Give it a score of 3 if the soil condition is fair with drainable topography and there are no wide gorges across the proposed path 16) Give it a score of 4 if the soil condition is good (red ash, sandy loam, or similar) and the topography is gentle with rivers and streams that can be crossed with footrail bridges The technician from the assisting organization can also judge the combination of other geographic and social factors.	3		
Possible livelihood improvements This criterion should be judged by the type of users and the purpose of trips. 17) Score 2, if the accessing footpath will improve social interactions (like people visiting their relatives during holidays, going to mourn the death of their relatives, etc.)	5		

18) Score 3, if the footpath will allow farmers to access an alternative market to sell their harvest and buy essentials. 19) Score 4, if the footpath will ease the day-to-day burden of vulnerable groups such as women and children as well as the abuse of domestic loading animals by providing better conditions of travel or shortening walking distances.			

Step 2: Planning Mobilization Strategies

As rural communities live dispersedly with their respective communication customs and cultures, mobilization can be unsuccessful unless a fitting advocation strategy is applied. To this end, the first step is creating a community profile. This can be done through desk study by gathering information from the lower administrative units (Kebeles and Lots). If recorded data is not available the enabling organization (the organization wishing to energize the community around the foot trail development) should ask the Kebele and Lot leaders to facilitate a direct survey or questioning.

Then the organization can undertake a qualitative survey regarding the community's geographic and demographic characteristics, the strength of functioning social institutions (like Edir, Equb, Debo), and whether or not access constraints are prioritized as a pressing problem. Questioning a focus group can also be taken as an alternative. A focus group should be representative of the community including men and women, as well as residents from any ethnic minority and any age.

The information gathered at this stage shall enable the enabling organization to understand the community's social fabric to develop a working mobilization strategy. The following two are best practices to mobilize rural communities.

20) Involve influential people and all stakeholders

The focus group has tremendous advantages including respected people, local authorities, and society leaders. These people will help to easily address the community members in their camp. It will also help boost commitment among different community factions and avoid misinformation that may result from informal communications.

21) Establish a well-thought communication structure

Following the establishment of a representative focus group, the next step is to establish a working communication structure. A constant flow of information must be ensured by adopting formal communication strategies that allow for frequent, deliberate, and productive exchanges between partners.

A skilled communicator among the community members can be appointed to the role of “relationship manager” and putting this person in charge of continually informing members and

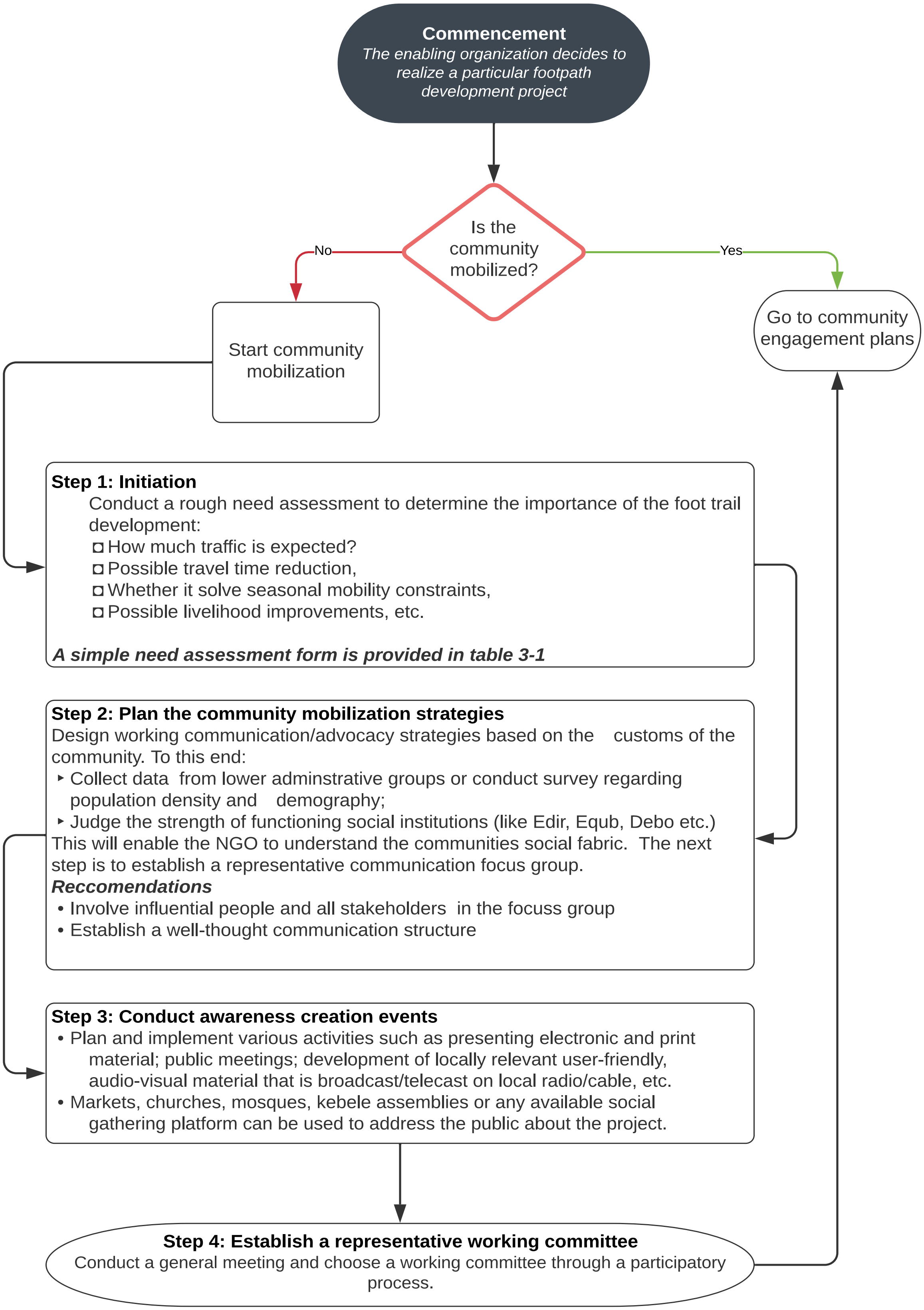


Figure B-2: Community mobilization workflow relevant stakeholders about what the partnership, the committees that will be tasked with a particular mission, the subcommittees, and even individual members are doing to advance the project.

Step 3: Conduct awareness creation events

The success of the community mobilization will be determined by the effectiveness of coordinated and well-delivered information, education, and communication strategy, which will require the cooperation of communities based on their understanding and acceptance of the project and its objectives. The mobilization strategy will include planning and implementing various activities such as presenting electronic and or print material; public meetings; development of locally relevant user-friendly, audio-visual material that is broadcast/telecast on local radio/cable, etc.

Markets, churches, mosques, kebele assemblies, or any available social gathering platform can be used to address the public about the project.

Step 4: Establish representative/working committees

Conduct a general meeting and choose a working committee through a participatory process. The following criteria should be used in choosing the committee members.

- The members of the group should be from different sections of the community, i.e., Young/old, men/women, elite/non-elite, village officials/non-officials, representative of different religious groups, etc.
- The group should have some legal status, i.e., be a committee under the village councillor be recognized by the village authority.
- The members of the group should be recognized by other members of the community.

B.6 Community Engagement

Working with a community can be a difficult and time-consuming process. However, it is essential to remember:

- The community is the client for the work. They have to provide the inputs and sacrifices and live with the outputs of the work.
- The technical assistance aims only to correctly identify the needs of the community and provide the best possible advice and guidance to the community on these. However, the community must make the final decision on what is to be done.
- The priority activities of the community are concerned with subsistence and survival. Work on improving paths has to be fitted in around these activities.

An essential starting point is to have a well-mapped-out strategy for working with the community to ensure there is proper consultation and agreement on all issues. The table sets out issues that are institutional/organizational and of a more technical nature to be discussed during group work or carried out by individuals in between.

Table B-3: Community engagement workflow

Milestone events	Community Organization / Institutional Works	Technical works
Kick-off meeting	***Introductions*** Recognizing the already mobilized community's representative committee as a working group or establishing a new one	***Setting out of planning process*** An initial introduction to community transport system – paths, roads, modes of transport, services, or markets to be accessed.
Interim work	Set up a representative organizational structure	***None***
Planning meeting	***Identify strengths and weaknesses*** of the community – financial, technical knowledge, tools, etc. Rank priority constraints and identify methods and resources to alleviate them.	***Identify access constraints*** Through a participatory mapping exercise identify key constraints in the transport system– path problems seasonal problems, slopes, poor access for animals, and IMT. Rank priority constraints and identify methods and resources to alleviate them
Interim work	Investigate the willingness of the community to contribute resources	Prepare technical designs and estimate resources needed.
Design meeting	Discuss options for path improvements and resources needed. Decide on options to be chosen and how to resource these.	Discuss/amend technical design options for improvements including maintenance implications. Discuss the work program/s
Interim work	Start to mobilize the community and discuss the organization of work.	Prepare final design and list resources needed.

Final meeting	Decide on how to obtain resources. Agreements made between bodies on resources and sourcing	Decide on final design and resources needed. Agree on the programs of work

The general principle is that the community must be involved in the whole process of the project development. All the decisions should be made in agreement with the community. And the communities shall provide the labour and material resources. Donations and resource gifts shall be welcome, but the community should believe in the project and be committed to independently bringing all the resources required.

Table B-4 Community participation procedure

COMMUNITY PARTICIPATION		TECHNICAL WORK
Kickoff Meeting 22) Community outlines problems and assistance needed 23) Discuss stages of planning	→	**Carry Out Survey of Path(s)** 24) Identify key features of the path and surrounds
Obtain Feedback 25) Main uses of path 26) Seasonal variations in traffic 27) Types of transport that need to use path	↔	28) Assess nature of traffic using path; carry out traffic survey if needed
29) Seasonal variations in problems 30) Observations on causes of problems	↔	33) Identify access problems along the path
31) What has been tried, why did it not work 32) Discuss and agree on possible options	↔	34) Identify and assess options for improvements ↓
Planning and Design Meeting 35) Discuss the proposal and agree on what is		**Prepare Preliminary Proposal** 39) Type and level of traffic to be designed for

36) Feasible

37) Agree on priorities

38) Agree on a detailed work program to be prepared

40) Design standard to be used

41) Improvements and new construction needed

42) Possible options and preliminary estimates of resources needed

Carry out Detailed Design

43) Select and design improvements/construction to be carried out

44) Specify steps and details in work to be carried out

45) Estimate resources needed

46) Specify ongoing maintenance programs that will be needed

Meeting to Agree and Finalize Program of Work

47) Work program to be carried out and scheduled

48) Resources to be provided by the community

49) Strategy on obtaining resources that cannot be provided by the community

50) Ongoing maintenance to be carried out by community

There will be four general meetings with the community at the four major stages of the project. 1) initial meeting at the beginning of the project work, on the same day the working committee is established. 2) Planning meeting, where the representative committee members will gather and layout the access constraints, challenges, previous efforts, and suggestions. 3) Design meeting, where committee members together with the assisting technicians from the enabling organization discuss options for path improvements and resources needed. Decide on options to be chosen and how to resource these. 4) Final meeting, where decisions regarding how to obtain resources and to make agreements between partners on resources provision and sourcing.

B.7 Guidelines on Technical Planning and Organization

This section is additional detail about the listed steps involved in planning and organizing the technical work. The main planning issues here are to gather detailed information on the users and also the functions of the foot trail, to put standards regarding the geometry and material minimum requirements, to conduct a technical survey along the proposed foot trail or the foot trail to be improved, preparing appropriate improving methods and finally resource estimation.

Users and Functions of The Footpath

This information will be gathered during the need assessment and the initial community meeting. At this stage, the community will have decided on the footpaths that need to be improved and the help they need. The information required for planning are:

- The route of the path – get the community group to draw a map on a large sheet of paper; mark on the main features of the path and the terrain. Collect any maps available from kebele, zone, or regional authorities.
- What are the access problems along the path where it is considered that improvements are needed – mark these locations on the map. Identify the seasonality of these problems, for instance when the problem occurs and, on average, for how many days in the year.
- What are the main functions of the footpath? i.e., which sections of the community does it serve, roughly how many people is this, and what facilities does it provide access to.
- It is important to get accurate and reliable information on both the types of users (walkers, bicycles, carts, etc.) and also the numbers of each type, as this data will determine the design standard needed for the path. For instance, it is a waste of effort to construct a wide path if it will only be used by people walking whereas if only a few carts use the track width of at least 2m will be needed.

Table B-5: a sample traffic survey template, for path improvement

Type of traffic		**Destination:** ____________________	**Origin:** ____________________
Generic category	***The specific type of traffic***		
Walking people	Man		
	Woman		
	Child		
Walking people carrying a load	Man		
	Woman		
	Child		
Walking people without load	Man		
	Woman		
	Child		
Disabled people with wheelchairs ♿	Man		
	Woman		
	Child		
	Man		

Bicycle/biking people 🚲	Woman		
	Child		
Bicycle with load	Man		
	Woman		
	Child		
Bicycle with passenger	Man		
	Woman		
	Child		
Wheelbarrow (ኩርኩር) 🛒			
Mule or Horse cart			
Motorcycle 🏍	Transporting a passenger		
	Transporting goods		
Four-wheel drive cars 🚘	Transporting a passenger		
	Transporting goods		
Light trucks (which are less than s tons) 🚚	Transporting a passenger		
	Transporting goods		
Tractor 🚜			

- It is, therefore, essential to get clear specifications from the community on the range of users that the path has to be designed for. The implications of different types of users should also be pointed out i.e., what type of path is needed for bicycles, what is needed for carts etc. This is particularly important if there is any demand for motorized vehicles to use the path or track. Point out the extra requirements needed and the large damage that can be caused by a heavy vehicle which can then make access difficult for other users.
- If it is clear that, if the path or track is heavily used by a range of different types of users then it may be worthwhile to carry out traffic surveys to get more accurate data on the level of use of the path/track.

However, the following should be checked when planning a traffic survey.

- Does any traffic data already exist, e.g., with the local planning department?
- The traffic will probably vary during the day with peaks early in the morning and middle to late afternoon. Dividing lines at 2-hour intervals in the traffic count boxes will allow the variation and peak rates to be estimated.
- Traffic will vary during the week. A Market Day in a local centre can cause a large increase in traffic. Therefore, surveys should be carried out on at least two days of the week, the busiest day and an average day.
- There will also be seasonal variations in traffic levels with peaks occurring during the harvest season. Information on this will need to be obtained from local informants
- Survey points should be positioned clear from large villages to prevent the counting of people undertaking local internal trips.
- Some paths may have short alternative routes that will distort the true number of travelers. Survey sites should be chosen to ensure all travelers are counted.
- Water crossings such as bridges are good survey sites.
- Two persons will be needed, one to count the traffic and the other to carry out spot interviews.

Conducting Technical Survey Along the Proposed Path or the Existing Path to Be Improved

This stage aims to obtain detailed information on the improvements needed on the path or track and to identify the options for carrying out these improvements. It should include the following steps:

a. Walk the path with key informants from the community. For each of the problem areas along the path obtain information on:

   51) The nature of the problem

   52) Why do the users think it occurs?

   53) How it varies over the year

   54) What has been done to try to solve the problem

   55) What happened, why did it not work?

b. Record the details of the problem areas with sketches and notes. Take measurements of relevant distances and gradients. Record other relevant details such as the type of soil and features of the surrounding terrain, maximum flood levels, available materials (stones, timber, water, etc.), and details of ownership and usage of adjacent land. If possible, take photographs to show details of the problem area.

c. Identify possible options for improving the path (see the design and construction section of the manual). Make sketches of what will be involved in carrying out these options. Note what will need to be done and what problems may occur.

Developing Appropriate Methods for Improving the Foot Trail

A detailed proposal of the work to be done and corresponding action plans should be prepared. The proposal should outline each of the proposed areas of improvement and the methods to be used. Guidelines and illustrations for this are given in the next chapter of the manual.

The outlines should be in sufficient detail to show what is proposed (use sketches), what problems may occur, and to allow estimates of resources needed. Estimate resources needed – labour, materials, tools – and the costs involved. Outline the ongoing maintenance that will be needed to sustain the proposed improvements.

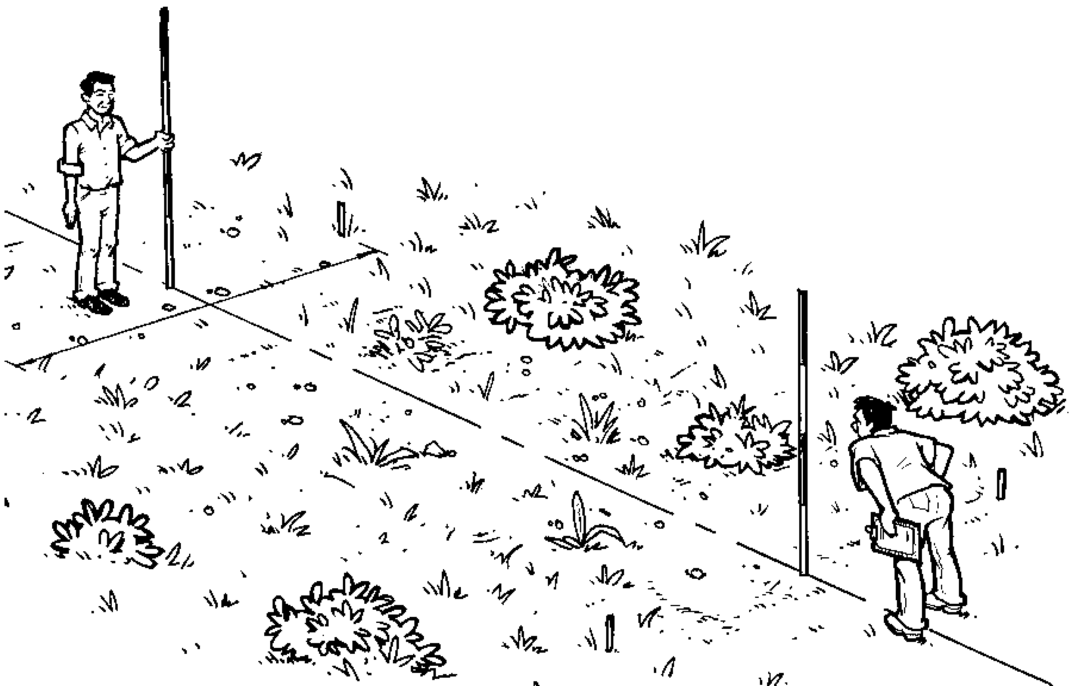
The proposal should be presented at the Planning and Design meeting with the community for discussion and agreement. The output of the meeting should be a written agreement on the program of improvements to be carried out and the order of priority of the work.

Preparation of a detailed work program is also important to avoid procrastinating. Full details of the agreed improvements to the path can now be worked out and estimates of resources needed to be checked. Detailed specifications and instructions for carrying out the work should be prepared.

A detailed program of work with weekly inputs and targets should be drawn up. This detailed program of work will form the basis of a contract with the community which specifies inputs from the community and the technical assistance support. Inputs from other sources, for instance, District Councils, should also be included and agreed upon. The contract should also specify a program of ongoing maintenance to be provided by the community.

Determining the Required Resources

The proposal to the community on improvements to be carried out on the path will need to include good estimates of the inputs of labour, tools, and materials needed to carry out the work. Here it is important to envision the method of traditional construction to be employed, the tools to be used, the skills of the community members who will work as a labourer, material availability, methods of hauling, etc. The following sequence of steps illustrates the main activities in labour-based road work for which estimates of labour inputs are needed.



quantities are measured in meter

Figure B-3: Setting out:

Mark the centre-line with poles at 5 to 10m intervals. Measure formation width Design Standards above) of the path and mark it with pegs.

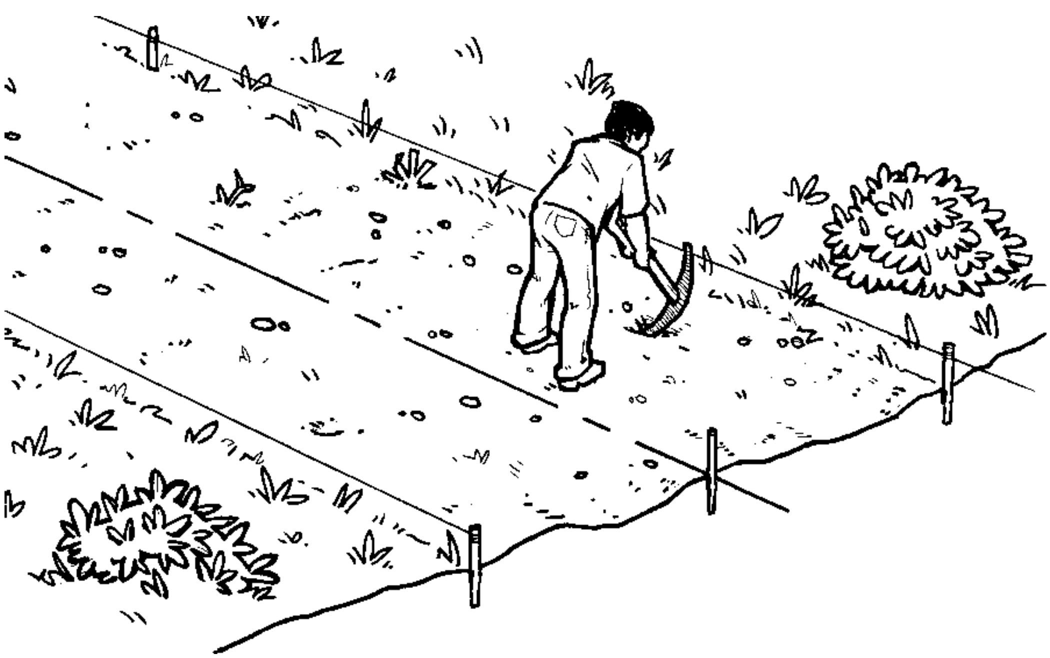


Figure B-4: Clearing and Grubbing:

Quantity is measured as area (m^2) as $formation\ width\ x\ length$

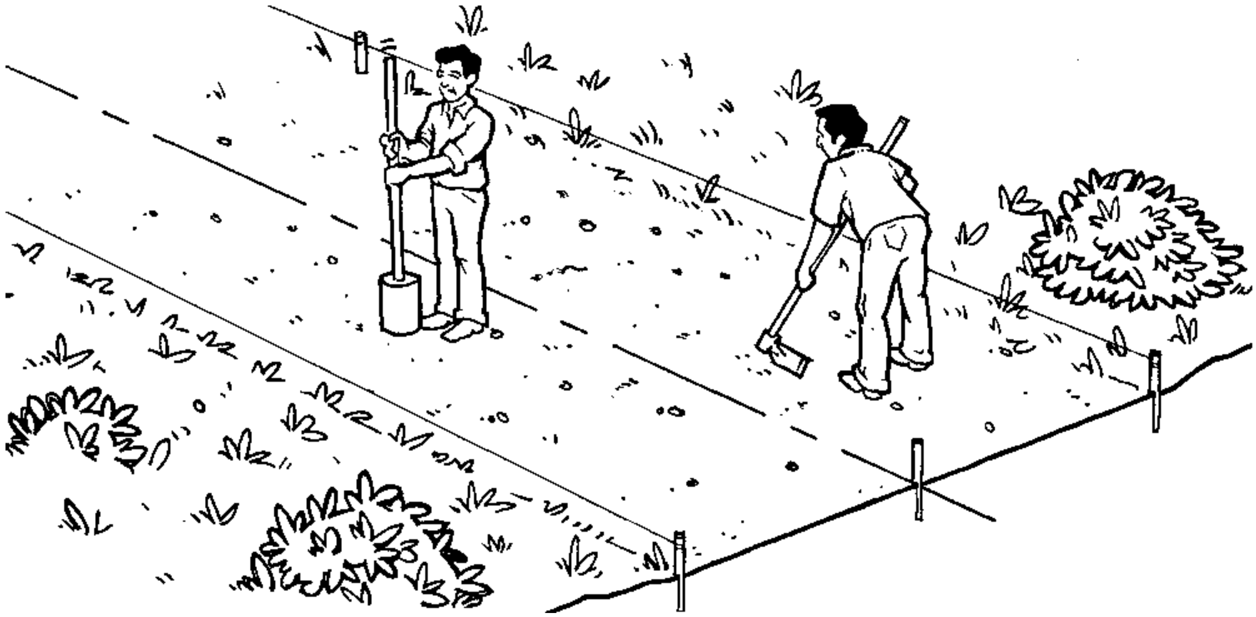


Figure B-5: Excavation: quantity is measured as volume (m^3)

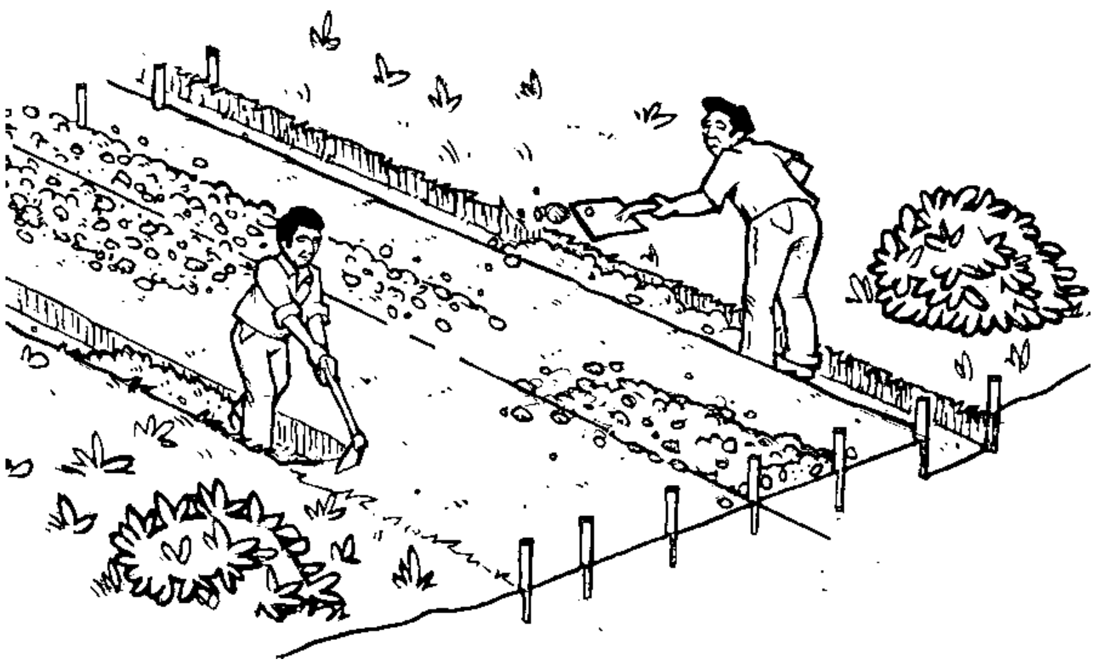


Figure B-6: Mark Out and Excavate Drains: the quantity is the volume excavated

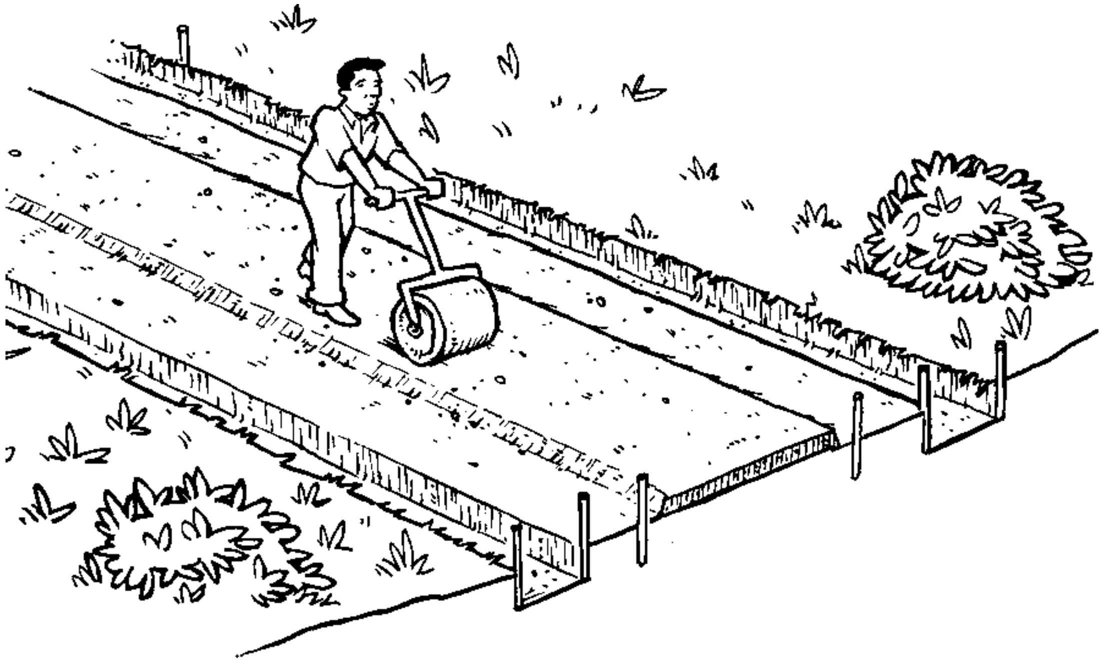


Figure B-7: Formation of 'Plug': $area\ compacted\ =\ width\ x\ length\ (m2)$

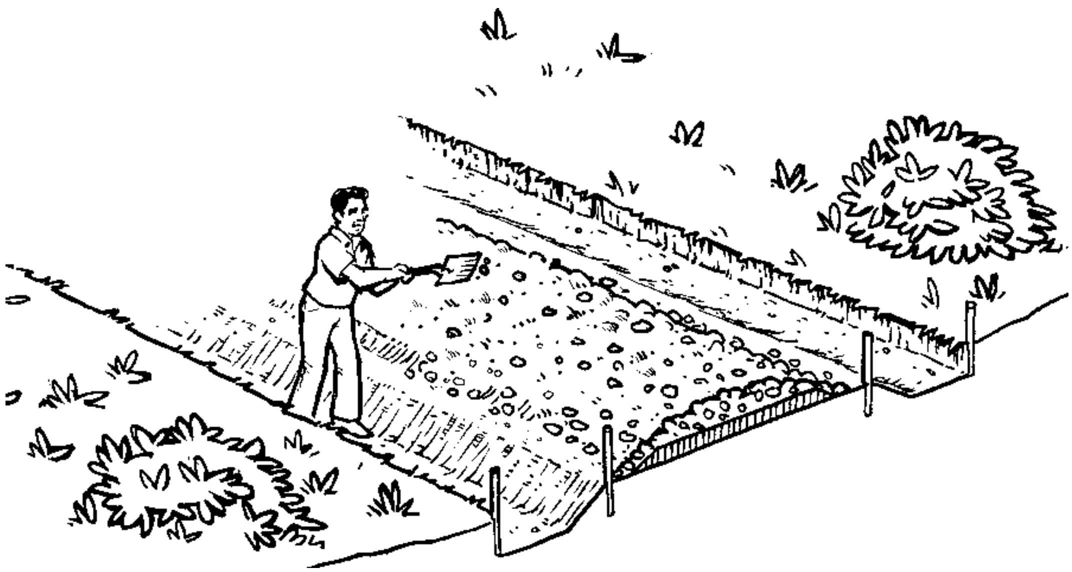


Figure B-8: Sloping of Ditches: quantity is measured in volume (m^3) as $cross - section\ area\ of\ drain\ x\ length\ of\ the\ segment$

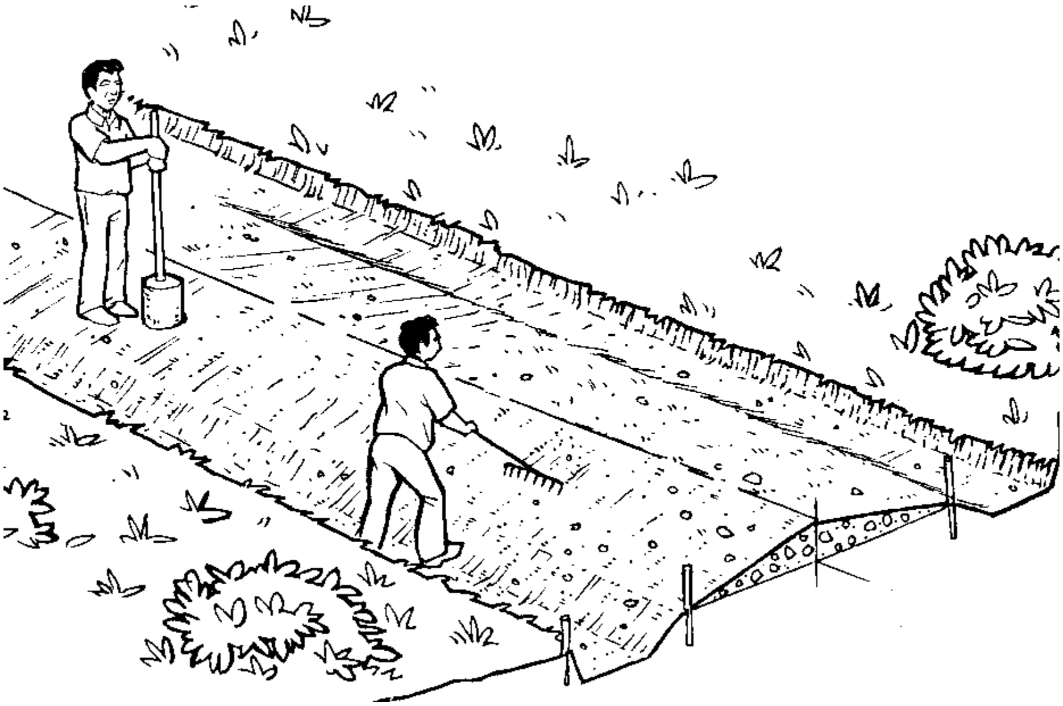


Figure B-9: Formation of Camber: quantities are measured as area (m^2) as $path\ width\ x\ length$

Part C

Foot Trail Design

C. FOOT TRAIL DESIGN

C.1 Introduction

For local short-distance movements and non-motorized transport users, simple improvements to paths and tracks can be of significant benefit to local communities by making them safer and easier to use. In addition, strategic investments can often reduce seasonal or sporadic periods of poor passability. In general, improvements of water crossings are the most cost-effective and easy-to-identify problem spots, although, in some cases, surface improvements (such as gravelling and stone pitching) of high traffic sections might also be merited. The most common problems on paths and trails that reduce functionality are:

- Slipperiness and erosion (caused by poor drainage or steep gradients),
- Wet, marshy, or seasonally flooded areas of poor passability,
- Dangerously steep and/or rocky sections, and
- Difficult and/or seasonal stream or river crossings.

C.2 Identifying Problems on Paths and Tracks

Identifying access constraints on paths and tracks begins with consultation with users and a visual Field survey to identify local conditions (soils, drainage, and grade). Local users identify the most heavily traveled and problematic routes in, around villages, and to major destination points, as well as what type of transport takes place over those routes. They make distinctions between regular and seasonal problems. A rapid field survey is required to get a picture of local conditions and help in selecting preliminary strategies for overcoming current problems. If necessary, a further technical survey may be undertaken after initial consultations to obtain observations that are more precise and measurements of the paths and tracks identified. An outline of a technical survey is given in Box 1. Below.

Box 1. Technical Survey of Path or Track

Technical surveys are carried out to gather information on the physical condition of a path or track. Information is usually only recorded for the section where there are existing or potential problems. The type of observations and measurements required are:

- Reference number and location of section (relative to obvious landmarks),
- Length of section (can be paced, but preferably measured with a tape),
- Soil type,
- Gradient of path or trail,
- Crossfall (sideways slope) of surrounding land,
- Type of problem (slippery section, erosion), and
- Details of the situation with possible solutions (sketches and notes).

An engineer or technician usually carries out the survey, but it is preferable if the users of the path or track, who can point out or confirm the problem areas, accompany the technician.

Source: (Jerry Lebo; Dieter Schelling, 2001)

C.3 Typical Design Guidelines

Once traffic and loading characteristics have been determined, standard design parameters are used to determine the appropriate level of investment. Most often, the least-cost method for improving paths and trails to all-weather passability is community-driven spot improvements. In some cases, where transport demand is high and benefits adequate, full upgrading of the path or track along its entire length may be justified. Technical assistance is needed for designing the spot improvements and managing the works.

The design standard for the path or track will depend on the number of users and their mode of transport.

1. What is the number of users per day or hour?
2. What types of loads are carried?
3. Do pack animals (carrying on their back) use the path or track, with or without carts?
4. Do wheeled vehicles such as bicycles use the path?

Note: It is essential to clarify and agree with the community the numbers and types of users that the path must be designed to take, as this will set the standard for the minimum width and bend curvature needed for the path and the maximum allowable gradient.

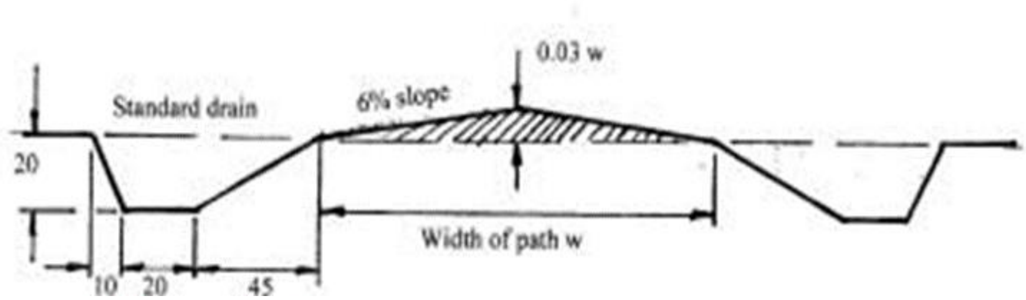
It is particularly important for the community to decide whether vehicles such as handcarts and animal-drawn carts will use the path, as this will require a minimum design standard, which may considerably increase the amount of work involved in improving the path or track.

The following are the most important first stage design parameters for basic access paths and trails

5. Camber and cross fall
6. The width of the path
7. Clearance above the path
8. The gradient of the path or track
9. The surfacing of the path or track

C.3.1 Camber and Crossfall

Camber and crossfall are essential for proper surface drainage and should be a minimum of 5 percent in rainy areas and higher in areas of heavy seasonal rain. A camber as low as 3 percent is possible in arid areas, but flat paths and tracks are not recommended.



C.3.2 The Width of the Path

This depends on the number of users and type of traffic. Guidelines are given in Figure C-1below.

Formation Width of Path

In most cases, the path will need to have side drains. The total or **formation width** of the path therefore needs to include the width of drains and shoulders as shown in the table.

Table C.1:- Recommended formation width for footpath

Width of Path		1m	1.2m	1.4m	2m	2.5m
Formation Width, W	Drain Both Sides	2.5	2.7	2.9	3.5	4.4
	Drain Only One Side	1.8	2.0	2.2	3.2	4.2

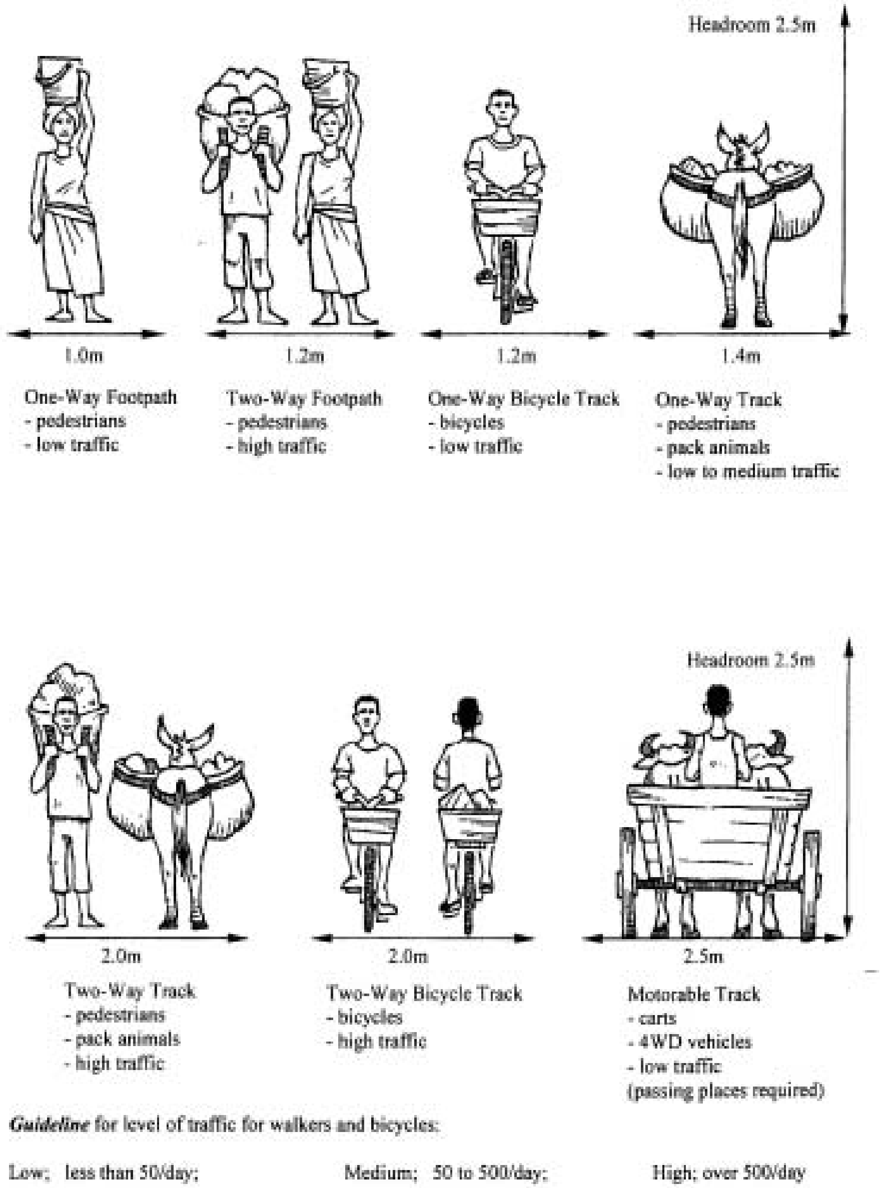


Figure C-1:-Proposed Design Standards for Different Paths and Tracks

C.3.3 Clearance above the Path

Minimum cleared height = 3m

Min.cleared height = 2.4m

Min.cleared height = 2.5m

Figure C-2:- clearance

C.3.4 Bend Curvature

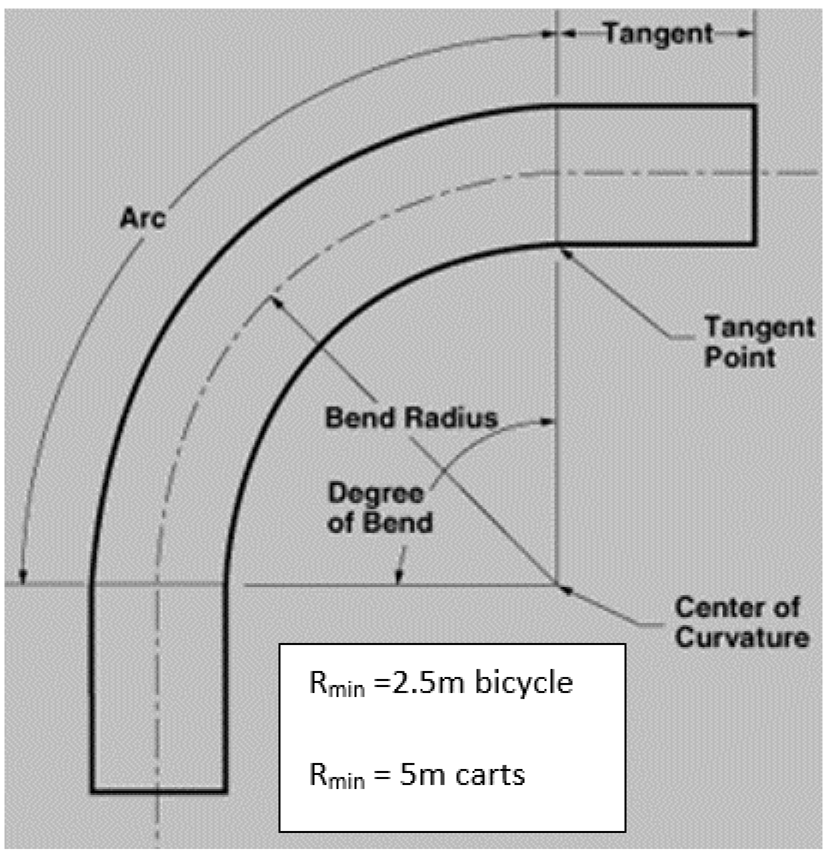


Figure C-3:- Bend curvature

A minimum of 2.5 m bend curvature is necessary for bicycle riders and 5m for animal drawn carts.

C.3.5 The Gradient of the Path or Track

The maximum gradients that can be comfortably climbed by different users are given in Table C.2.

The table below lists the maximum slopes recommended for different footpath users – for example if animal- drawn carts are to use the path the slope should not exceed 8%.

As slopes approach 25%, even walking becomes difficult and steps are needed.

Table C.2:- User and maximum gradient relationship in footpath

User	Desirable maximum gradient	
Bicycle with Trailer	5%	1 in 20
Bicycle	7%	1 in 14
Animal-drawn carts	8%	1 in 12
Loaded porters	10%	1 in 10
Pedestrians	12%	1 in 8
Pack animals	12%	1 in 8
Shallow steps required	25%	1 in 4
Moderate steps required	33%	1 in 3
Steep steps required	50%	1 in 2
Hands needed to aid ascent	70%	1 in 1.4

The ***desirable maximum gradient*** is the steepest gradient that can be negotiated without excessive effort by the particular user.

The desirable maximum longitudinal gradients together with a summary of basic access standards for non-motorized access are summarized in Table C.3 as per Design and Appraisal of Rural Transport Infrastructure World Bank technical paper.

Table C.3:-Basic standards for non-motorized access

Feature	**Terrain**		
	Flat	Rolling	Steep
Path Width	1 to 2 m, depending on traffic density and type	1 to 2 m, depending on traffic density and type	1m
Path Surface	In-situ soils except on sand or steep erodible slopes		
Camber	5%	5%	5%
Maximum Gradient	N/A	7% for bicycles, 8% for animal drawn carts, 12% for pedestrians and pack animals, 26 to 70% for pedestrians when steps provided	
Drainage structures and water crossings	Stepping stones, timber footbridges, suspension bridges		
Special features	Earth or brushwood cause ways in marshy areas	Timber water bars	Hairpin bends, steps, handrails, timber water bars

C.3.6 Surfacing

Most paths and tracks have developed naturally from the passage of traffic. The compaction of the soil by pedestrians, animals, and light vehicles is usually sufficient to give a satisfactory surface. The addition or replacement of surfacing material is relatively expensive and can only be justified in special circumstances such as the occurrence of wet marshy areas, very rough terrain, very sandy soils, black cotton soils, areas with sharp rough rocks, or easily erodible soils on steep slopes. These cases are explained from section C.5 to **Error! Reference source not found.**.

In the Amhara region, some areas with cinder/scoria gravels exist. These make excellent surfacing materials for trails. Other areas contain colluvial gravels, which are also good.

Figure C-4: Cinder/scoria gravel

C.4 Design of foot trail structural components

C.5 When the surface is Erodible

Where the major problem is an erodible surface, a single layer of well-compacted (with simple hand compacting tools) gravelly soil may be adequate.

A certain amount of clay mixed in with the gravel helps bind the material to produce a dense impermeable surface layer. Stone pitching or "Telford" construction may be necessary for heavy traffic or on steep gradients. Figure C-6 illustrates some of these methods.

After the addition of some gravels on the footpath, one has to add a fine soil to the gravel to make the surface of the path smooth by compacting as shown because many people in the rural areas may also be bare footed while using the footpath.

Figure C-5: Hand compaction

C.6 When the surface is Wet or Marshy Areas

In wet or marshy areas, it is necessary to use different techniques to minimize the costs. Wherever possible footpaths should avoid crossing marshy and wet areas. However, if this is impossible there are a few methods, which will provide reasonable access for most or all of the year. The basic approach is to provide a foundation, which can be supported by the soft marshy soil and raise the path above the surface of the marsh area. There are three main approaches:

C.6.1 Stepping Stones or Stone Causeways

Stepping stones or stone causeways, in which large stones are firmly set in the ground to provide a stable walkway.

- This is only suitable for pedestrian traffic (not suitable for people with disabilities, elderly, and children)
- Large block-shaped stones are ideal. If these are not available, a stone- box, sections of large tree trunks, or sandbags may be used.
- This option is not suitable if the water level rises more than about 10 cm in the rainy seasons. Figure C-7 illustrates this method.

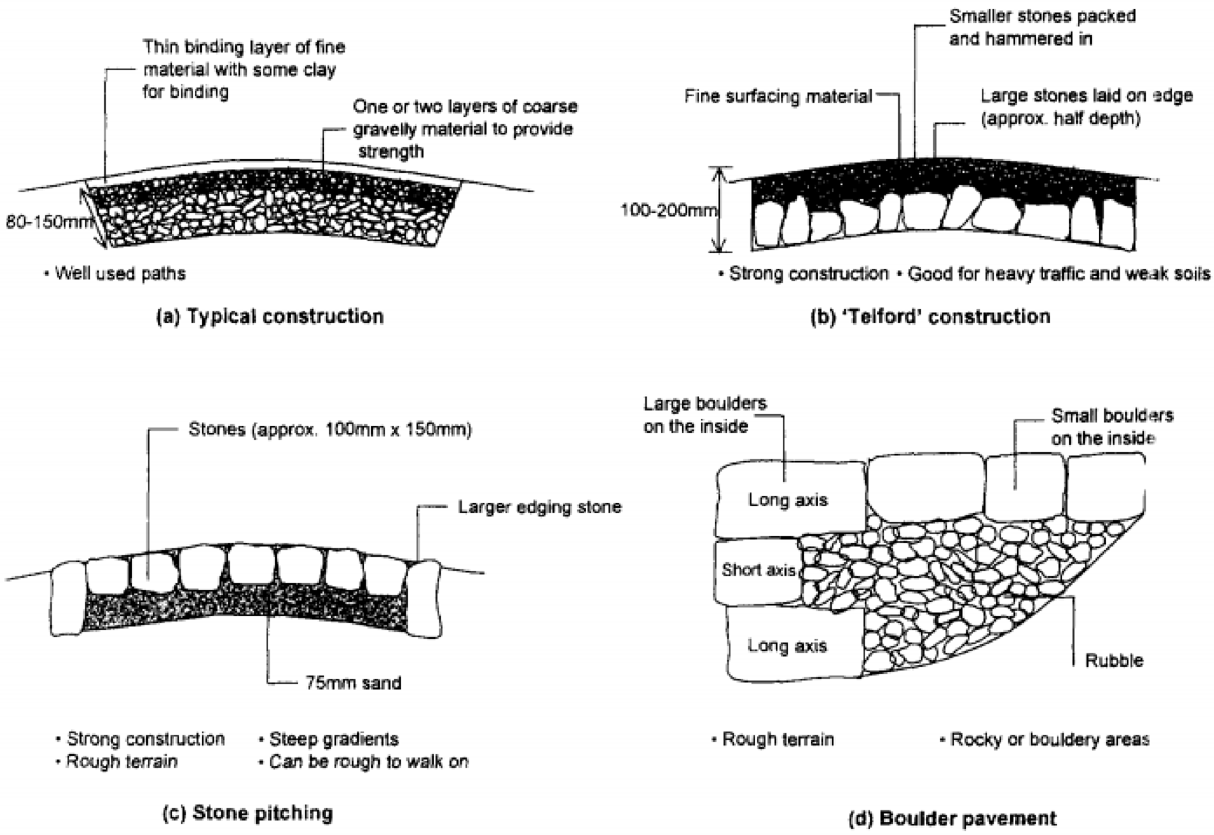


Figure C-6:- Surfacing Methods for erodible soils

Figure C-7:-Stepping Stones

C.6.2 Rafts or Boardwalks

Rafts or boardwalks, in which a timber walkway is built to sit on top of the wet soil. These are usually of light construction, for pedestrian or cycle traffic only. For less wet areas, a simple and reasonably low-cost option for walkers is to use trimmed logs supported at each end on log-sills.

These are preferable for animal carts, persons with disabilities, the elderly, children, and for improving all-year access and climate resilience.

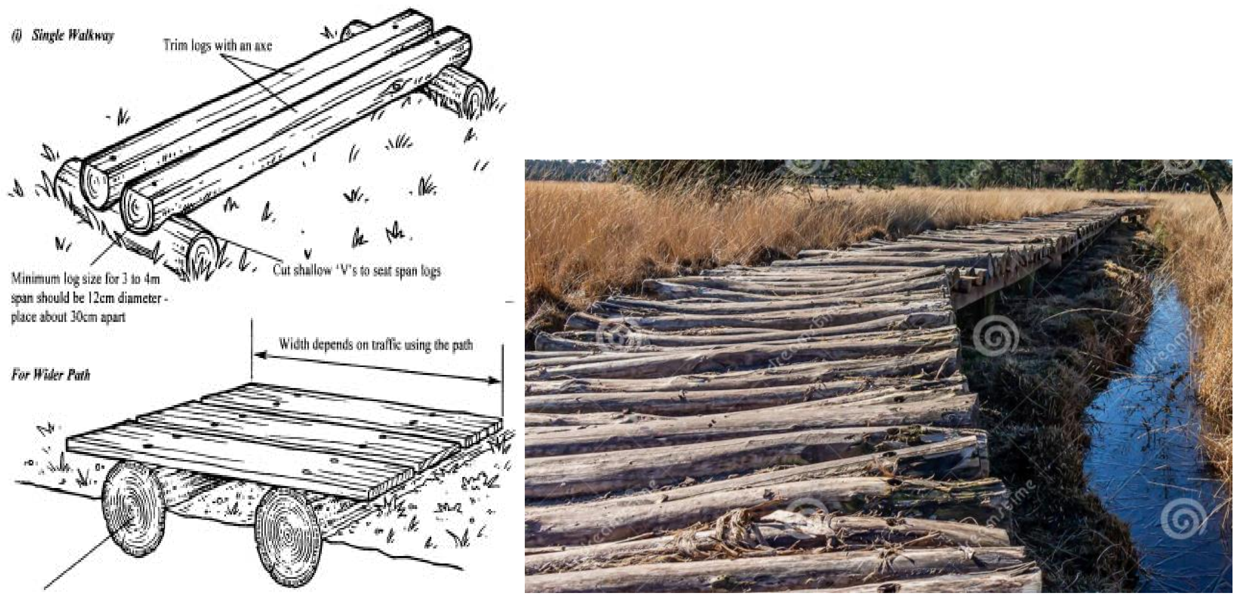


Figure C-8:- Boardwalks for Less Wet Areas

- For more general traffic, sawn planks can be nailed on top of the logs. This introduces a significant extra cost.
- In wetter areas, the boardwalk may be supported on posts or stiltsdriven into the ground. This is the most appropriate option for waterlogged areas, particularly in areas where the water level rises by more than a few cm in the rainy season. However, it requires a great deal of timber and is relatively costly. It also requires substantial labour.

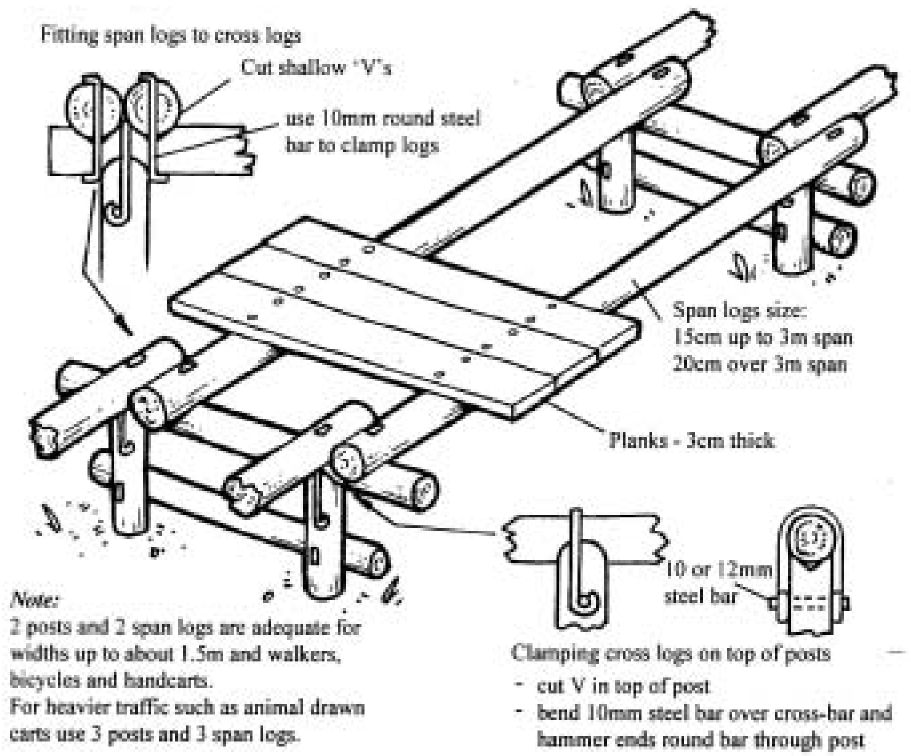


Figure C-9:-Boardwalk for Waterlogged Ground
Boardwalks require regular maintenance to repair joints and replace rotting timber.

C.6.3 Turnpike Sections (Raised Paths)

Turnpike sections (Raised paths), where the path or track is raised as a small embankment, with the edge constrained by logs or rocks.

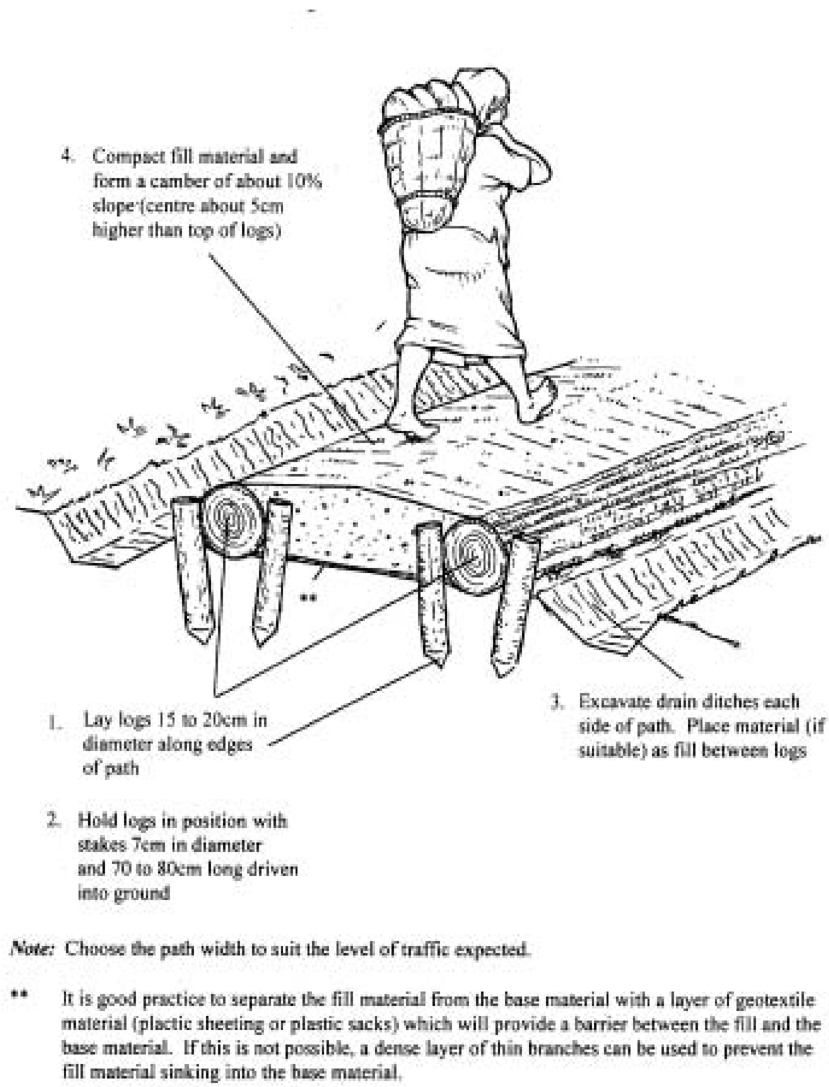


Figure C-10:-Raised Path

Methods of dealing with steep slopes: If the maximum recommended gradient will be exceeded when the path leads directly up the slope, the path may be aligned across the slope to reduce the gradient to an acceptable level. If this is not feasible, the following options are available

- Use of handrails of wooden poles or rope allows path to follow direct route and requires little construction. Only suitable for walkers and may not be suitable for persons carrying heavy loads, or adequate on steep, slippery slopes. It is Not recommended, although may be used with steps.
- Realignment of path into zigzag form: May be used by walkers, animals and wheeled vehicles. However, increases length of path and therefore construction work substantially. It is **recommended** as only feasible method for a range of traffic. Zigzag paths may be used on the sides of steep hills to keep the path gradient within acceptable limits. They "zig-zag" across the slope rather than directly up the slope

C.6.4 Dealing of steep path with steps:

- Steps should only be used for steep paths (gradients over about 25% - 1 in 4) as they will prevent the use of wheeled transport and inhibit the use of pack animals on the path. They can also require frequent maintenance. Steps should be convenient to use, so the layout should match the average climbing and walking strides of users. The following rules should be followed:

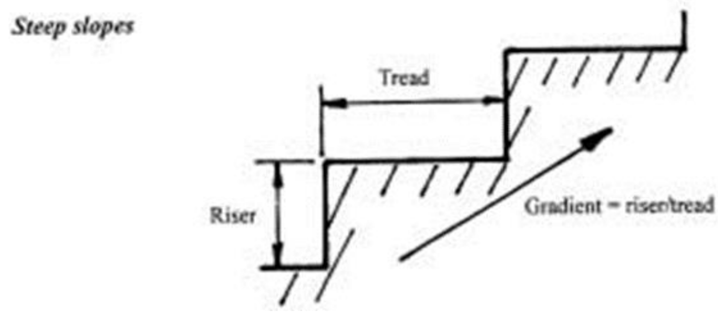


Figure C-11:-Steps

1. Risers should never be above 25 cm
2. Treads should be a minimum of 30 cm
3. The best values are: riser = 17cm, tread = 30 cm which gives a gradient of 57%
4. The maximum practical gradient is about 67% - riser 20 cm, tread 30 cm
5. If the gradient of the steps is greater than about 60% (1 in 1.7) a handrail should be provided for safety.
6. Steps should have a cross-fall of about 5% so that water drains to the side of the stepsrather than down the steps.

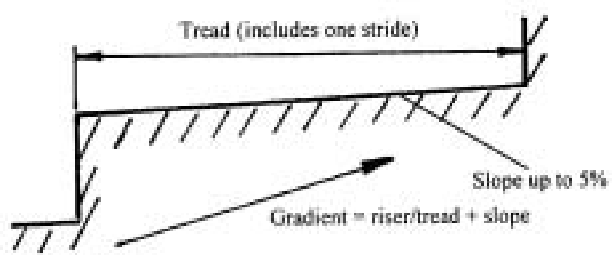


Figure C-12:- Less steep slopes

7. Where a shallow gradient is required, the tread width should be increased by one stride(about 60cm). For example: riser 20 cm + tread 30 + 60 = 90 cm and slope 3% gives agradient of 25% (1 in 4).
8. Wider/longer treads may have a slope of up to about 5% as this reduces the number of steps needed. However, the step must also have a cross-fall of about 5% to make sure water runs off to the side of the steps

General Guidelines for Design of Steps

- Construction of steps can require substantial work. Therefore, choose the shortest route that minimizes the work needed.
- However, long straight sections of steep steps can be intimidating to users. Therefore, slightly curved routes are better for long, steep slopes – they also help with drainage.
- For lengthy, very steep slopes, it may be necessary to provide zigzag routes for steps to reduce the gradient and the effort for the user. In this case, provide obstructions to discourage users from taking short cuts down the slope, which may erode the slope.
- It is important to provide effective drainage for steps. Side drains, turn-off drains, and scour checks may be needed to achieve good drainage without causing erosion (see section C.9).

C.7 Retaining Structures

Where landslides have occurred, or there is a high risk that they will occur, some form of retaining structure is needed to hold back the soil and prevent the bank from collapsing. The common method is to build a retaining wall. Two examples are shown in Figure C-13 and Figure C-14 of dry walls (no mortar) using large stones. If only smaller stones are available then these need to be bound together with mortar. This will add a cost to building the wall. If stones are not available, an option is to use wooden poles. However, these will have a limited life and will need to be replaced every few years.

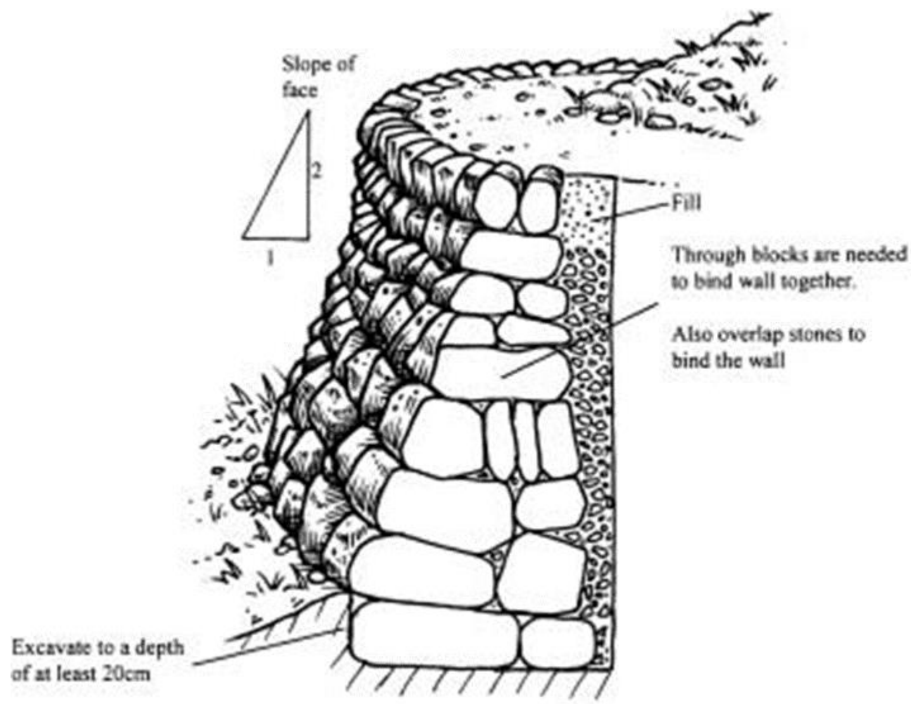


Figure C-13:-dry retaining wall used to support a hairpin bend

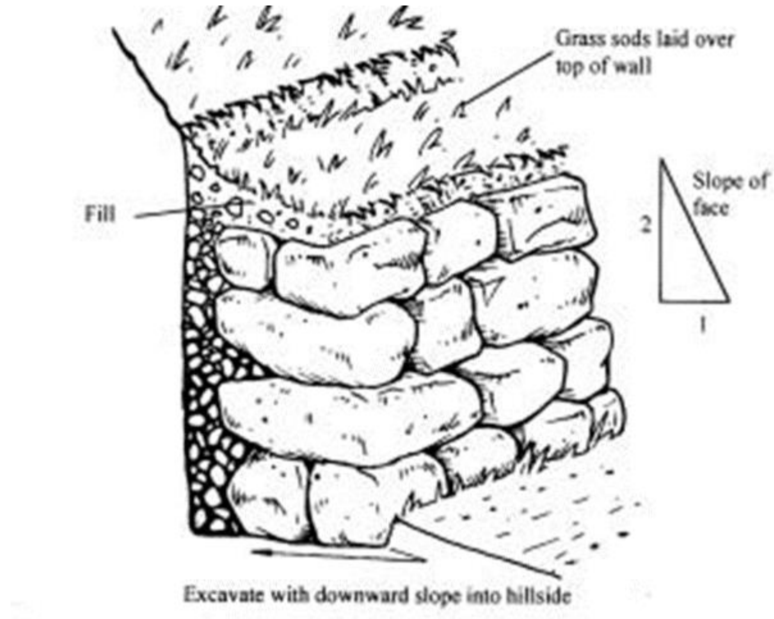
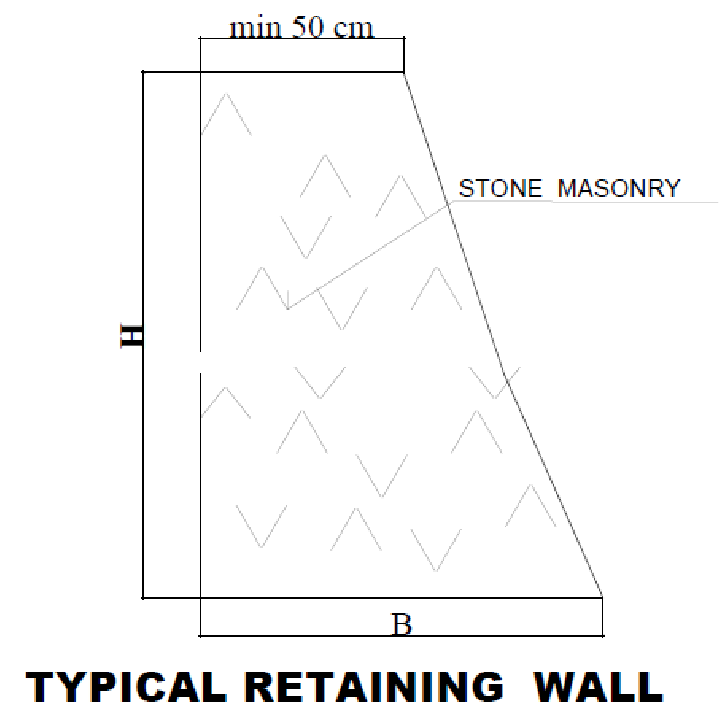


Figure C-14:-Retaining Wall Used to Support an Excavated Embankment on a Steep Slope



H(cm)	B (cm)
0-50	50
50-100	100
100-150	125
150-200	150
200-250	175
250-300	200
300-350	225
350-400	250

Figure C-15:- dimensioning retaining wall

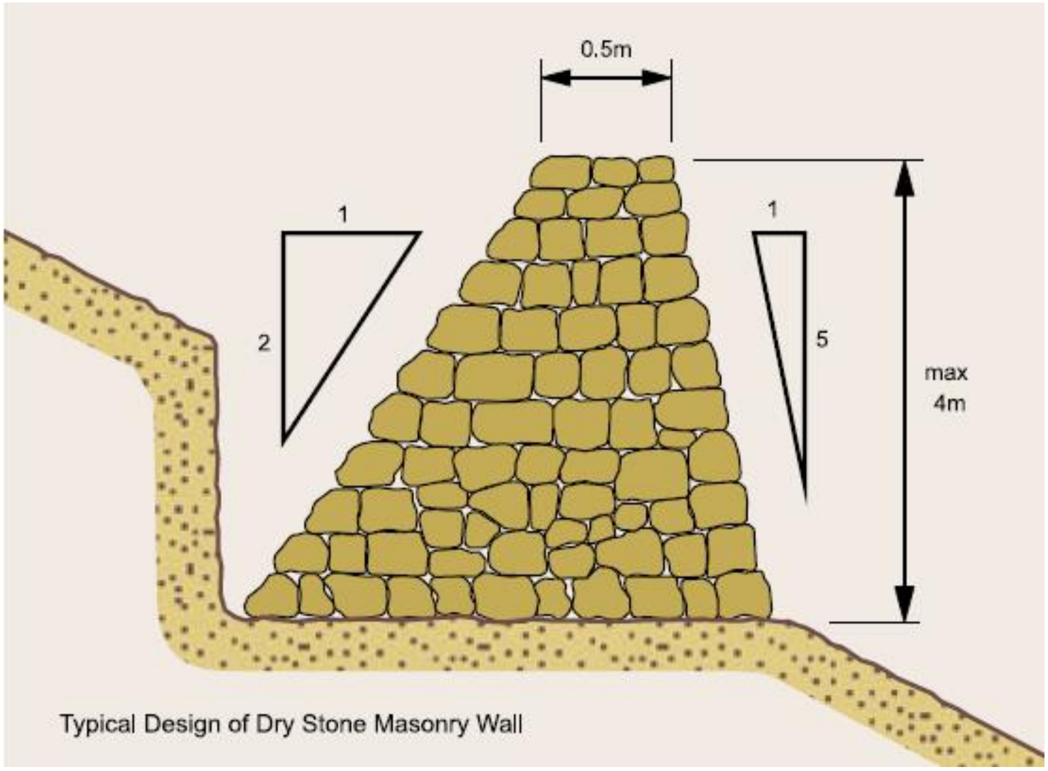


Figure C-16:- if only dry stone is used

C.8 Water Crossings

As per (Development, 2002) Effective drainage is the most important factor in achieving a good footpath. Section **Error! Reference source not found.** dealt with the drainage and removal of w ater from the path. This section describes the transfer of water across the path. This is required at stream crossings, dips in the footpath alignment and on sloping ground to transfer water from the high side of the path.

Two types of problems are dealt with in this section:

- Transfer of drain water or small streams across the path
- Crossing of narrow or shallow streams

The following options are considered:

Table C.4: Cross drainage Suitability

Cross Drainage Option	Suitability
Cross Drains	• Occasional low volumes of water e.g. After rain • Small dips in the footpath

Culverts	• Low to medium flows of water • Suitable for all types of footpath users
Stepping Stones	• Streams or wide rivers with normal flow Depths up to approx. 50 cm • Only suitable for pedestrians*
Drifts	• Suited for wheeled vehicles to cross shallow streams, with depths up to about 30 cm

C.8.1 Cross Drains

Cross drains are drains which carry water across the path. They are particularly needed on paths on side slopes to carry water away from side or catch-water drains from the uphill side to the downhill side of the path. They may also be used to carry small streams across the path.

If walkers only use paths, cross drains can be open. In this case, the maximum width is 50 cm and the flow capacity is limited.

Figure C-17: Open cross drain

To avoid erosion, cross-drains should be stone-lined, particularly where water flow is high. This will make the drain far more effective and longer lasting as shown in the Figure C-17.

For higher water flow, crossing paths, which need to cater for a range of traffic, animals and wheeled vehicles, Culverts, should be used.

In the construction of stone drains, the stones should be big enough to form both the side of the drain and the surface of the path and heavy enough that they do not move when trodden on. Thin stones that merely line the drain are not sufficient and will soon get displaced. The drain can be up to 50 cm wide and as deep as the side stones will allow.

To protect against scour the drain can be built by first lining the bottom with large slabs or boulders, which are then held firmly in place by the side stones. Smaller stones may be placed at the inlet to help prevent material washing in and blocking the drain.

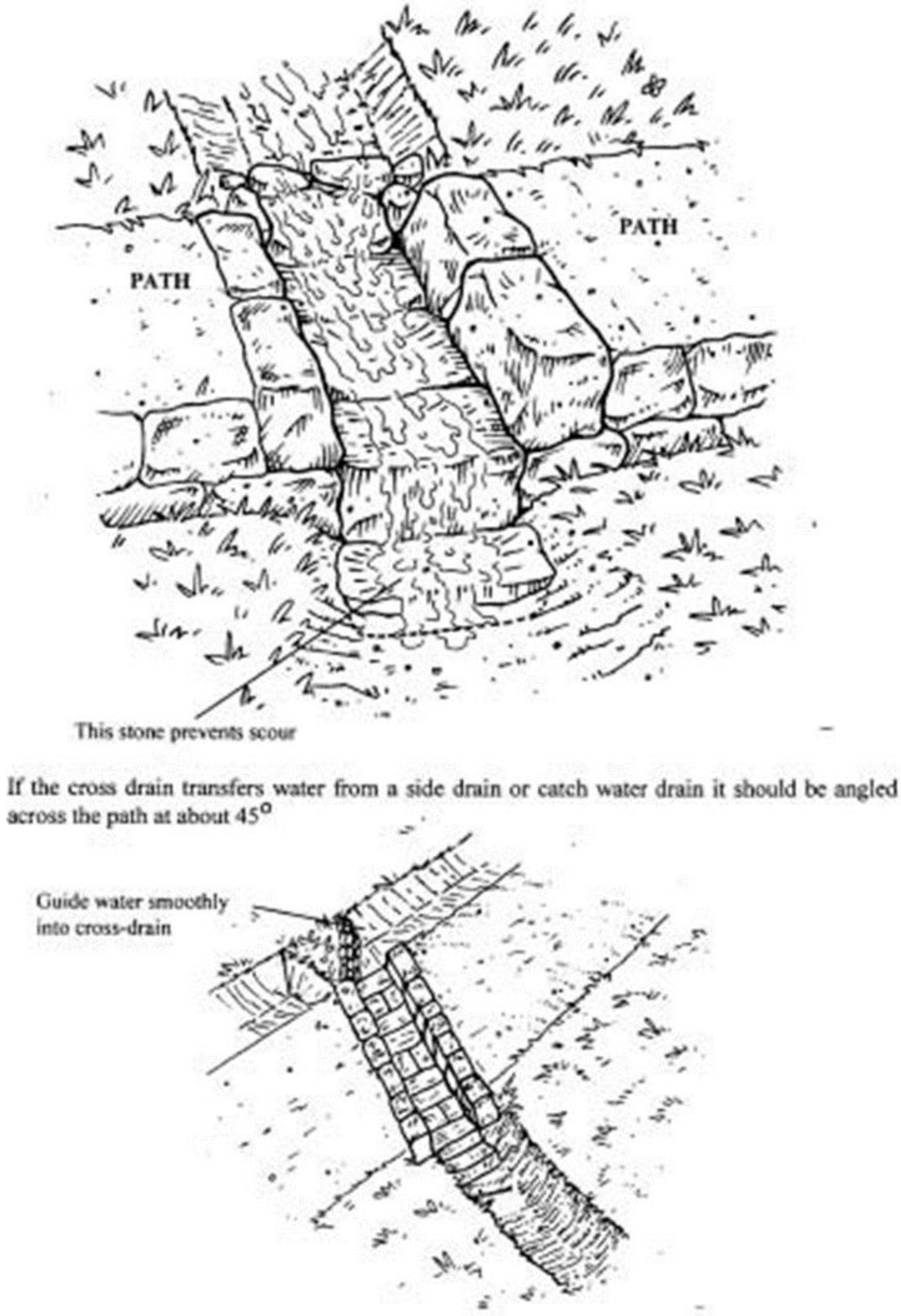


Figure C-18:-Stone-Lined Cross Drain

For those people like elderly, persons with disabilities, children, etc., cross drains should be covered at the top with timber or stone slab at one position of the drain.

C.8.2 Culverts

Culverts may be considered as an intermediate option between cross drains and footbridges.They can provide a water crossing for a range of traffic. Because they can provide a much larger area for water flow than cross drains, culverts can handle large flows of drainage water across the path.

Three options are considered in this section:

1. **Bush Culverts**: This is basically a log bridge across the drain or stream. It is therefore cheap to construct, but the logs will need to be replaced periodically. Spans can be up to 2 to 3 m. Ethiopia with regular wet and dry seasons may not be suitable for bush culverts, so, this option may be the last one in choice.

Figure C-19:- Bush culvert

2. **Slab Culverts***:* This uses stone slabs rather than logs. It is longer lasting but needs the availability of suitable stone slabs. It will therefore probably have limited use. The span is dependent on the sizeof slabs available and will probably be less than 1 m.

Figure C-20:- stone slab culvert

3. **Pipe Culverts***:* large pipes (at least 30 cm diameter but preferably 60 cm) are used to transfer the water under the path. Fill is used around the pipes to build up the path surface. This is a relatively costly option which requires substantial work. It will mainly be appropriate if vehicles use the track.

Summary: Bush culverts generally provide the most appropriate option for footpaths.The width can be readily selected to suit a range of traffic. However, they are not suitable for motor vehicles.

The boardwalk designs described in Section C.6.2 may also be used to span drains or small streams, making sure a solid foundation is provided for the support logs on each side of the drain/stream

C.8.3 Stepping Stones

Stepping stones are suitable for any width of stream or river, providing the water depth is less than 50cm. Stepping-stones should be placed at a spacing of about 50 to 60 cm between stones with a maximum spacing of 75 cm.

Each stone should:

- Have a flat step area of at least 30 cm x30 cm
- Be 10cm above the water for normal flow levels
- Be large enough not to be washed away during floods
- Be stable and not rock when walkers step on them
- Preferably not be slippery when they are wet

The use of stepping stones can be made safer by providing tight rope guides on each side of the crossing.

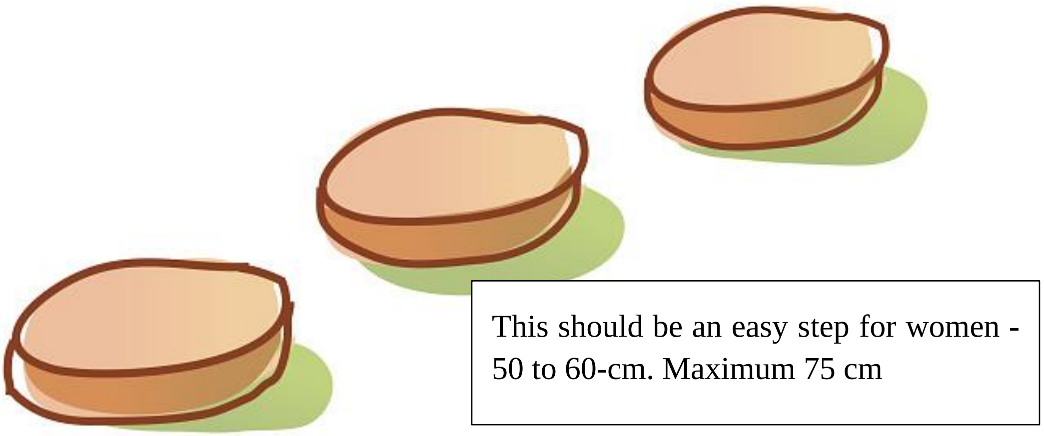


Figure C-21:-Stepping Stones

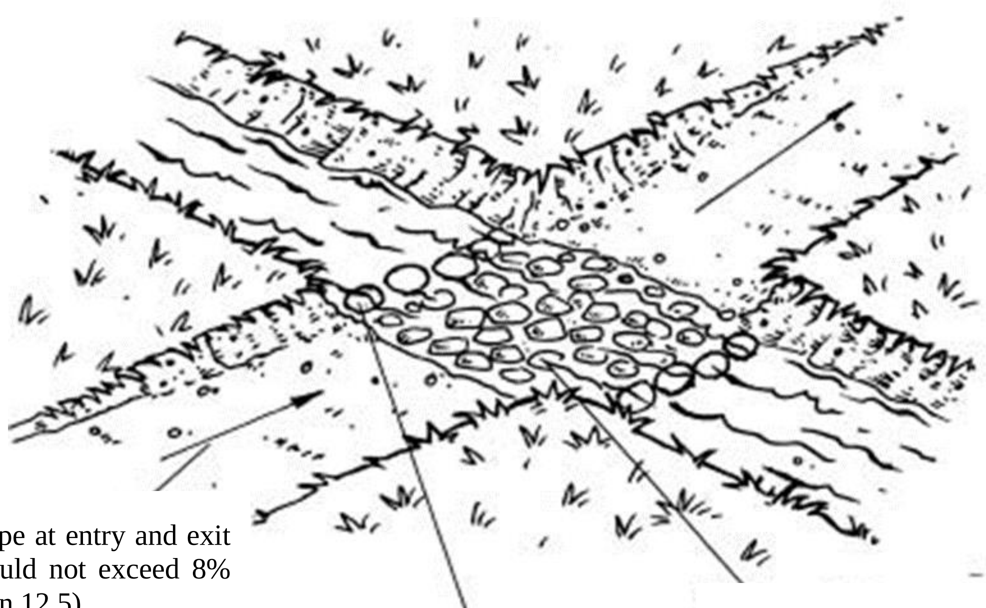
C.8.4 Drifts

A drift can be used to cross a shallow stream especially when wheeled vehicles like animal drawn carts use the path. It should be located where the stream is shallow enough for walkers and vehicles to cross without any problems. The main construction required is to excavate suitable approach and exit ramps so that wheeled vehicles can easily enter and exit the drift. The slope of these ramps should not exceed 8% (1 in 12). The drift should have a firm, level bottom across the stream so that wheels do not sink in. A smooth, stony surface is best.

Note: it is possible that water flowing down the approach or exit slopes will cause erosion of the path. A simple method of dealing with this is to construct a side drain on the DOWNSTREAM side of the path, with a cross fall on the path to cause the run-off to flow into the side drain. The side drain should exit downstream of the drift.

If animal drawn carts to be using this drift, the width of the drift should be 3 meters and above

Try to choose a location where the water is at its shallowest



Slope at entry and exit should not exceed 8% (1 in 12.5)

Place a row of larger stones along each edge of the drift to protect smaller stones from being carried away in the current.

It is useful to arrange these as stepping-stones

Proved smooth, firm surface

Figure C-224 ~~20~~:- Drift Water Crossing

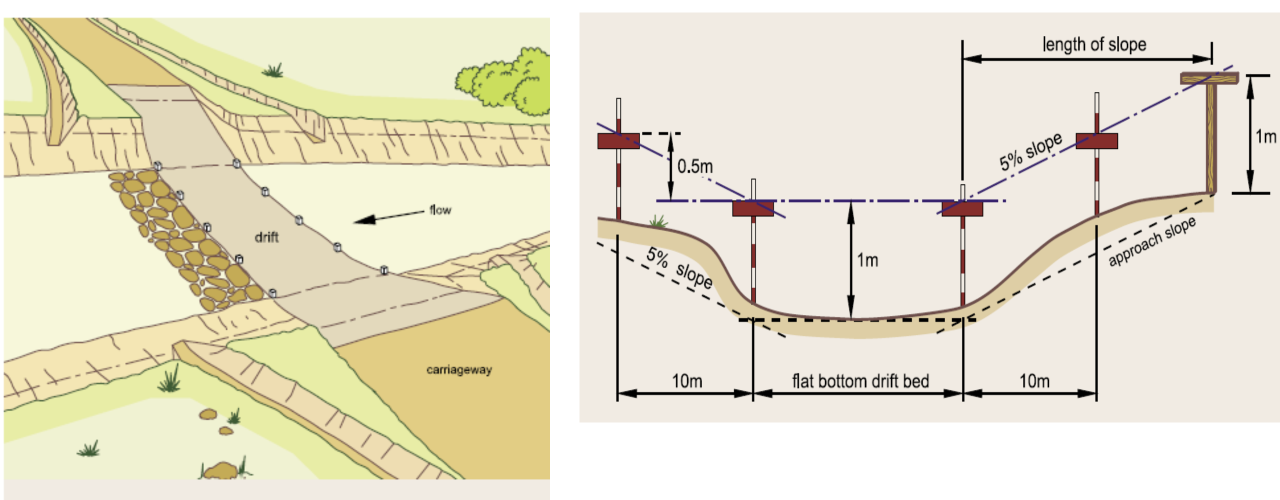


Figure C-23: drift possible dimensions

C.9 Drainage

Lack of drainage is the cause of most problems associated with footpaths. A poorly drained path allows water to collect causing local flooding or areas of mud which are difficult or impossible to cross.

For most unimproved paths, nothing has been done to control the flow of water or improve drainage. Uncontrolled flow of rainwater can cause erosion to the path surrounds, depositing debris and silt on the path. It can also cut channels in the path and wash away the path material.

The primary aims of good drainage are therefore:

1. To prevent rainwater collecting on the path
2. To control the flow of rainwater on and around the path to avoid erosion damage to the path and surrounds.

This section provides guidelines on standard drainage methods for achieving these aims. However, the most important factor in providing or improving drainage is to understand the behaviour of the rainwater and what is causing the problem. It is essential to obtain information from the local community and wherever possible to observe the problems firsthand.

Methods Covered in This Section:

- Path Surface - camber or cross-fall to drain water off path
- Side Drains - remove water drained off path and edges
- Turn-Out Drains - carry water away from side drains
- Catch-Water Drains - prevent water running down hillsides onto the path
- Scour-Checks - control flow of water in drains to reduce erosion
- Water-Cut Offs - prevent water running along path causing erosion
- Stone-Lined Drains - for steep slopes and high run-off where erosion of drains is a problem.

C.9.1 Path Surface

The surface of the path should not be flat but should have a small cross- slope on it to encourage water to flow off the path. The direction of slope will depend on the ground conditions. A slope of 5 to 6% is needed (1 in 20 to 1 in 16) for cambers and cross-falls. If the slope along the path is greater than about 4% (1 in 25) cut-offs may be needed to prevent too much water flowing along the path.

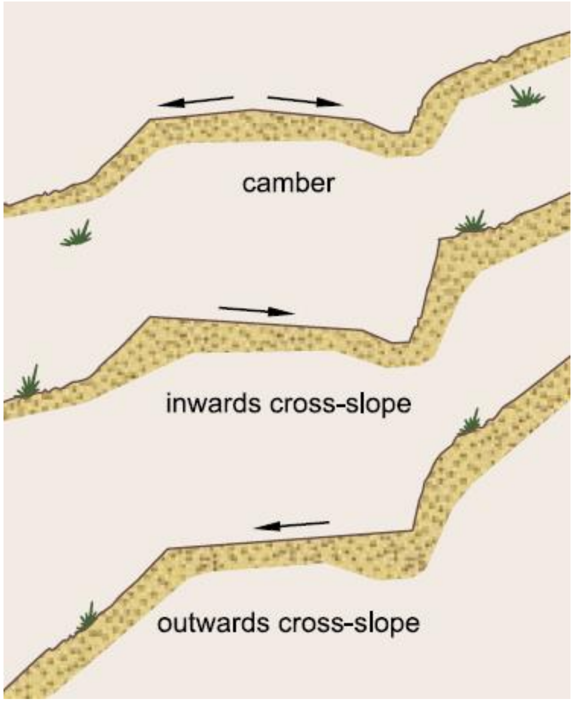


Figure C-24:- cases of footpath surface drainage

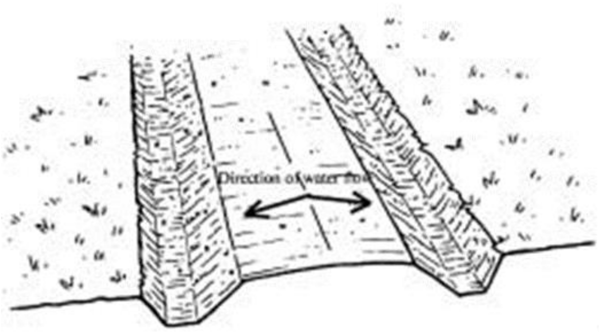


Figure C-25:-Paths on Flat Ground, Gently Rolling Terrain or Following a Ridge

A camber on the path is the most appropriate for these paths. Side drains are required on both sides to collect water from the path and surrounding terrain. This water should then be diverted away from the path through turnout drains.

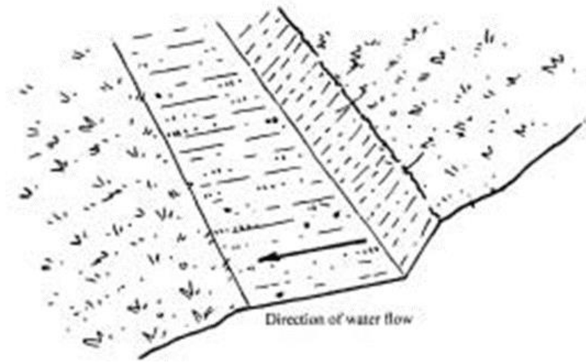


Figure C-26:-Paths on Gentle Slopes with Permeable Soils and Low Run-Off

Out-sloping crossfall is suitable for these paths.

- A side drain is not needed if water flows away from the path unaided.
- As slope or run-off increases a catch water drain should be provided on the up-hill side of the path.

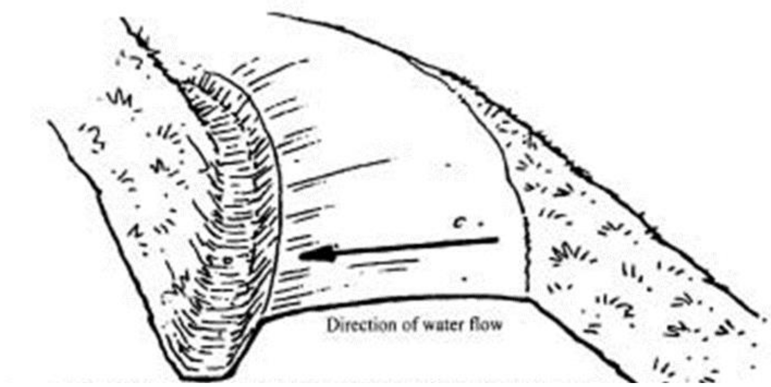
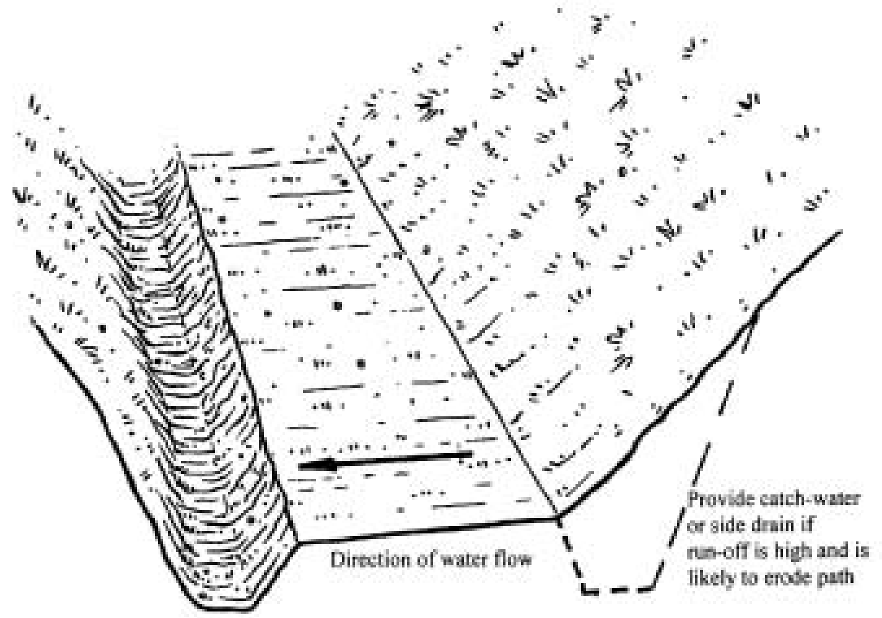


Figure C-27:-Paths on Steep Slopes with High Run-Off

This may be used where a catch water drain is not feasible. A side drain will be required on the uphill side of the path. Cross drainage is needed at regular intervals to pass water from the side drain across the path.



- This has to deal with water run-off from both sides of the path.
- If run-off is high on both sides then side drains will be needed on both sides of the path.

Figure C-28:- Paths passing through Gulleys

C.9.2 Side Drains

Side drains should be constructed along the sides of paths on flat or rolling ground and on sloping ground where water does not naturally drain away from the path.

They collect surface and sub-surface water flow and carry it away from the path preventing the paths themselves becoming waterlogged. The shape and minimum dimensions of side drains are shown in Figure C-29. The cross- section should be larger where run-off is particularly high.

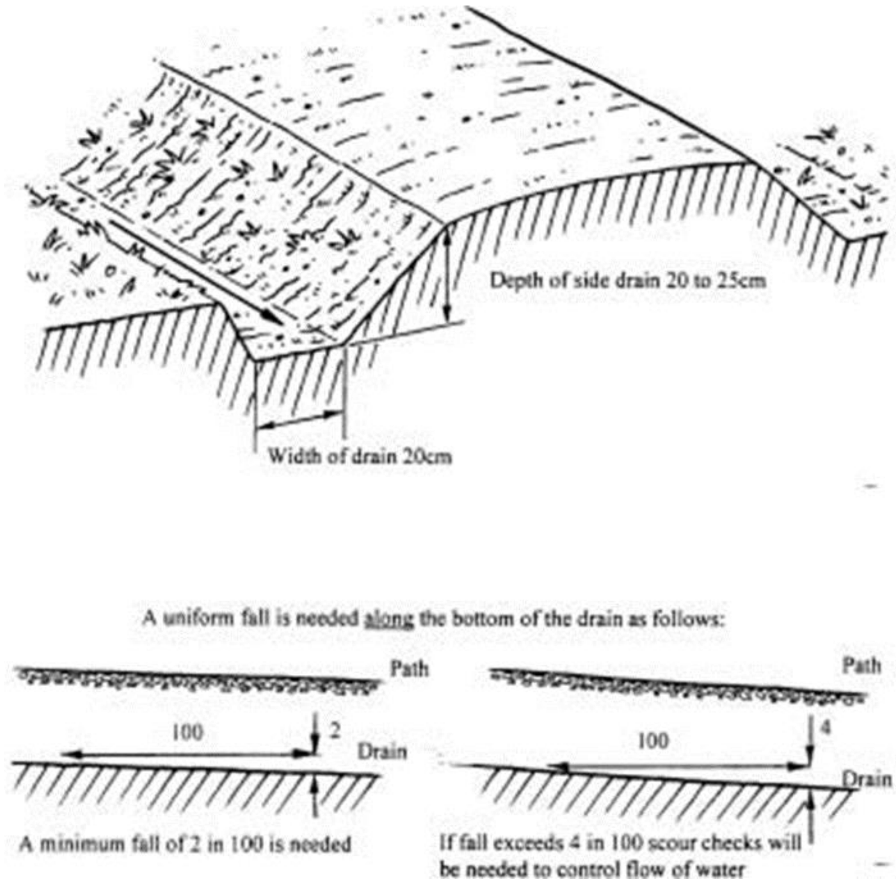


Figure C-29:- Details of side drains

Side drains must be constructed to allow water to flow smoothly along the drain without too much speed which can result in erosion of the drain.

C.9.3 Catch Water Drain

Catch water drains are required for paths on a hillside where there is a considerable flow of water down the hill towards the path. The catch water drain prevents the water flowing onto the path. A catch water drain is a ditch about 30 cm deep by 30 cm wide (at the bottom), constructed on the uphill side at a distance of 3 to 5 m, from the centre of the path. The soil excavated from the ditch can be placed to form a small bank on the lower side of the ditch. The drain should follow the contour of the hill to give a slope along the drain of 2 to 4%. A higher slope will need scour checks to control the water flow.

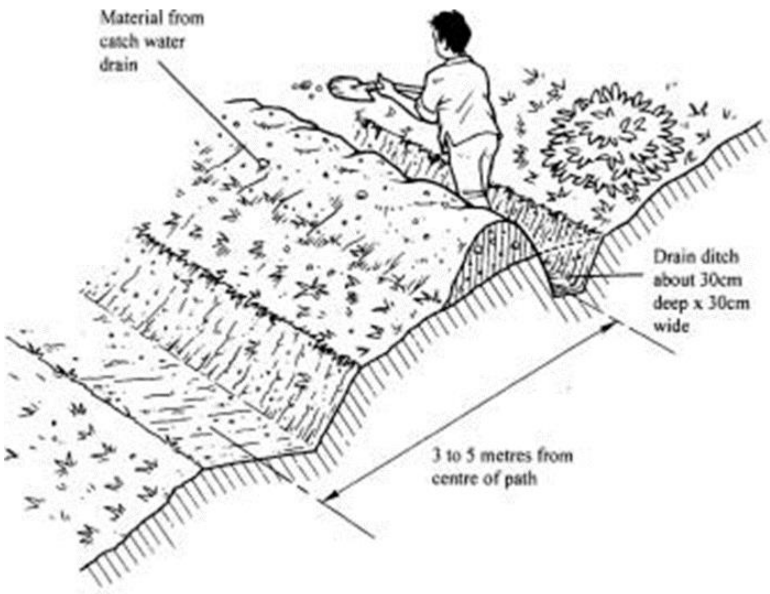
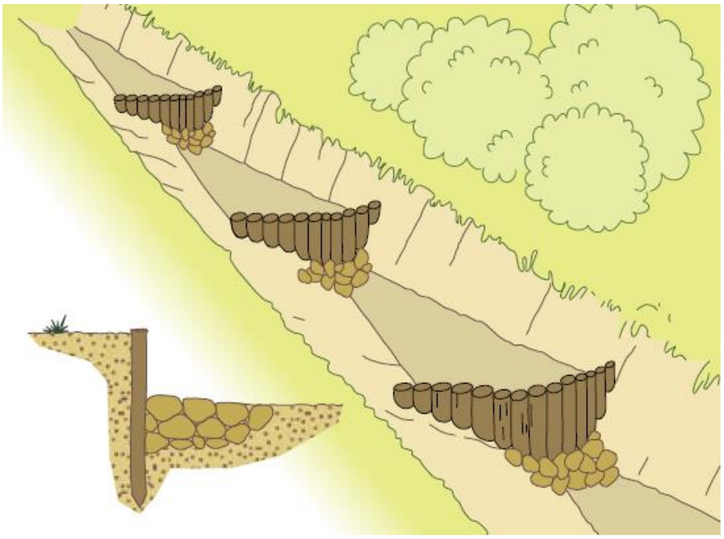


Figure C-30:- Construction of catch water Drain

If the catch water drain is long, turnout-out (miter) drains may be needed to prevent overflow. These should be directed away from the path if the slope allows this. If not, the **turn out drain** should lead into a cross drain or **culvert** to take water across the path.

C.9.4 Scour Checks

If the slope of drains is greater than about 4% (1 in 25), the surface of the drain is likely to be eroded (scoured) by the fast flow of the water. In this case scour checks should be used. These comprise small structures (checks) built within the drain that slow the flow rate of water by reducing the gradient of the side ditch due to silt building up behind the structure. Scour checks can be built from either sticks or pebbles. The action of the scour check is shown in the sketch below.



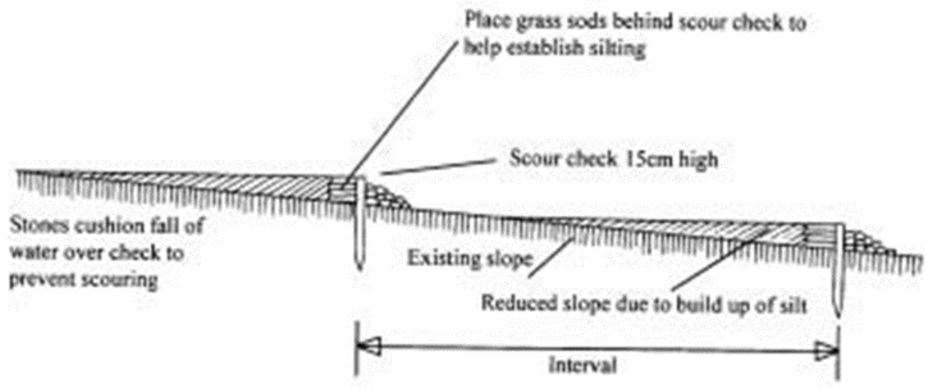


Figure C-31: Scour check

Interval

The distance between scour checks should reduce the effective slope of the drain to about 4% as follows:

- about 20m at a drain slope of 5% (1 in 20)
- to about 6m at a drain slope of 10% (1 in 10)

Note: The scour check should be shaped to reduce flow rate BUT not to block the drain.

Natural Checks

Erosion of drains can also be reduced by natural means, by allowing grass and other vegetation to grow in the drains. This can also reduce silting. This is a technique, which should be encouraged, but it needs regular maintenance to cut the grass to prevent drains from becoming blocked. Natural checks of suitable plants can be planted at appropriate intervals (similar to distances between scour-checks) to reduce flow rates where required.

C.9.5 Water Cut Offs

As the slope along the path increases there will be greater flow of run-off water along the path which can cause erosion, particularly in softer soils. For slopes above 3%, water cut-offs should be used to divert the run-off to the side of the path. The spacing of cut-offs depends on the path soil and slope. General guidelines are given in the following table 3-5.

Table C.5:-Recommended Spacing of Water Cut-Offs (m)

Type of Soil	**Longitudinal Gradient in %**					
	2	**4**	**6**	**8**	**10**	**12**
Loam	100	50	30	20	15	*
Clay-sand	150	100	60	50	30	15
Clay or clay-gravel	-	150	90	60	50	30

Gravel/rocky	-	-	230	150	100	80

Water cut-offs should be particularly located where there are signs of significant erosion, such as channels cut in the path, and patches of debris. The cut-off should lead into a turn- off drain to take the run-off well away from the path. If there is no cross-fall on the sides of the path to permit water to drain away naturally then side drains should be used to carry run-off further along to where it can be drained away.

C.9.6 Stone-Lined Drains

Stone-lined drains are used to overcome problems of excessive erosion of earth drains. They tend to be used mainly in hilly areas with high rainfall and run-off. Although construction involves substantially more time and effort in collecting and placing the stones, stone-lined drains require less maintenance.

French Drains

Although these resist erosions and are used on hillsides, they are less useful for high run-off than lined drains because of their reduced flow capacity. However, they are useful for other situations:

- Low maintenance drains – the stones limit growth of vegetation so French drains may be used in situations where maintenance is particularly difficult.
- Cross drains or water-bars on paths where wheeled vehicles use the path
- Intercepting sub-surface flow – can be used to intercept sub-surface flow of water, which is seeping onto the path.

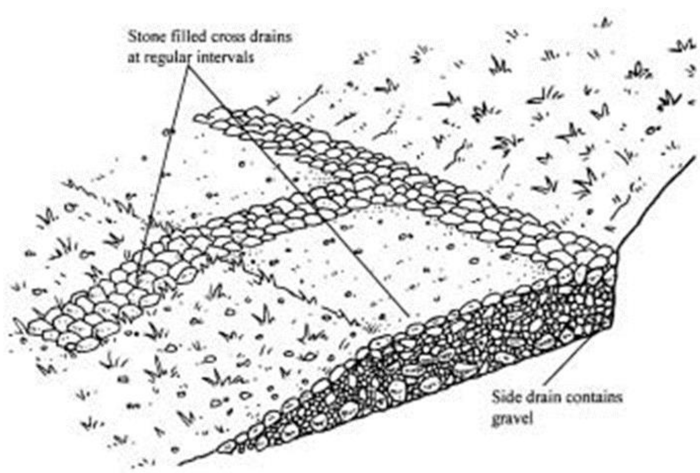


Figure C-32:- French Drain

Lined Ditches

In hilly areas with a high rainfall, large amounts of water may flow down the path drains. This water can cause severe erosion of the drain. In areas where erosion is excessive, it will be necessary to line the ditch. This may be done by using flat stone slabs or smaller stones held in place with mortar.

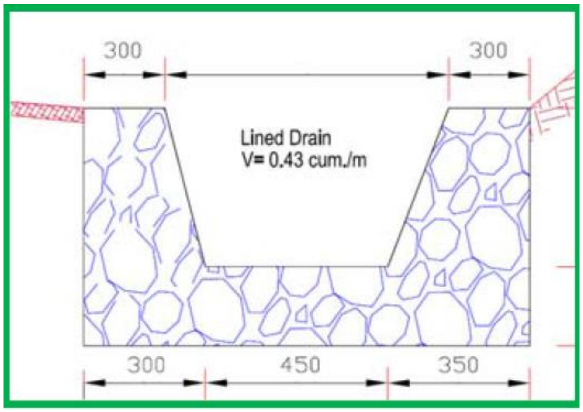


Figure C-33:- cross section of lined drain

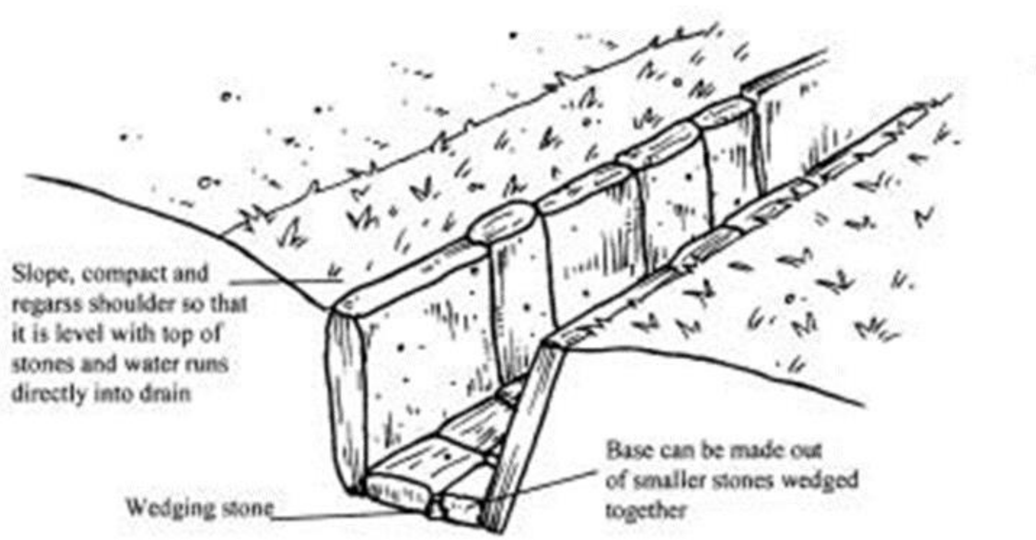


Figure C-34:-Ditch Lined with Stone Slabs

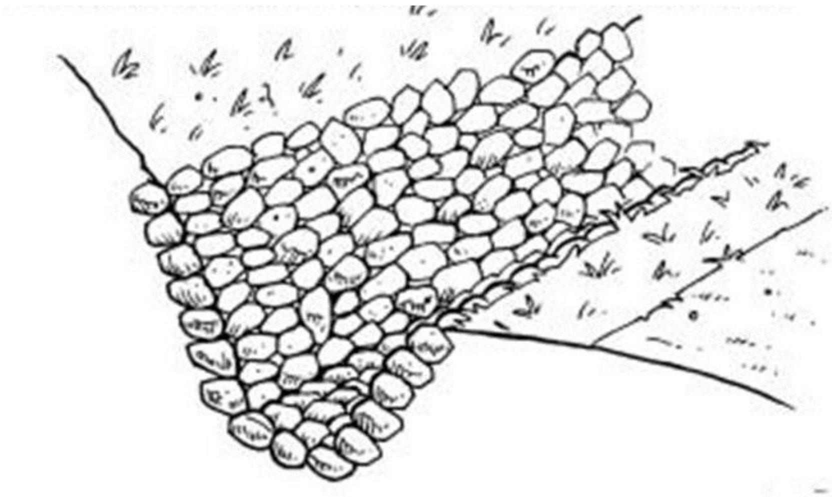


Figure C-35:-Ditch Lined with smaller Stone of different size bound together with mortar

C.10 Measurement and Payment of Work

The proposal to the community on improvements to be carried out on the path will need to include good estimates of the inputs of labour, tools and materials needed to carry out the work.

Guidelines on these are given in the following pages as follows:

C.10.1 Excavation to Level

i. Across the path

It is important to prepare a level bed across the formation width of the path. As a guide, slots about 0.5 m wide are cut across the width about every 5 to 10 m. The aim is to minimize work in preparing the level bed by balancing the cut against the fill.

ii. Along the path

If the longitudinal profile of the path is very irregular due to humps and dips it may be necessary to smooth it out, especially if vehicles are to use the path. In this case, the aim will be to balance the excavation of the humps against the fill in the dips to get a smoother surface. This can be done by eye. Because of the considerable work that may be involved it should only be done where necessary and to the least amount needed. This additional work will need to be included in the estimate of person work-days required to carry out the work.

Table C.6:-Main Steps in the Construction of a Path

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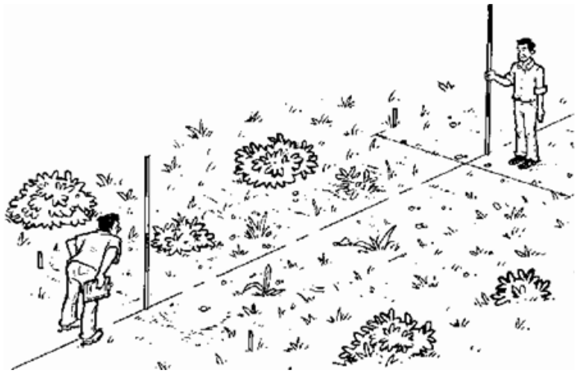
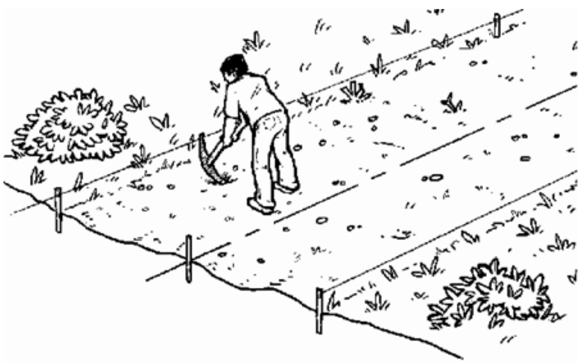
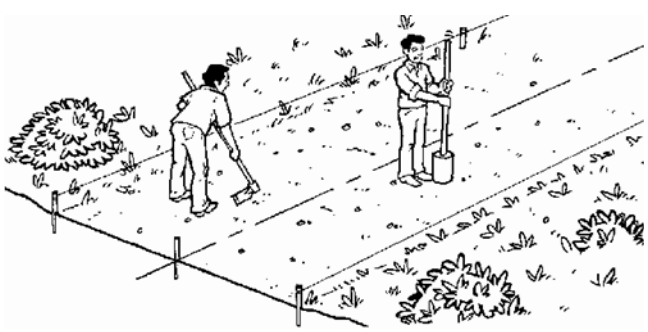
<tr><td>
Quantity = length set
out (m)</td><td>STEP 1: Setting Out the Path

Careful setting out of the alignment of the path is needed to produce a good quality path with the least amount of work.

In many cases an existing path will be followed, but there may be cases where it is necessary or easier to change the route.

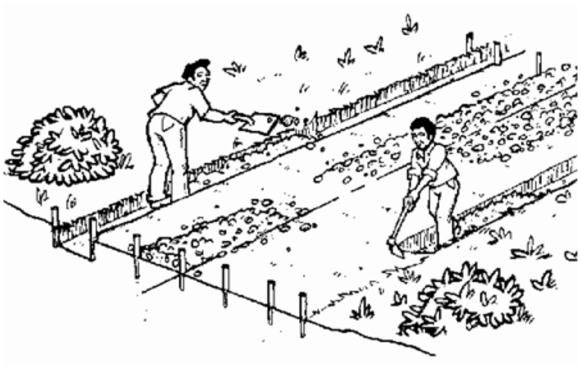
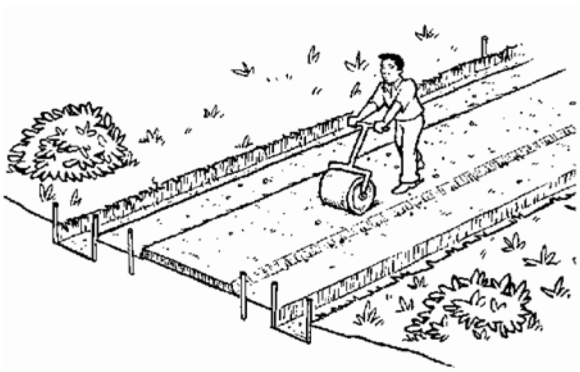
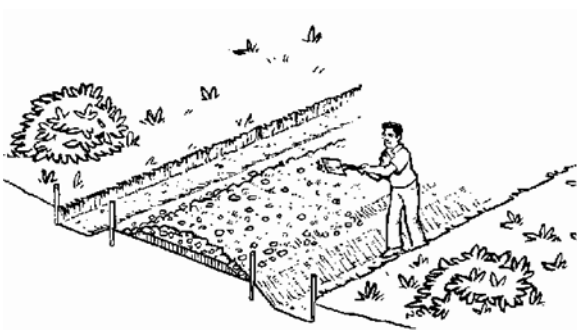
a. Mark the centre-line with poles at 5 to 10 m intervals.
b. Measure formation width of path and mark with pegs</td></tr>
<tr><td>
Quantity = formation width x length (m2)</td><td>STEP 2: Clearing and Grubbing

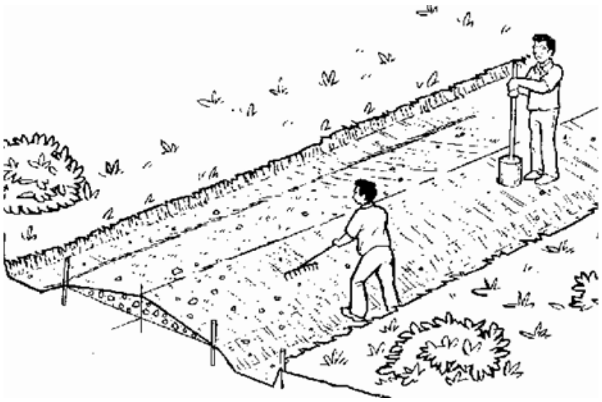
a. Remove any rocks (avoid them wherever possible) from the formation width of the path.
b. Cut back all vegetation
c. Then dig out all bush stumps and grass roots (“grubbing”).</td></tr>
<tr><td>
Quantity = volume excavated (m3)

= Sum of areas at each slot x distance between slots</td><td>STEP 3: Excavate to Level

The aim is to provide a level base and minimize excavation by balancing fill with excavation.

a. Cut slots about 0.5 m wide at 5- 10 m intervals to provide a guide for excavation to level. These should balance fill against excavation.
b. Complete excavation to level.
c. Water fill (if dry) and compact</td></tr>
</table>

 Quantity = volume excavated (see Step 6)	**STEP 4: Mark Out and Excavate Drains** a. Use pegs and string to mark out drains b. Excavate drains – throw soil to centre of path. c. Use slope template and spirit level to check slope of drains
 Quantity = area compacted = width x length (m2)	**STEP 5: Formation of 'Plug'** a. Spread the excavated material over about ¾ of the width of the path surface to form the 'plug'. b. Water and compact the plug. Note: hand compaction can be used but a hand roller will save considerable time and effort. As an alternative, motorized pedestrian rollers may be used for this.
 Quantity = cross-section area of drain x length (m3)	**STEP 6: Sloping of Ditches** a. Excavate the slopes on each side of the ditch and throw the soil onto the 'plug'. b. Use a template to obtain the correct slopes and shape of the drain.



Quantity = area formed

= path width x length (m2)

STEP 7: Formation of Camber

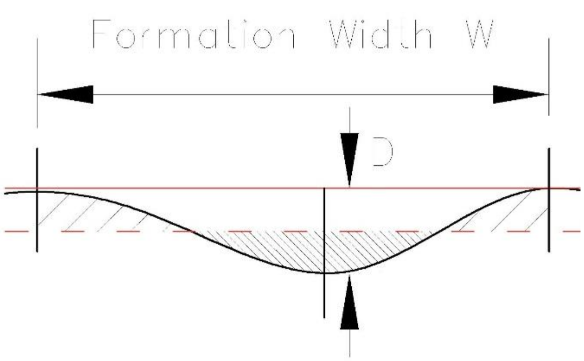
A good camber is essential to ensure that rainwater flows off the surface of the path.

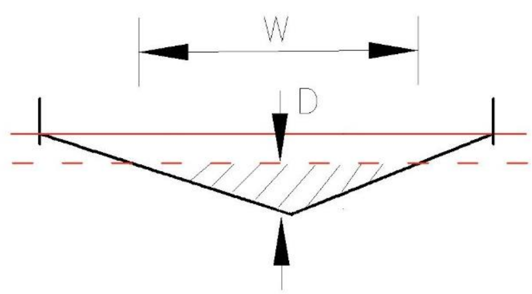
a. Spread material to initially form a camber with a cross-fall of about 8%.
b. Water and compact the soil either using a hand rammer or hand roller (if one is available). The cross-fall after compaction should be about 6%.

C.10.2 Estimating Volume of Excavation

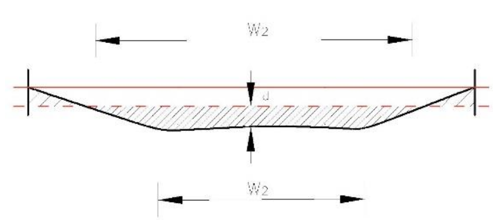
1. **Excavation to Level:** Aim is to balance excavation and fill and produce a level bed across the formation width (path and drains) of the path.

   1.1. Paths on level ground

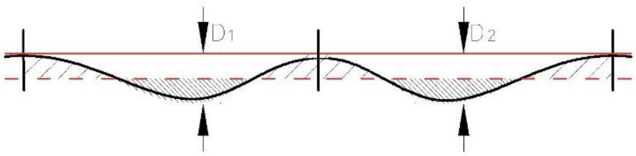


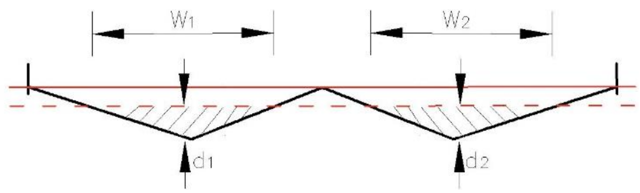


$$Area = \frac{1}{2}wd \quad or$$



$$Area = \frac{1}{2}d(W1 + W2)$$

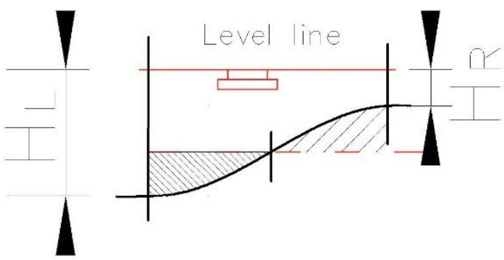


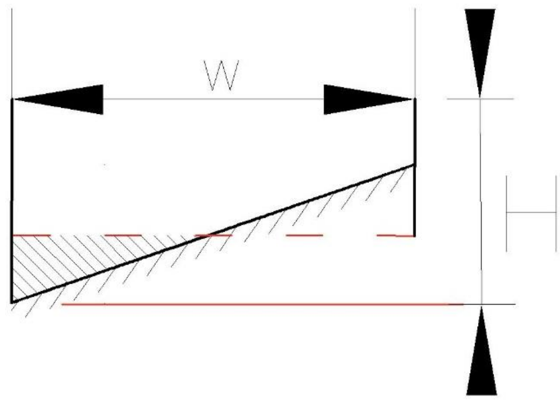


$$Area = \frac{1}{2}w_1 d_1 + \frac{1}{2}w_2 d_2$$

Figure C-36:- paths on level ground

1.2.Paths on cross-slopes





Key

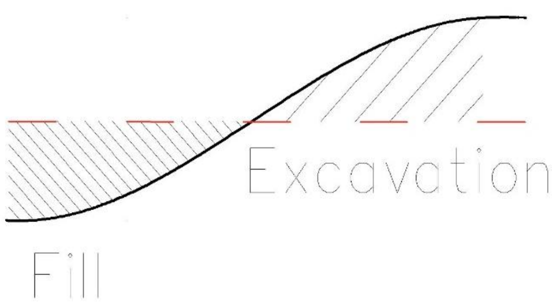
Level reference line

Path cross-section

Final level line

Area of excavation =Area of fill as above

Volume of excavation of path lenghth =Area X $1m^3/m$



Notes

1. Excavate at 5 to 10m intervals depending variation of cross-section
2. Approximate method is usually good enough doe paths
3. Areas may also be estimated from slots cut prior to leveling

Figure C-37:- How to excavate to level on sloping ground

C.10.3 Excavation of Drains

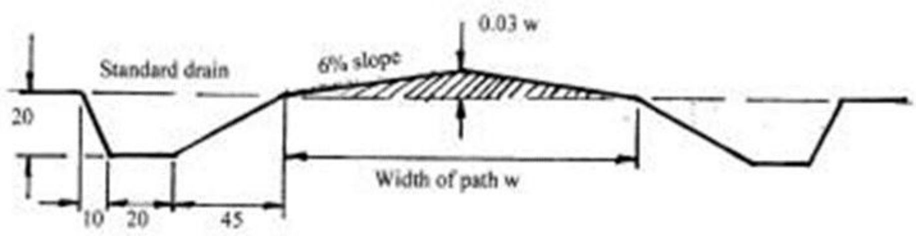
- 

Figure C-38:-Standard Cross-Section of Path

Aim is to balance excavation of drains with fill needed to form the camber. Cross-sectional area of camber = 0.5 x w x 0.03 w = 0.015 w^2. Allow extra 30% for compaction, area of fill = 0.02 w^2

Width of path, w (m)	1	1.2	1.4	2.0	2.5
Area of Fill (m^2)	0.02	0.03	0.04	0.08	0.13

Area of standard drain shown in sketch = 0.09 m^3 Area of 2 drains = 0.18 m^3

- This means that for paths with side drains each side the volume of soil excavated from the drains is more than adequate to form the camber for path widths up to 2.5 m.
- For paths with a side drain on one side, only the drain size provides adequate fill for the camber for path widths up to 2 m. For a 2.5 m wide path, the depth of the drain should be increased to 25 cm with the same shoulder slopes.

C.10.4 Task Rates

Guidelines on task rates (the amount of work that will typically be completed by one person in a day) are shown in the table below.

Table C.7:-Typical Task Rates for Labour-based Road Work:

Activity	**Unit**	**Daily task Rates**
Setting out of centre line and marking formation width of path	m	100
Removal of boulders/excavation of rock	m^3 (loose)	0.5 to 1.0
Clearance of grass, bush, incl. Grubbing	m2	50 (heavy) –150 (light)
Cutting of slots and setting of profiles (Based on formation width x length)	m2	600(hard soil) –1200(soft soil)

Excavation to level or side borrow (1)	m3	3.0 – 5.0
Ditching and spreading	m3	3.0
Sloping	m3	3.5
Camber formation	m2	100
Compaction by hand	m2	100
Excavation and stocking of gravel	m3	2.0 – 3.0
Loading and off-loading of gravel	m^3 (loose)	8.0 – 12.0
Spreading of gravel to camber	m^3 (loose)	10 to 15
Collection of sand/gravel	m^3 (loose)	0.5 – 1.0
Stone/rock collection	m^3 (loose)	1.0
Crushing stones/rock	m^3 (loose)	0.15 (small pieces, 5 to 40mm) to 0.5
Lay dry stone masonry (construction) Volume = length x width x height	m3	1.0
Lay stone pitching – area = length x width	m2	2.0 to 4.0

NOTE:

1. All rates for excavation are for digging and throwing only. For additional movement of material add haulage time.
2. Range of task rate indicates "difficult" to "good" conditions.

C.10.5 Collection/Haulage

In most improvement or construction work on footpaths there will be a need to move or transport materials, mainly soil, gravel and stones, although every effort should be made to keep this to a minimum.

Note: in collecting material for the path surface, include an extra 30% to allow for compaction.

Guidelines on the most appropriate methods of haulage for different distances and the typical rates that can be achieved are given in the following table:

Table C.8:-Guideline on Methods of Haulage

Haulage Distance	Method and Typical Rate per Person
Up to 10m	Shoveling or raking – typical rate for movement of 10 m is 3 to 5 m^3 per day
Up to 50m	Carrying in buckets, baskets or on stretchers. Assume 25 kg/trip and 3 km/hr on flat, 2 km/hr uphill – remember time for return trip and loading/unloading. Typical rate for 50 m distance on flat ground is 1.5 to 2 m^3 per day
10 to 150m	Wheelbarrows are best if terrain is suitable – they are not suited to rough ground and above medium slopes. Assume $0.05m^3$ per trip and other factors as above for carrying. Typical rates on flat: 50 m – 3 to 4 m^3 per day 100 m – 2 to 2.5 m^3 per day
150 to 800m	Animal drawn carts are best if there is suitable access and slopes are not too great. On flat, assume loads of $0.16m^3$ for single donkey cart, and about $0.4m^3$ for pair of oxen. Average speeds as for walking. Considerable time will be needed for loading and unloading. Typical rate for ox-cart on flat for 500 m distance would be 2.5 to 3.2 m^3 per day
Over 800m	Difficult to justify hauling materials this far for a footpath. Consider these cases very carefully.

Note: The typical haulage rates in the table include estimates of loading and unloading time. However, they do not include time for excavation and stocking.

C.11 Signage and Marking

As per (Bike way and Trail Design standards and planning guidelines, 2003) signage is Designed to increase the safety and comfort of trail users, adequate signing and marking are essential on any trail or trail system and should be incorporated into bikeways and trails. Signs communicate important information about the trail to the user, such as navigational and educational information, cautionary warnings of potential trail hazards, and regulatory uses.

Placement of Signs

The placement of signs along each trail will vary greatly, depending on the intended use of the trail, and should comply with the following standards:

- Lateral sign clearance shall be a minimum of 1m and a maximum of 2m from the near edge of the sign to the near edge of the path.
- Mounting height for ground-mounted signs shall be a minimum of 1.2m and a maximum of 1.5m., measured from the bottom edge of the sign to the near edge of the path surface.
- When overhead signs are used, the clearance from the bottom edge of the sign to the path surface directly under the sign shall be a minimum of 2.5m.
- Placement of signs to be reviewed during trail design review phase

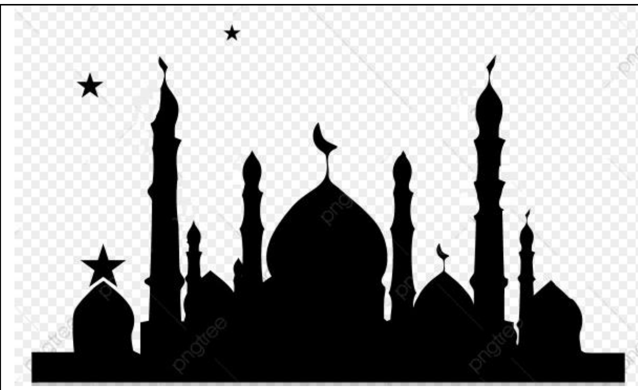
 (a)	 (b)

Figure C-39:- Religious areas signage

Part D

Foot Trail Construction

D. FOOT TRAIL CONSTRUCTION

D.1 Community Based Trail Construction Guidelines and Procedures

1. Construction of a new trail requires following the planning process as described above in Part B
2. Realignment of an existing designated trail or track involving a segment greater than 1.0 km in length requires approval of the management team.
3. Execution and direction of all trail construction and maintenance activities are the responsibility of the Trails Supervisor.
4. Conduct preconstruction analysis and design procedures as described in this manual prior to any construction work.
5. All shortcuts, braiding, illegal and vandal routes should be closed and naturalized. Immediately remove all unauthorized markers.
6. All major trail work requires onsite supervision of an authorized project leader. Qualifications include knowledge of the policies, specifications, and guidelines within this manual. Project leaders are authorized by the Trails Supervisor.
7. All trail workers must wear appropriate clothing and utilize proper safety equipment. This includes long sleeved shirts, long pants, work boots, gloves, eye wear, wide brimmed hat, etc. Do not allow work to proceed in case of an unsafe situation.
8. Trail edges should never be lined with rocks, unless the Trails Supervisor determines it to be essential for controlling shortcuts and other impacts to off-trail areas.
9. Do not permit adverse impacts to cultural resources and/or plants and animals listed as threatened or endangered species.
10. Remove all project markers (flagging, stakes, etc.) immediately upon the completion of any project.
11. All construction and maintenance should be finished in a manner, which preserves the visual quality of the landscape.

12. Volunteers who wish to participate in trail construction and maintenance work must contact the woreda coordinator prior to attempting any trail work.

D.2 Safety Guidelines

Safety is the single most important thing when conducting trail work. Knowing how to use tools properly and safely plays a critical role in the efficiency of the trail construction process. Knowing what to use for each task and when to use it, in addition to practicing the safest techniques can save time and money. However, Safety is always the number one priority and should never take a back seat to time or money. If you feel something is unsafe, then do not do it.

Your most important tool is your brain—use it. Always use proper personal protective equipment (PPE), such as hardhats, gloves, and safety glasses etc.

The crew should always have a first aid kit on hand as well as the training to know how to use it, and a realistic emergency and communication plan.

Specialized trail tools can help make your trail work more enjoyable. Pace yourself. Take rest breaks, drink plenty of water, and keep your mind on your work. Crew members should trade off on work tasks occasionally for relief from repetitive stresses.

Posture is important. Stand comfortably in balance. Adjust your stance and tool grip continually to prevent slipping and to avoid glancing blows. Be especially careful when working in wet, slippery conditions.

D.2.1 Safety Equipment

- **Hard Hat.** Wear a hard hat when felling trees, cutting branches over your head or whenever there is a possibility of being hit by flying or falling debris. When operating a chain wale, attach a face shield to the hard hat.
- **Safety Goggles/Glasses.** Wear safety goggles or glasses for all trail-clearing work, especially when working in a forest or brush land or when cutting or chopping wood and breaking rocks.
- **Ear Muffs.** Ear muffs for sound protection are essential when operating or working near noisy equipment.
- **Long-Sleeved Shirt and Pants.** They are nearly always appropriate to wear for protection from minor scrapes, cuts, punctures, irritating plants, biting insects and thorns, or when operating power tools.

- **Tear-Resistant Pants or Chaps.** Wear these when operating a chain saw or working in thorny brush.
- **Gloves.** Wear gloves to protect your hands from blisters, cuts and scratches, and when operating a chain saw.
- **Boots.** Sturdy boots provide ankle support and protection from saw blades, thorns, sharp rocks and other hazards.

D.2.2 Safety Rules

1. Tools should be carried in the safest way. The tool should be gripped by the handle about 15 cm behind the head (or at the balance point) and carried to the side, on the down-slope side of the body rather than over the shoulder or as a walking stick. This prevents injuries due to falling on the tool, since it can be easily tossed away when carried correctly. Tools with sharp blades should be carried with the blade facing the ground and equipped with a sheath to prevent accidental cuts and to retain their sharp edge. The sheath should remain on the tool while it is carried to the worksite and removed only when used. Bulky or clumsy items should be held with two hands or carried by two people.
2. Plenty of room should be allowed between volunteers for walking and working—generally 3 m between each crew member.
3. Crew members should always be aware of what others are doing and take full responsibility for their own safety and the safety of others.
4. The right tool should be used for the job.
5. The "Scan-Shout-Swing" order of doing things should be implemented. Crew members should look around to make sure no one is in harm's way and there is plenty of room to swing safely. If necessary, brush or limbs first should be cleared to avoid injury from a deflected tool. Second, intentions should be communicated and third, when all is clear, crew members may proceed.
6. Trail hazards should be removed as they are encountered, or their presence communicated to other workers down the line—either verbally or with a temporary sign (for instance, a temporary sign could warn others of a nearby yellow-jacket nest or a poorly supported

leaning tree). Hazards should be removed as soon as practical to prevent others from being harmed.

7. Dehydration, heat stroke, hypothermia, and allergic reactions are life-threatening concerns. First aid supplies should be kept on hand and every crew member should know what is available and where it is kept. If working in remote locations, someone should know the crew's location and expected time of return.
8. Crew members should be aware of their physical condition and limitations—weariness can lead to accidents.
9. Chainsaw operators cannot work alone. Sawyers must have a Sawyer at all times.
10. Any crew or individual going out into the woods should carry a phone or radio device that provides reliable communications to emergency responders and have an up-to-date emergency response plane.

D.3 Construction Work Methodology

D.3.1 General

Tools that will be used for construction and maintenance of foot trails are shown in the Figure D-1: The procedure on how to construct and quantifying the work is discussed in chapter 4 section C.10 and the list of tools is attached in the appendix part of the document. but here some important additional points

Figure D-1. Tools used for construction and maintenance of foot trails

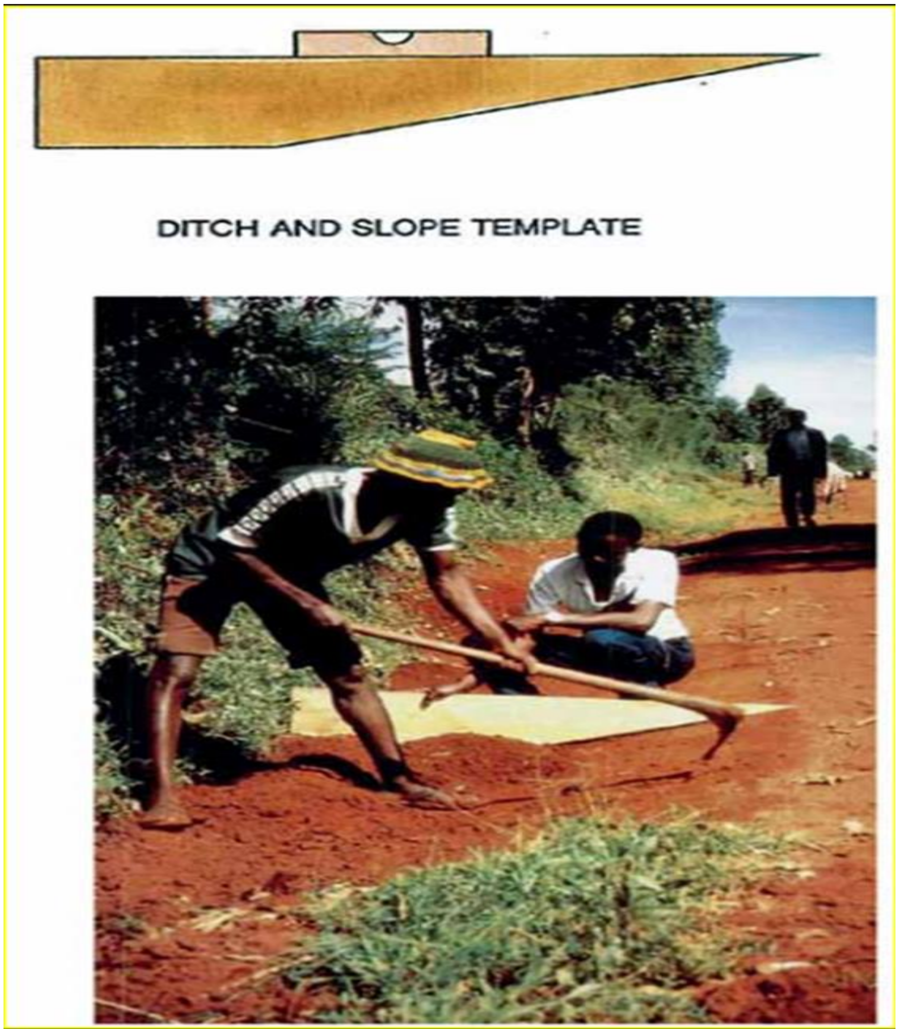


Figure D-2:-Template to obtain the correct slopes and shape of the drain

D.3.2 Clearing and Grubbing

I. Clearing of Rocks and Boulders

The removal of large rocks or boulders can be a particular problem. A number of methods are shown in the following sketches. *Great care is needed to avoid accidents***.** The work should be carried out by experienced workers. Proper tools which are strong enough for the work must be used.

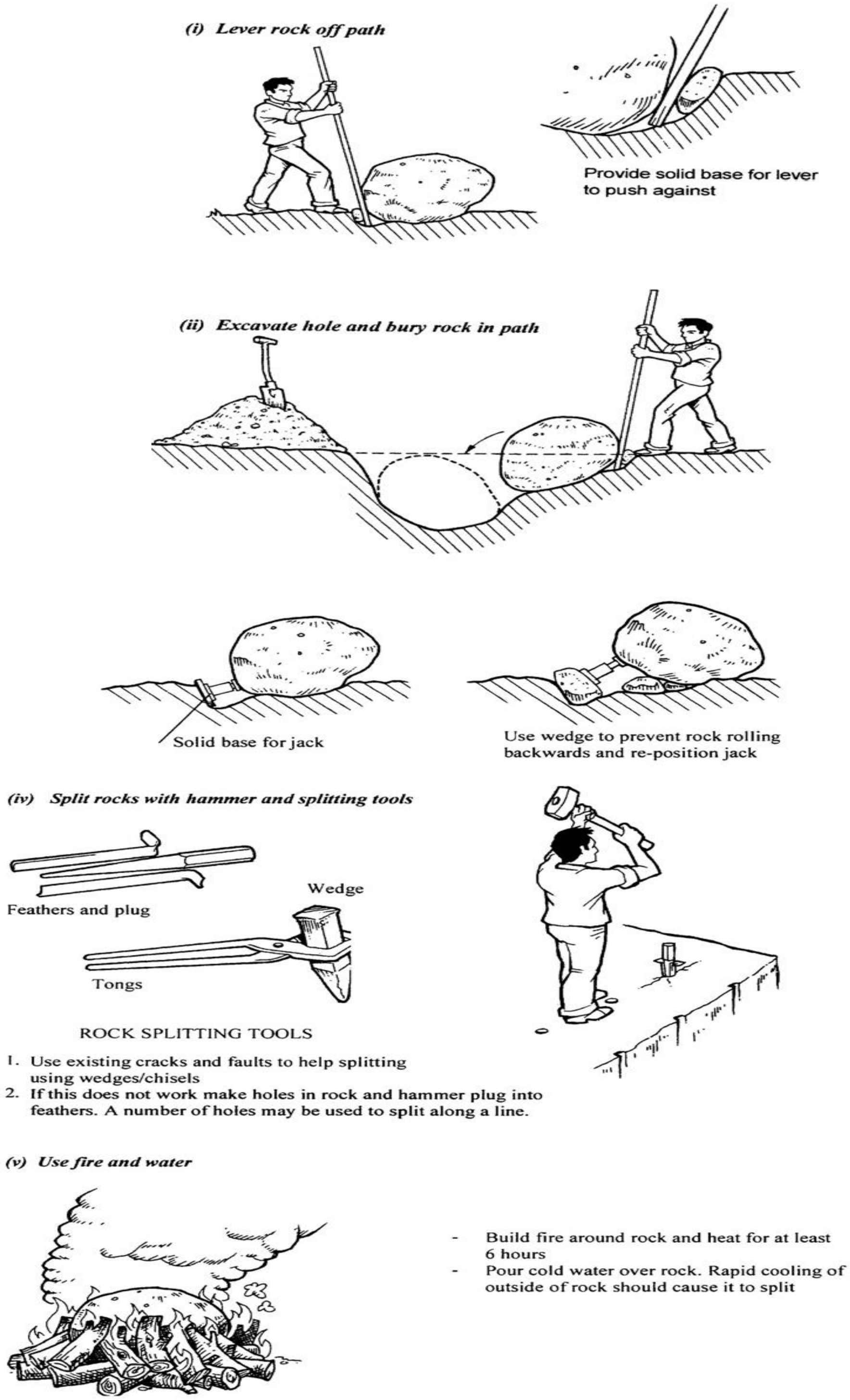


Figure D-3 :- Clearing of Rocks and Boulders: Methods in order of ease

II. Vegetation Clearing

This work consists of clearing, grubbing, trimming, removing, and disposing of live and/or dead vegetation. Where large trees are near or within the clearance limit, study the possibility of slightly realigning the trail to reduce maintenance needs and to retain the maximum amount of vegetation in the natural environment.

The best way, generally, to trim branches is to make cuts with a handsaw. All side branches extending into the trail clearing should be cut flush with the parent branch or stem, leaving no stubs. This is safer, lasts longer, and also allows for the wound to heal naturally. Small trees and shrubs within the tread should be grubbed out to prevent tripping. Trees and brush outside the tread (but inside the trail clearing) should be cut as close to the ground as possible, leaving no sharp pointed stumps or stems.

If roots of big trees cross the trail alignment. The crossing roots should have to be removed due to the fact that removing a few roots of a big tree will not cause it to die.

In high use sections of the trail or near camping areas, remove dead or dying trees that have a high probability of falling across the trail or camping area. These hazard trees are extremely dangerous and should only be removed by experienced sawyers who are trained and certified to fall standing trees.

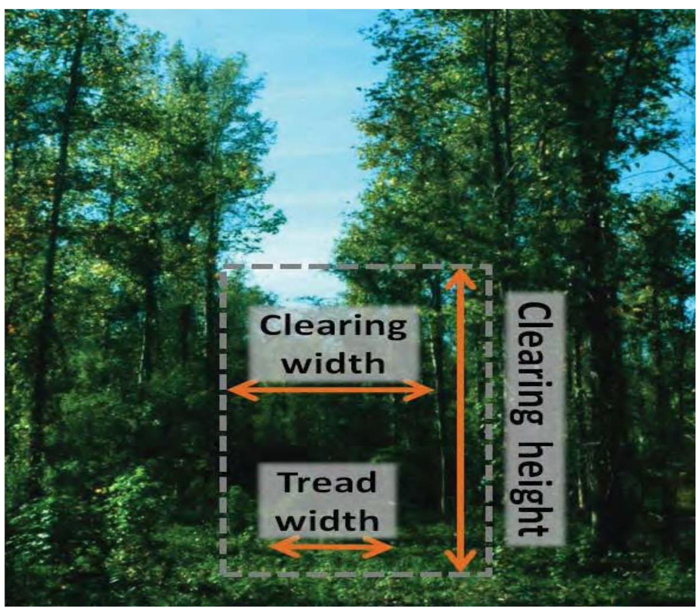


Figure D-4:- Vegetation Clearance

D.3.3 Construction of Foot Trail on Flat land

To construct foot trails on flat land, the following steps should be followed.

1. Prepare a level bed for forming the path**.**

i. Measure out and clear the formation width (path and drains) of the path.

ii. Cut slots every 5 to 10 m to provide a guide for excavation to level.

2. Excavate the drains and form the profile of the path.

   i. Excavate drain ditch, spread and compact the soil to form the ‘plug’.

   ii. Cut side slopes of the drains; use a profile board to get the correct shape.

   iii. Spread and rake soil to form camber, use camber profile board to get correct slope of 8%. Compact the soil to form the surface of the path.

**It is essential to achieve good compaction at all stages to avoid damage and depression of the path surface.*

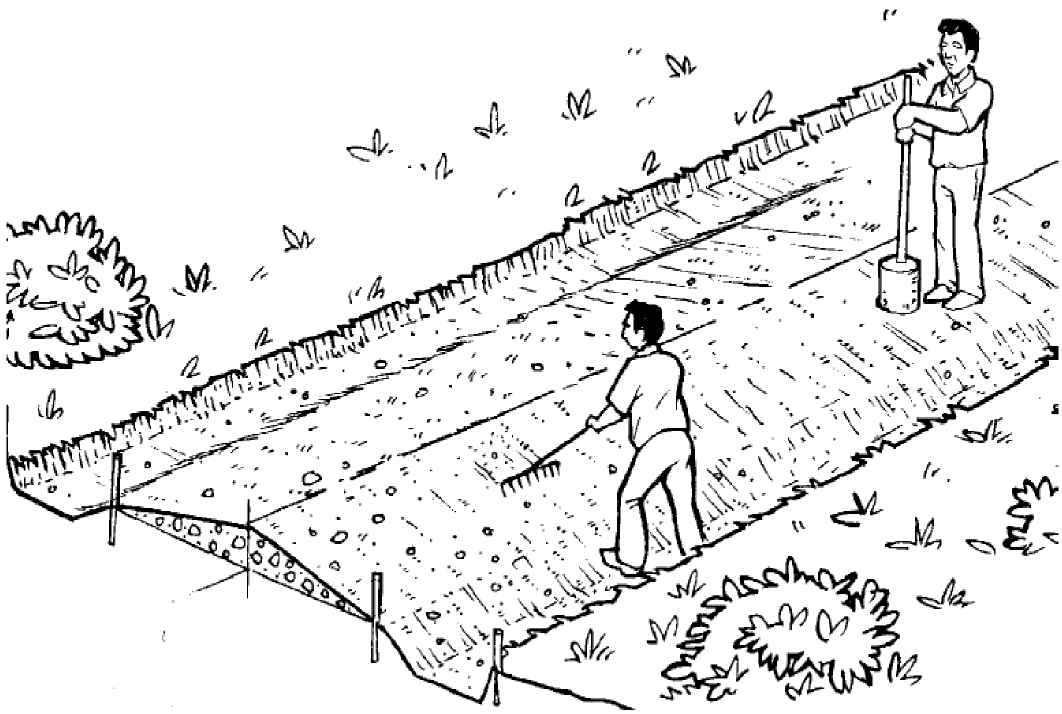


Figure D-5:- Excavation of the drains and forming the profile

The profile of the camber and drains should be checked with profile boards. It is important that side drains have a fall along their length of at least 2% to allow water to drain away efficiently. Flat land may seem like an easy place to build a trail, but if the soil is mainly clay or silt or the water table is high, poor drainage may lead to mud puddles. Generally, it is best to avoid building a natural surface trail on flat land. Solutions include relocating the trail where there is side-hill drainage or raising the tread above the surrounding flat ground.

D.3.4 Construction of Foot Trail on a Hillside

A hillside trail, relatively, drain surface water off the tread while maintaining its shape and a grade that is comfortable for trail users. Constructing contour trails into the side slope requires excavating the side of the hill to provide a solid, stable trail tread. Flat areas should be avoided whenever possible, since rainwater would not easily drain away. Slightly out-sloping the tread (about 5 %) is a must to help move water across the trail.

I. Full-Bench Construction

Trail experts almost always prefer *full-bench* construction. A full bench is constructed by cutting the full width of the tread into the hillside and casting the excavated soil as far from the trail as possible. Full-bench construction requires more excavation and leaves a larger back slope than partial-bench construction, but the trail bed will be more durable and require less maintenance. A full-bench trail usually has a well-compacted base because the underlying material has been in place for a long time. You should use full-bench construction whenever possible

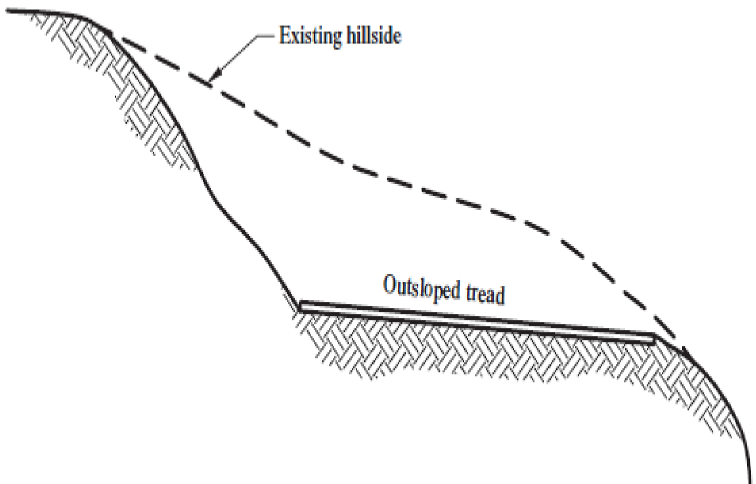


Figure D-6~~5 6~~:- A full-bench trail is constructed by cutting the full width of the tread into the hillside

II. Partial-Bench Construction

Partial-bench construction is another method to cut in a trail, but it takes a good deal of trail building experience to get this method right. The trail tread will be part hillside and part fill material. The fill part is difficult to compact, especially with hand tools. If fill material is not well compacted, horses and vehicles may destroy the tread. If fill material must be used for part of the trail bed, large rocks should be used to form the trail bed and serve as edging, then cover them with tightly compacted soil.

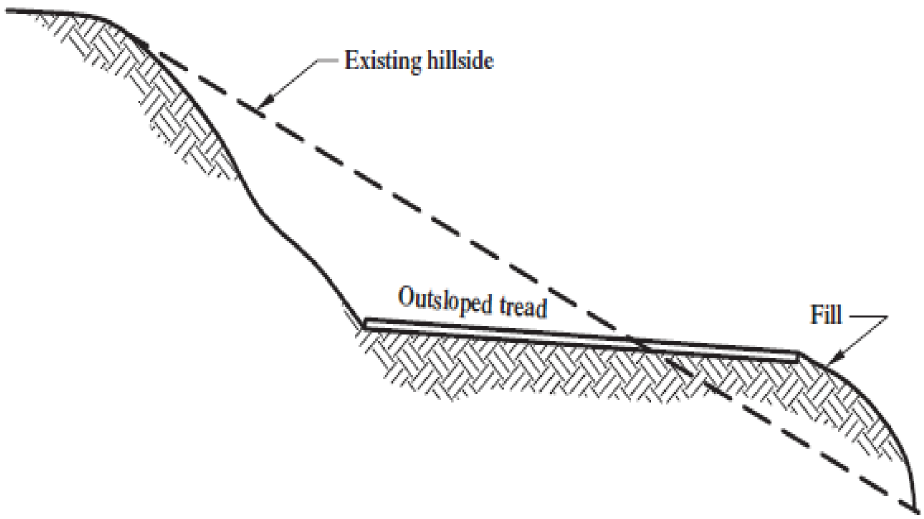


Figure D-75 7: Partial-bench trail is constructed by cutting from the hillside and partly by fill material

Back slope

The back slope is the excavated, exposed area above the tread surface. The back slope should match the angle of repose of the parent material (the side slope). Trail specifications recommend 1:1 back slope. This means 1-meter vertical rise to 1-meter horizontal run. Most soils are stable with 1:1 back slope. Solid rock can have a steeper 2:1 back slope, while less cohesive soils may need a 1:2 back slope

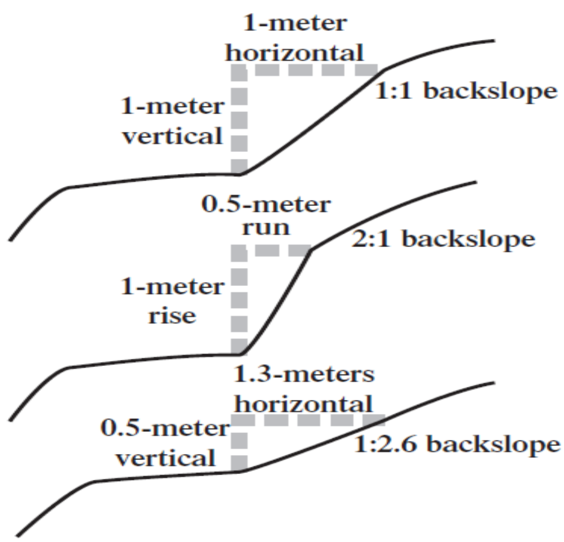


Figure D-85 8:-Back slopes are a ratio of vertical to horizontal distance, or rise to run

D.3.5 Tread Construction

Tread is the actual travel surface of the trail. Tread is constructed to support the designed use for the trail. Trail construction requires creating a solid, sustainable tread. Forces such as soil type, annual precipitation, and other factors may influence how long the tread remains stable before maintenance is needed.

Soil type and texture have a major influence on soil drainage and durability. Texture refers to the size of individual soil particles. Clay and silt are the soil components with the smallest particles. Small particles tend to be muddy when wet and dusty when dry. Clay and silt do not provide good drainage. Sand is made of large particles that do not bind together at all and are very unstable.

The best soil type is a mixture of clay, silt, and sand. If the soil is lacking any one of these, then attempt to add what is missing. Knowing the soil types encountered when building trails will help you develop a solid, stable tread.

Tread, whenever elevated, should be slightly crowned (higher in the center than on either side) to drain better.

Remove roots that are parallel with the tread; otherwise it help funnel water down the trail and create slipping hazards. In addition to these, the trail should be routed above large trees. Building below trees undermines their root systems eventually killing the trees

Compact the tread as much as possible during initial construction, paying close attention to maintaining an outslope. Compaction comes from the downward force from feet, hooves, wheels, etc. When a tread is fully compacted, it holds its shape and resists displacement and erosion. Some materials have better compaction properties than others. Tread materials that do not compact (e.g., sand, organic soil, water-saturated soil) or that compact too much (e.g. peat) will not retain a desired shape. Excessive compaction tends to lower the tread and encourages water to collect in depressions.

D.3.6 Surface water control

Diverting surface water off the trail is of the highest priority in achieving sustainable trails. Running water will erode the tread and support structures and result in the deposition of sedimentation. Standing water can result in soft boggy conditions, and tread and support structure failure. The most effective way to address these risks is through designing contour trails and out slopping the tread, as previously discussed.

I. Grade Dip

As shown Figure D-9 a grade dip is where the grade of the trail is reversed for about three to five meters and then ‘rolled’ back over to resume the descent. Using the existing terrain (e.g. where the trail winds around trees or rocks) as the control point for the grade reversal and building on the local drainage to remove water from the tread is the most effective means of incorporating grade dips. The drain outlet (the lowest point of the grade dip) may require some protection by the placement of guide structures, such as rocks, along the lower edge of the tread. Grade dips are best located mid-slope and frequently enough to prevent water from building enough volume and velocity to damage the tread.

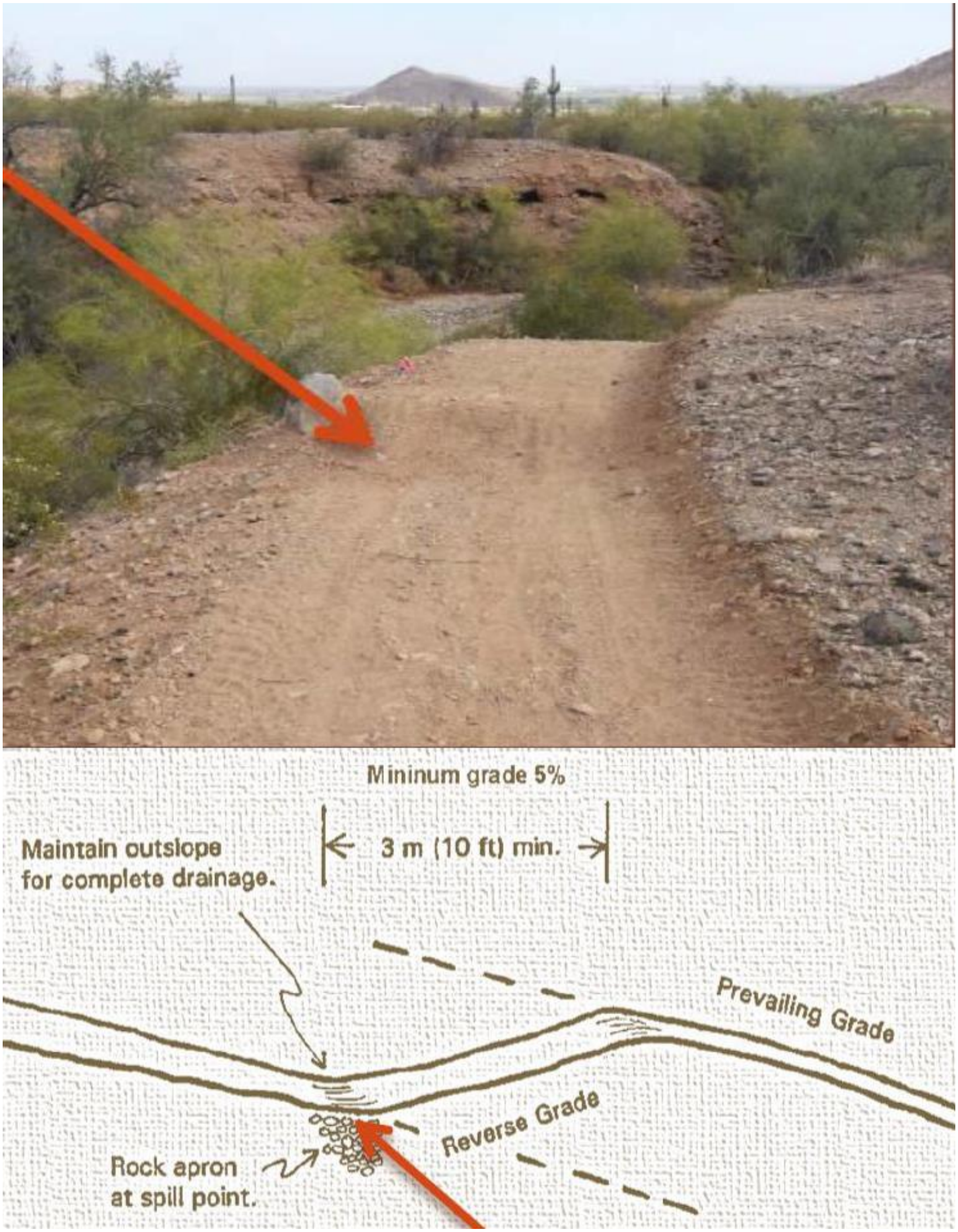


Figure D-9: Grade Dip

II. Water Bars

This work consists of excavation, installation of rocks or logs, backfill, and rock-lined spillways. Rock is the preferred material for water bars; wood will rot eventually, and additional material for anchoring would be required.

Water bars should be installed at an angle of 30% to 60% from the direction of travel. All water bars should extend a minimum of 30 cm beyond each outer edge of the tread or farther as needed to ensure complete diversion of water from the trail on a steep side slope. On steep side slopes, the upper end of the water bar is buried at least 30 cm into the cut bank, while the lower end is flush to the drop-off point.

A finished water bar has an appearance similar to a grade dip. Use fill material to create an embankment against the downgrade side of the water bar to act as a ramp. A smaller embankment is compacted against the upgrade side to serve as a shorter ramp and to guide water into the drain spillway.

A drain ditch should be constructed to provide proper runoff from the tread. It should be at least 30 cm wide and 24 cm deep. Install a rock apron where there is potential for erosion at the spill way. Place rocks in a manner that does not obstruct water flow. Typically, it is necessary to place loose rocks, deadwood, and/or transplanted vegetation at the trail edges to discourage travelers from going around the structure.

Construct embed large rocks into the tread. A rectangular shape is best, and rocks must be large enough not to be knocked over by travelers, including livestock, nor spilled over by water. Bury at least ½ of the rock depth into the tread. All rocks will be set in a shingle fashion, tightly overlapping each other towards the downslope side. Compact rocks and fill dirt around the base of the rocks to solidify the structure. Add fill material to make rolling ramps as described above

A water-bar is an obstruction placed at an angle of 45 to 60 degrees to the direction of the path to lead water running on the path away to the downhill side. The obstruction can be constructed from logs or stone depending on what is available.

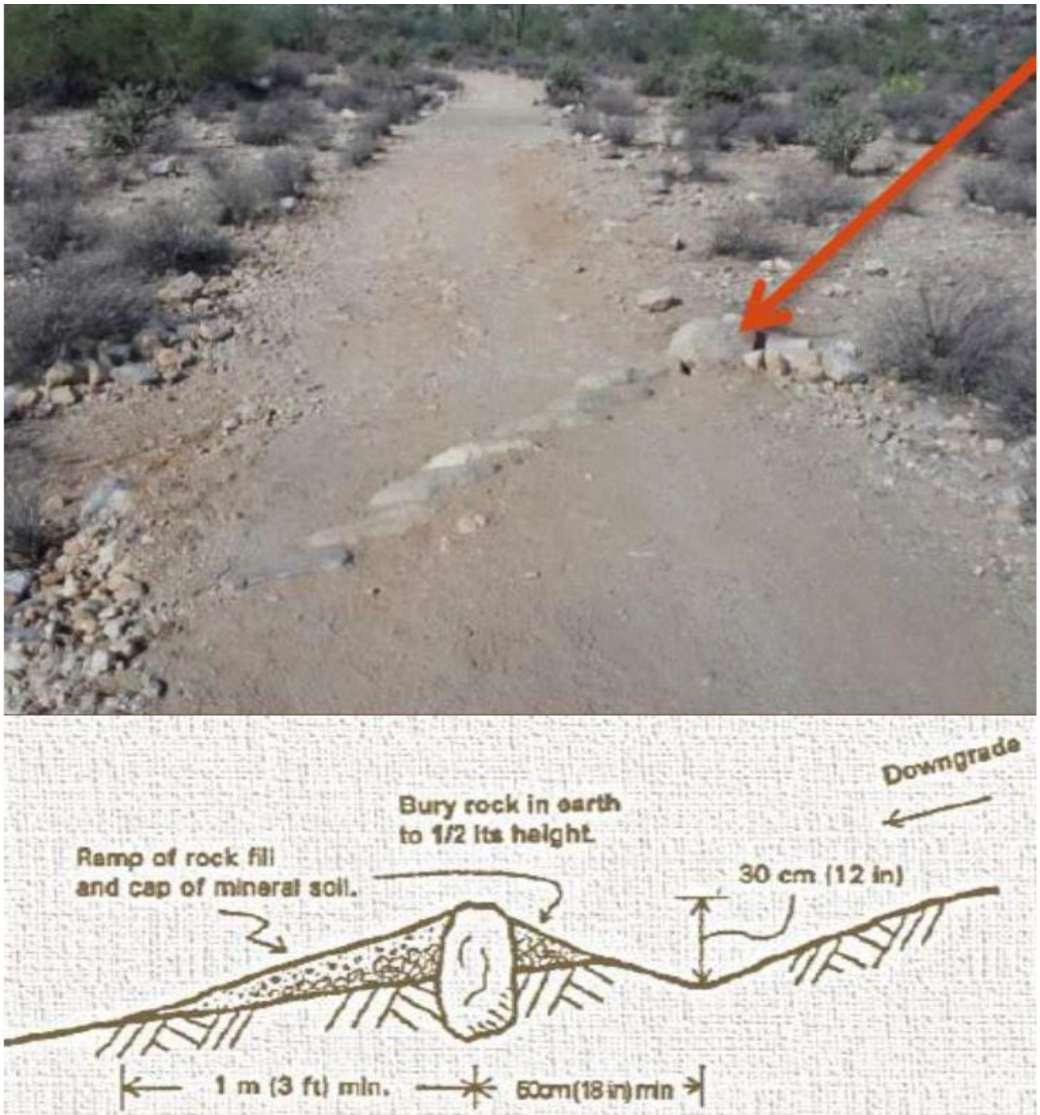


Figure D-10:-. Rock Water bar

Incorporating turn on hill sides

Two types of turns are possible: a climbing turn or a switchback turn. Both are relatively difficult, expensive and time consuming to construct so it is best to plan trails with a minimum number of turns if possible. Avoid 'stacking' turns up a hill by using the full available width of the hill). Always seek the flattest site to construct a turn and in the planning, stage identify such sites as control points.

I. Climbing Turns

Well-constructed climbing turns require little maintenance. However, next to water bars, climbing turns are the trail structure most often constructed inappropriately. The tread is out sloped so that water runs perpendicular across the trail without impedance from rocks, branches, or other debris either beside or on the trail. A climbing turn continues to change grade through the turn. It is built on the slope surface, and where it turns, it climbs at the same rate as the slope itself. If the slope is 15 percent, the turn forces travelers to climb at 15 percent. It becomes increasingly difficult to travel if the slope is steeper than 20 percent.

The advantage of climbing turns in appropriate terrain is, a larger radius turn is relatively easy to construct. Trails that serve off-highway-vehicle traffic often use in sloped, or banked, climbing turns so that riders can keep up enough speed for control. Climbing turns are also easier than switchbacks for horses to negotiate.

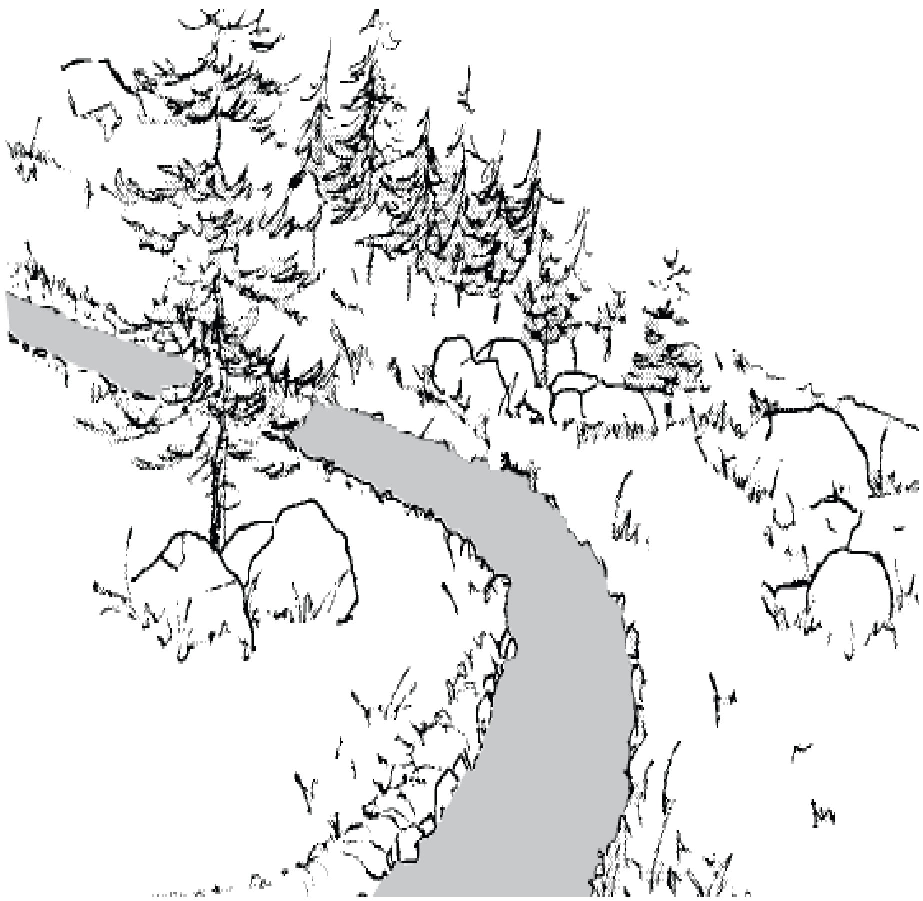


Figure D-11:- Climbing Turn

II. Switchback

A switchback reduces trail grade by lengthening the trail in a zigzag pattern. Design each trail segment to conform to the desired grade as much as possible.

The entire tread of the upper approach should be a full bench. The lower approach section will be an excavated bench, if possible, but is likely to be fill- supported by a retaining wall or rip-rap. Construct a retaining wall to support the lower approach. This retaining wall should be constructed according to specifications.

The lower approach as well as the majority of the turn section should have an out slope. The upper approach and the upper edge of the turn section should have an in slope towards a drain ditch. This ditch should be at least 30 cm deep x 30 cm wide. Construct a rock apron to protect the spill point.

Figure D-12:- constructed switchback

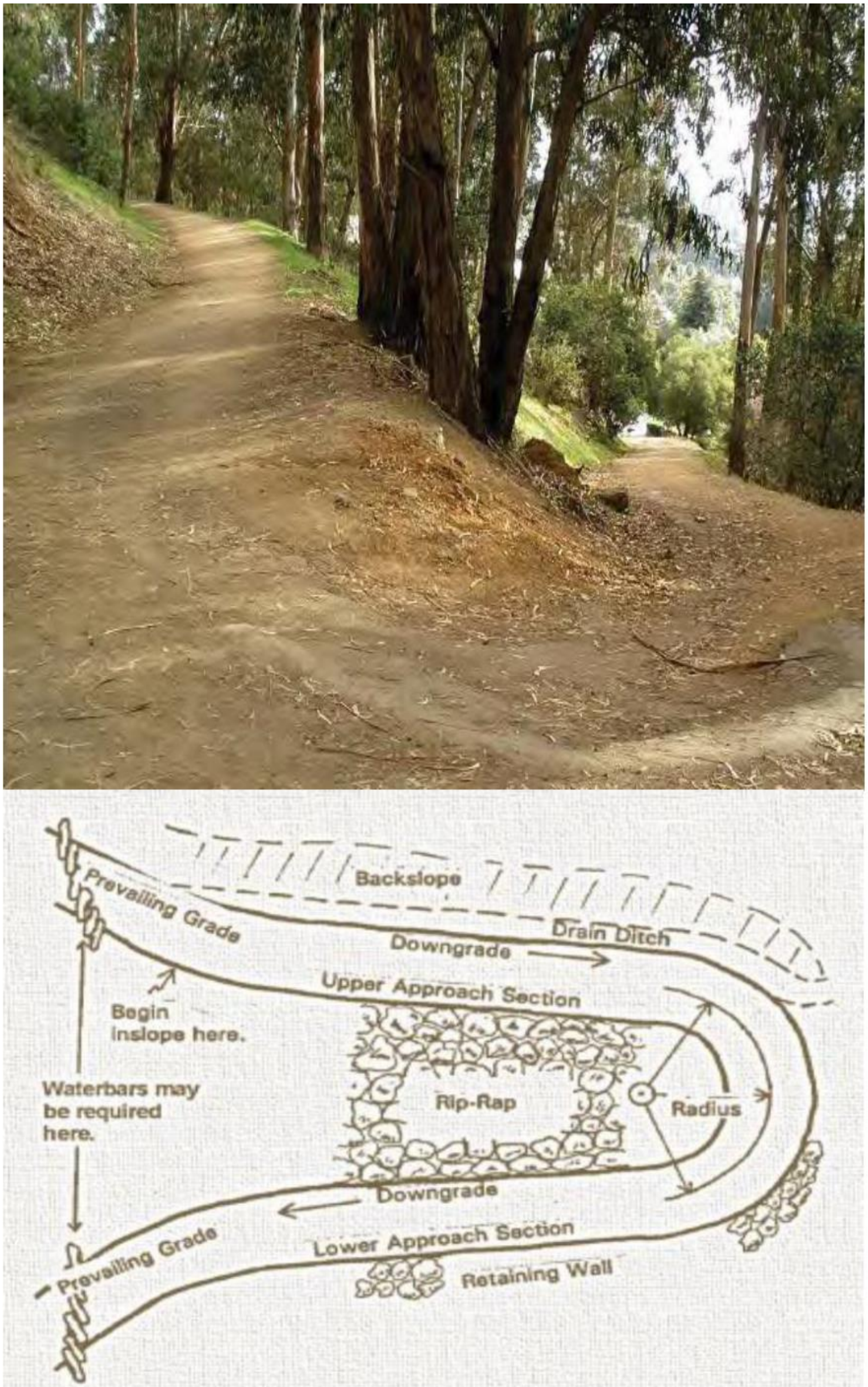


Figure D-13:- Switchback

D.3.7 Trails Crossing Marshy and Wet areas

The case for trails crossing Marshy and wet areas discussed section C.6

D.3.8 Cross Drainage Structures

The case for trails crossing Marshy and wet areas discussed section C.9

D.3.9 Additional Trail Elements

I. STEPS are discussed well in section C.6.4

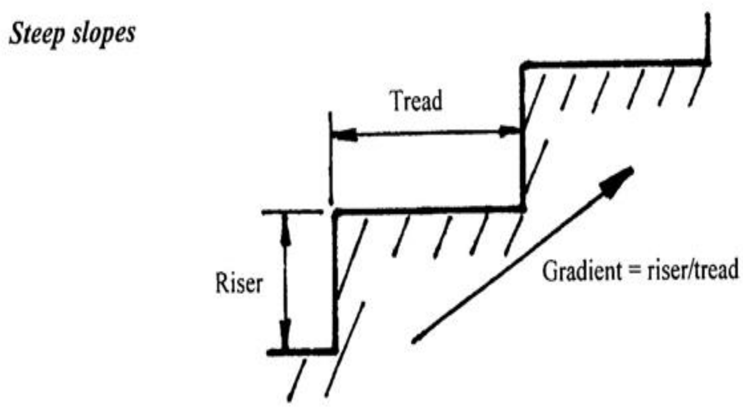


Figure D-14:- Steps

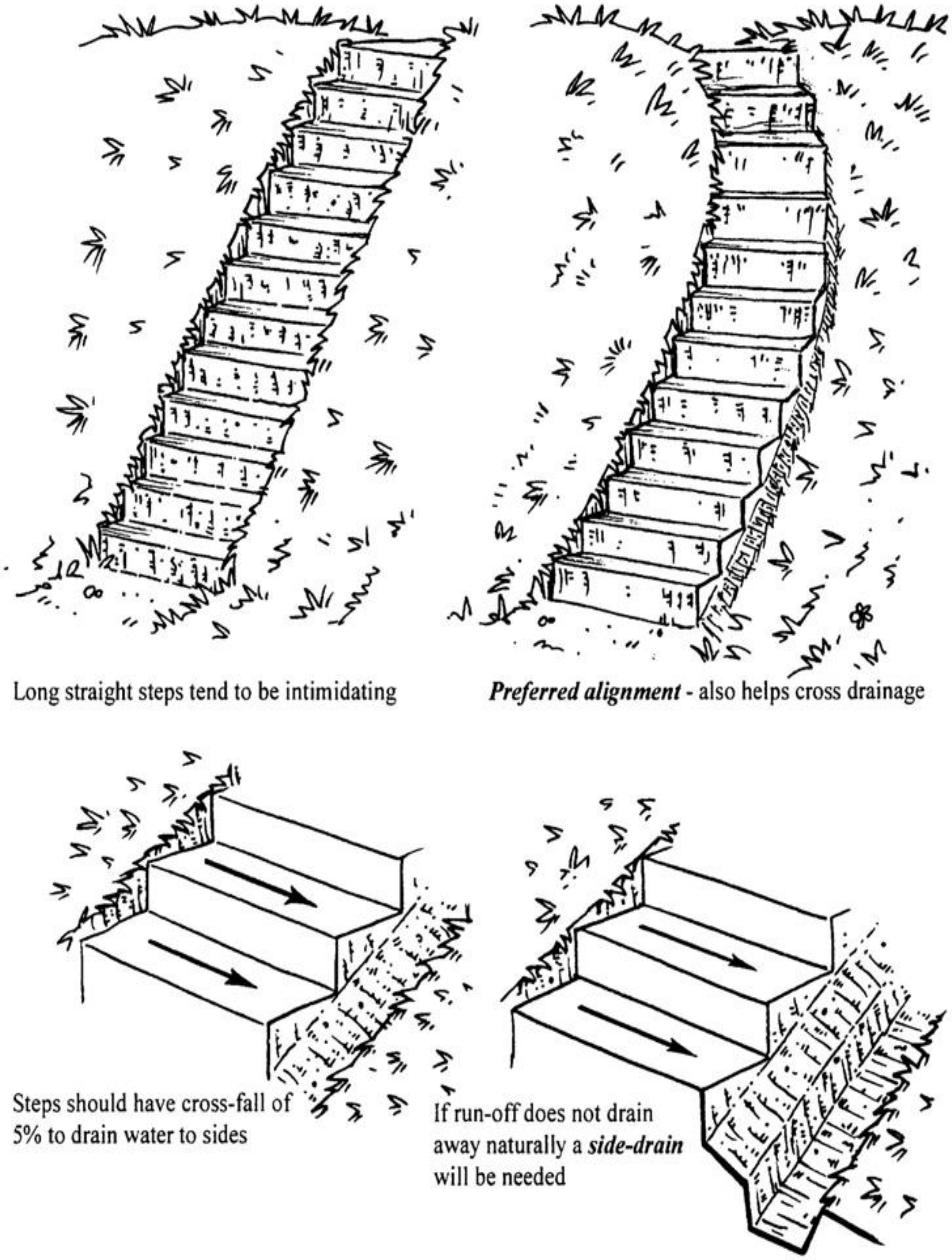


Figure D-15:-Preferred Designs for Steps

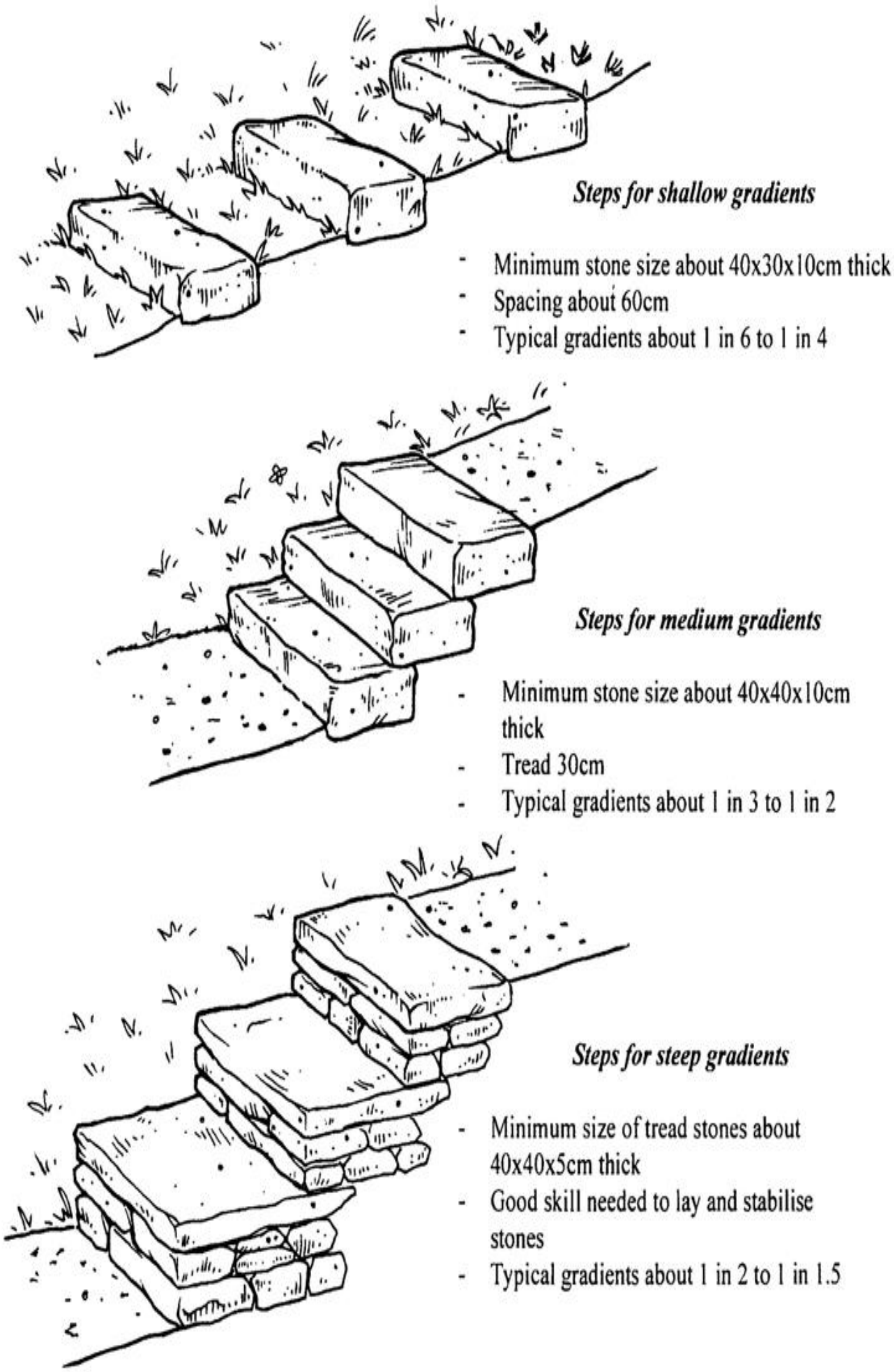


Figure D-16:- Stone Steps

II. Retaining Structures are discussed well in chapter for section C.7

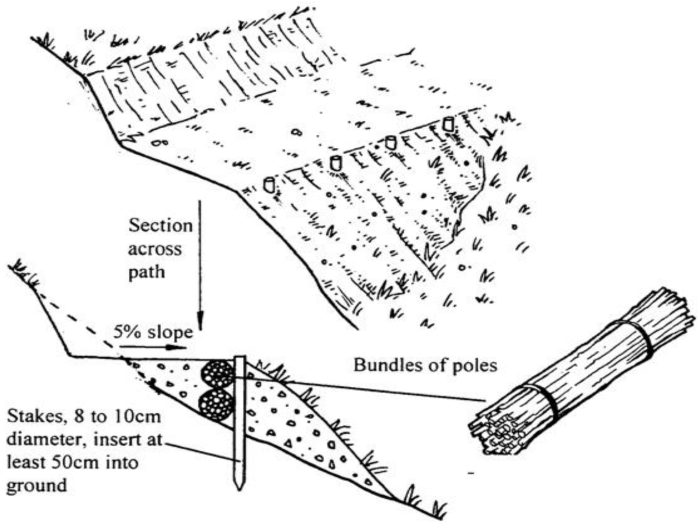


Figure D-17:- Retaining Structure made from Wood

D.4 Onsite Testing

Some of the tests which will be conducted for Trial path construction and maintenance on site are the following:

1. Soil Ribbon Test:

- It is important to know type of soil

13. Roll a handful of moist soil back and forth between both hands into a tube shape
14. Squeeze it between your thumb and forefinger to form the longest and thinnest ribbon possible
15. Much how it feels the texture properties with the attribute properties in the table below

Table D.1. Soil Ribbon Test and best trail soil required to improve it

Texture	Feel	Ribbon	Best Trail Soil[1]
Sand	Grainy	Cant form ribbon	Add clay and silt
Loam	Soft With some graininess	Thick and very short	
Silt	Floury	Makes flakes rather than a ribbon	Add Sand and clay
Sandy Clay	Substantial graininess	Thin, fairly long-50 to 76mm (2 to 3 inches)-holds its own weight	Add Silt

Clay	Smooth	Very thin and long-76mm (3 inches)	Add Sand and silt
[1] Adding soil to improve trails is realistic only for short stretches where ground is most vulnerable			

2. Clinometer

- Is a useful tool for evaluating trail grade
- Make Clinometer with Protractor, short string and small weight
- To measure grade:
  - Sight the tangent at eye level
  - Sight along the protractor's flat edge and read the degree aligned with the string
  - Determine the slope angle:

90° - (Angle read on protractor) =Slope angle in degrees
Example: 90°-80°=10°

  - To convert degrees of slope to percent slope:
    - Look up the tangent of the slope angle in degrees on a scientific calculator on in a tangent table in a book
    - Determine the percent of slope:

Tangent (of slope angle in degrees) x100%=% slope

Example: Tangent (10°) x 100%=0.176x100%=17.6 or 18%

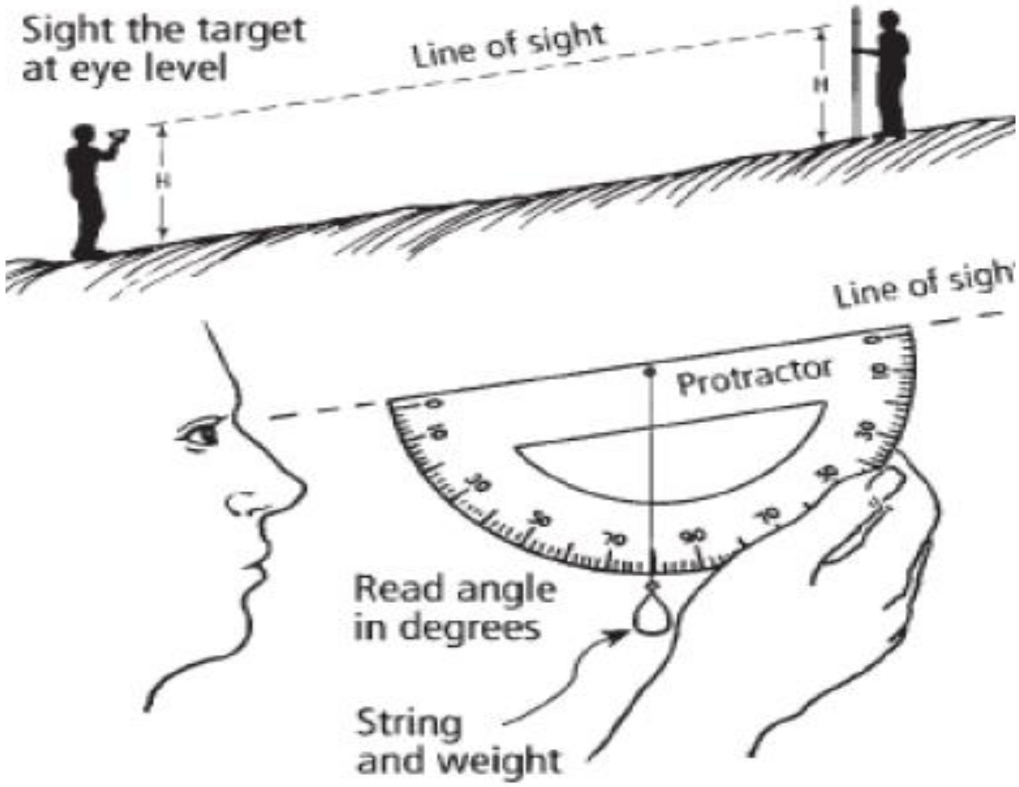


Figure D-18:- Slope measuring by using Clinometer

3. **Profile boards:** To check the profile of the camber and drains

- The profile of the camber and drains should be checked with profile boards as shown below in Figure D-20

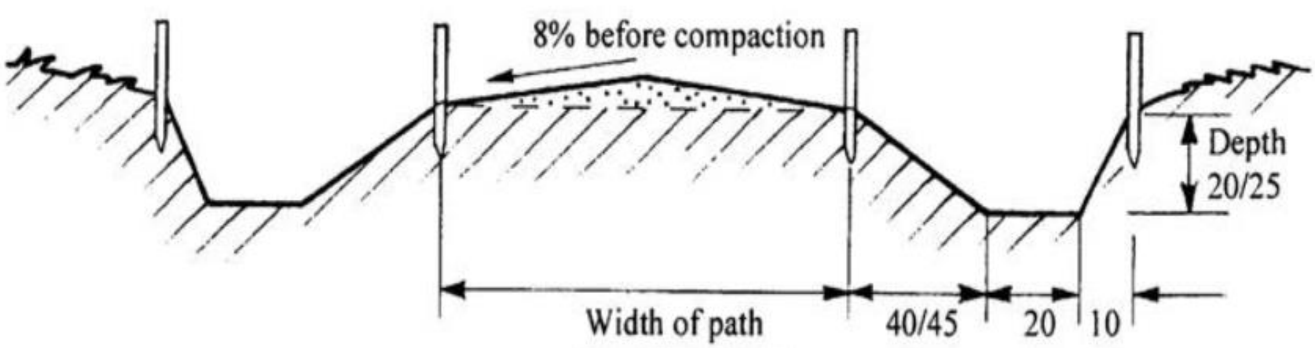


Figure D-19:- foot trail cross-section

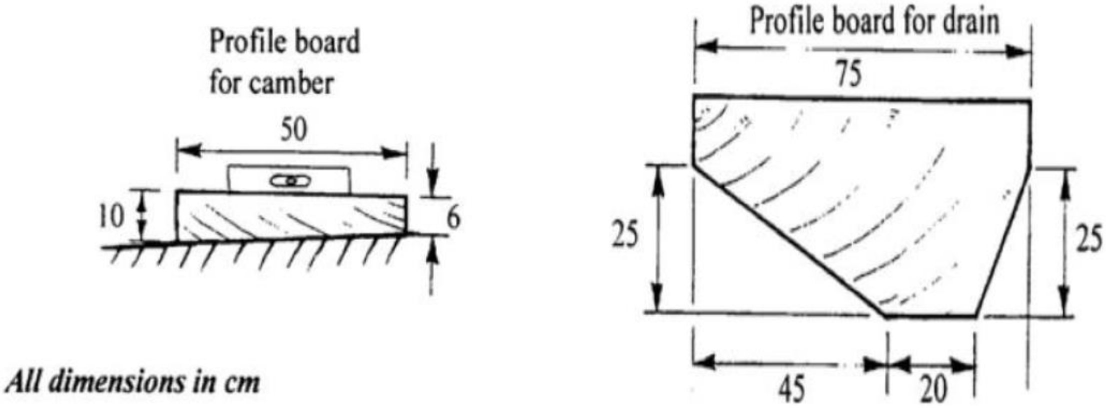


Figure D-20:profile board for camber and drain

Part E

Foot Trail Maintenance

E. REHABILITATION AND MAINTENANCE

Maintenance of trail is essential to sustain the benefits obtained from the improvements. Without this, the benefits would soon be lost and all the time and effort involved would be wasted.

Although this is an extra task for the community, the time and effort spent on regular, year-round maintenance would be far less than allowing the path to deteriorate over a few years and then having to rehabilitate it again to provide adequate access.

There are three types of maintenance activity that are required to be undertaken

- **Routine Maintenance:** Regular and continuous work to reduce path deterioration and thus prolong its lifespan, make it more comfortable for the user and increase user safety.
- **Periodic Maintenance:** More substantial work carried out at intervals of a year or several years
- **Emergency Maintenance:** Work undertaken after flooding or landslide etc. to reopen or keep the trail open for users.

A maintenance assessment is needed to let the local managing authority know about any major needs. With this information at hand, it may be possible to find the funding or labor to correct the problem. A maintenance assessment can also serve as a basis for applying field grants or other available project funds. A trail assessment or inventory form may be used to conduct an annual trail assessment and document heavy maintenance needs or simply collect information on the condition of the trail over time.

E.1 Maintenance Activities

The main activities which need to be carried out on to keep the path in good condition and to guard against serious damage

E.2 Clean-up

The trail must be cleared of all debris following clearing or heavy maintenance. Maintenance results should appear neat and hardly noticeable to a walker. Inadequate clean-up can spoil even the most thorough clearing job. One person on the crew should be assigned responsibility for this job. All cut growth should be carried off the trail and scattered—not piled. If eroding gullies are nearby, the cut material can be placed in the gully to slow the flow of water and catch sediment. All flagging, construction stakes and debris, litter, etc. should be removed. Follow Leave No Trace principles.

E.3 Vegetation removal

All side branches extending into the trail clearing should be cut flush with the parent branch or stem, leaving no stubs. This is safer, lasts longer, and also allows for the wound to heal naturally. Small trees and shrubs within the tread should be grubbed out to prevent tripping. Holes should be filled and compacted. Trees and brush outside the tread (but inside the trail clearing) should be cut as close to the ground as possible, leaving no sharp pointed stumps or stems.

Fallen branches and trees should be removed except for a few large trees/logs near access points. On larger logs, remove a section only the width of the tread to further restrict unwanted use. In high use sections of the trail or near camping areas, remove dead or dying trees that have a high probability of falling across the trail or camping area. These hazard trees are extremely dangerous and should only be removed by experienced sawyers who are trained and certified to fall standing trees.

E.4 Tread Maintenance

When tread repair is needed, it should be restored to the original design condition, free of loose stones, rock points, stumps, and roots. Attention should be given to dips and outs loping so that water does not collect on the trail. Some of tread maintenance activities are the following

I. Clear all debris and obstacles from path and

- Prepare potholes and erosion galleys for filling
- Cut out all loose and crumbly soil until a firm surface is obtained

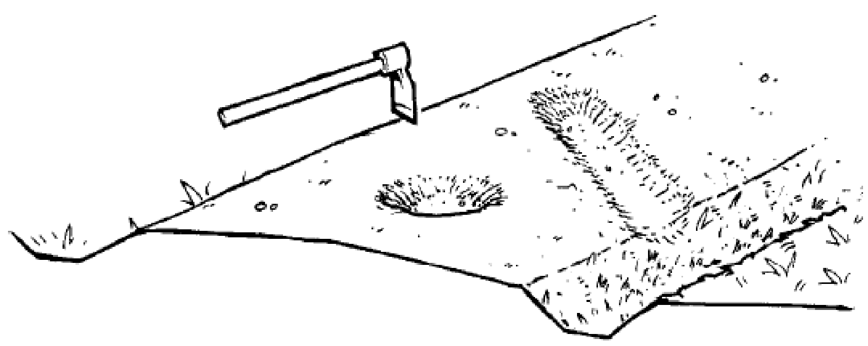


Figure E-1:- lear all debris and obstacles

II. Fill Potholes and Galleys with suitable soil and compact

- Fill with suitable soil
- compact in layers and
- leave filling slightly above surface to allow for setting

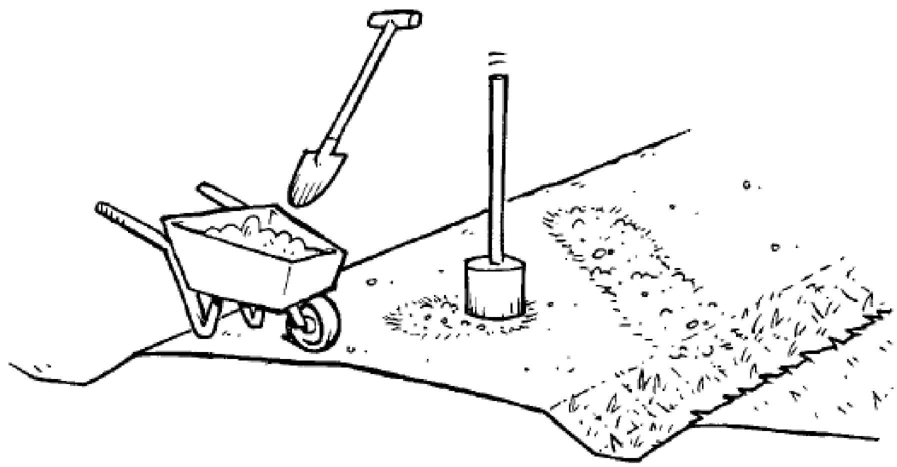


Figure E-2:- Fill Potholes and Galleys with suitable soil and compact

III. Grub edges of path to remove grass and weeds

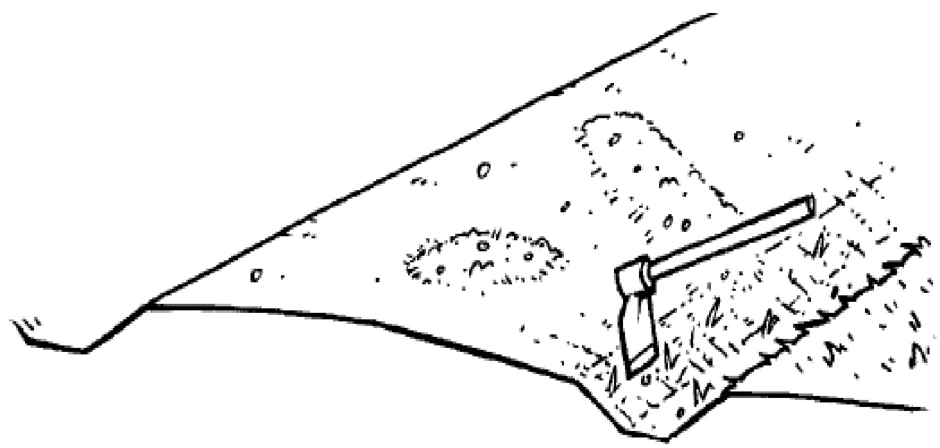


Figure E-3:- Grub edges of path

IV. Repair Camber of path:

- Loosen edge soil and rake towards center to reform the camber.
- Check camber with a profile board
- Compact loose soil with hand rammer

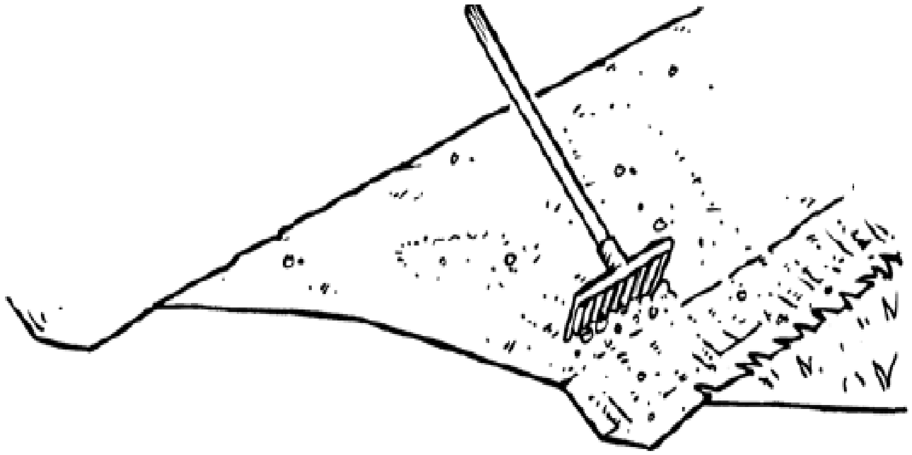


Figure E-4:- Repair Camber

V. Removing Slough and Berm

On hillside trails, slough is soil, rock and debris that have moved downhill to the inside of the tread, narrowing it. Slough needs to be removed as show the Figure E-5.

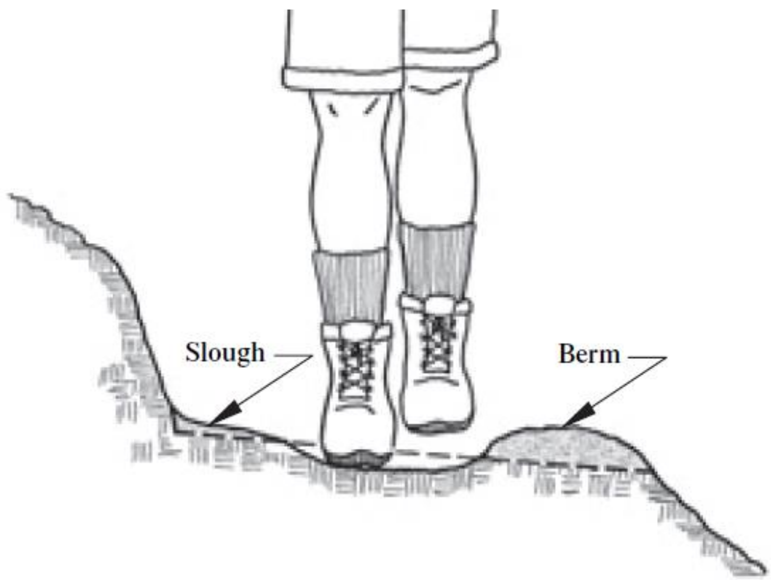


Figure E-5:- Removing slough and berm

Remove the slough and berm, leaving the trail out sloped so water will run off

Removing slough is hard work and is often not done adequately. Leaving slough is another reason trails “creep” downhill. Loosen compacted slough and remove the soil. Use excess soil to fill holes in the tread. Reshape the tread to restore its out slope. Avoid disturbing the entire cut bank unless absolutely necessary.

Berm is soil that has built up on the outside of the tread, forming a barrier that prevents water from running off the trail. Berms are a natural consequence of tread surface erosion and inadequate compaction during construction. Berms prevent water from flowing off the trail. Water runs down the tread itself, gathering volume and soil as it goes. Berm formation is the single largest contributor to erosion of the tread surface. Removing berms is almost always the best practice. Observe erosion on trails with and without berms. See what works best in your area.

Berms, especially when associated with tread creep, may form a false edge. A false edge has almost no ability to bear weight. This is probably the least stable trail feature on most trails and the major contributor to step-through and wrecks. Berms should not be constructed intentionally. Maintaining an out sloped tread will keep users on the center of the trail and water off it.

Trails may require periodic maintenance to fix problems with slough and berm

VI. Fix Tread Creep

Most livestock, wheeled traffic, and some walkers have a natural tendency to travel the outside edge of side hill trails. Sloughing makes the edge of the trail the flattest place to walk. Back slopes that are too steep may slough material onto the tread, narrowing the trail. The trail becomes too narrow. The result is that traffic travels closer to the outside edge. Your job is to bring the trail back uphill to its original location and keep it there. To fix tread creep, cut the back slope properly, remove slough, and reestablish the 5% slope.

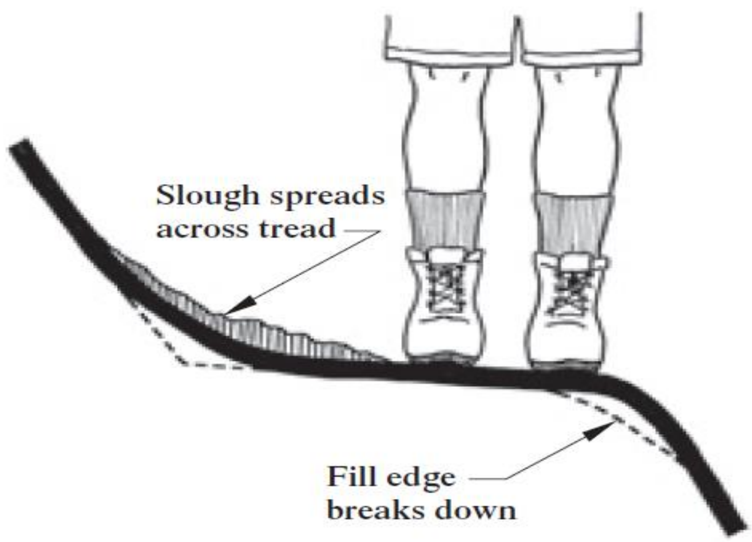


Figure E-6:- Tread creep due sloughing and soft fill slope

1. Maintenance of Drainage and Support Strictures

Proper drainage protects the trail from erosion damage. Trails should be routinely inspected to ensure that all culverts, dips, water bars, drainage ditches, boardwalks, and all support structures etc. Are free of debris and ready to function properly at all times—especially during the rainy season or spring runoff.

Routine maintenance is not only necessary, but valuable in terms of labour, material, and money saved on emergency repairs, and in the number of days the trail is useable. If repairs are necessary, they should meet or exceed the original construction specifications. Commonly Routine and Periodic Maintenance conducted to sustain drainage and support strictures.

Table E.1. Routine and Periodic Maintenance for drainage and support strictures on foot trails

Path	**Routine Maintenance**	**Periodic Maintenance**
All Drains	1. Cut grass and clear bush 2. Remove debris silt etc	o Inspect drains for erosion damage and identify problems o Use techniques above to deal with problem
Scour Checks	1. Remove debris and excess silt (NOT main silt build-up) 2. It is important that there are no gaps through which water can flow: - replace any missing or damaged sticks - replace missing stones	o Replace rotting sticks
Water Bars	1. Clean and remove debris, silt etc 2. Ensure logs are kept in position by proper plugging 3. Fix stones where loose or missing	o Replace logs and plugs, if they are rotten or eaten by ants o Replace stones that are washed away
Drainage Dip	1. Remove and clean silt or debris	
French Drain	1. Remove debris and silt from the surface	o If completely blocked take out the stones clean them and place them back in the trenches
Steps	1. Secure loose logs and plugs	o Replace logs and plugs if rotten or eaten by ants

	2. Add soil to fill depressions on step surface and compact 3. Fix loose or missing stones on stone steps 4. Reshape side slope to drain away water 5. Check and make safe hand rails	○ Replace stones where washed away ○ Inspect for erosion damage, identify any problems and use appropriate techniques from above to deal with these
Boardwalks	1. Fasten loose cross boards in position 2. Check all joints 3. Fill depressions at approaches	○ Replace the whole structure if rotten or eaten by ants
Raised Paths	1. Fill any depressions on path surface 2. Check for any erosion damage. If found, improve drainage to overcome problem	○ Replace the logs if rotten or eaten by ants
Stepping Stones	1. Secure and replace stones as required 2. Remove any slippery fungus from surface of stones	
Culverts	1. Clean out culvert including inlet and outlet	○ Replace the whole structure if rotten or eaten by ants

E.4.1 Priority of Maintenance Activities

No matter where the path is located, the overriding priority for routine maintenance is to keep the drainage system working effectively. Blockage of the drainage system is likely to lead to serious damage to the path and surrounds. Therefore prior to and during the rainy season priority must be given to making sure all drains and associated features are working efficiently. During the dry season greater priority will be given to maintenance of the path itself and the surrounds.

E.4.2 Implementation of Routine Maintenance

Maintenance of paths and tracks is usually the responsibility of the villages that use them. They may need technical assistance to help with persistent problems. Paths and tracks fall into 2 categories:

I. Village Paths: used mainly by one village and therefore the responsibility of that village.

II. Route Paths: used by a number of villages. Each village should be responsible for the length of path that falls within their boundaries.

A clear agreement is needed between the villages to define responsibilities and boundaries. This should also include provision of labour to assist in maintaining the most heavily used or difficult sections of the path/track. There may be sections of the footpath which require much more than the average input of labor for maintenance. It is not equitable that this extra burden should all fall on the adjacent village. Some help should be provided by other villages using this section of the path.

Village Path Committee

A committee is needed to be responsible for keeping paths and tracks in good condition. This should include both men and women who use the paths regularly.

The committee should identify and plan the work needed. Advice on problem areas should be obtained from the District Works Department. Inputs of labor and materials required should be recommended to the village leadership who will be responsible for organizing these.

Most labor will need to be provided on a voluntary basis. In many communities there is a requirement for members to contribute a number of days per year to community upkeep. There may also be an arrangement for persons who do not wish to participate to pay an equivalent tax that can be used to employ extra labor.

A community payment by convincing them is needed to pay for materials such as timber, steel, and cement. Some specialized tools may also need to be provided.

The maintenance program needs to be organized around the agricultural cycle but also needs to be carried out when it is most effective. For instance, drains should be kept clear in the rainy season but work on the path surface is unlikely to be effective at this time. This needs to be done as soon as possible after the rains have ended.

Length Man Arrangement

Experience has shown that an effective organization of routine maintenance is the ‘length man arrangement’ where a person is made responsible for a specified length of road or path. This allows the person responsible for the maintenance of each section of road/path to be readily identified and any problems sorted out by the supervisor.

This is an appropriate method for organizing routine maintenance of footpaths by the community, with sections of paths being allocated to a person or family. The length to be allocated will depend on the total length of path(s) to be maintained and the number of persons/families available to carry out the work. The maximum length per person should not exceed about 0.5 km otherwise the time required will be too great and the maintenance may not be properly carried out.

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Appendix 1.

Bill of quantities checklist

Road Code -------------------------

Section Name----------------------

Contractor-------------------------

Bill of Quantities					Page: 1
Bill No.1	General: Office administration and overheads/Preliminaries				Project
Item No.	Description	Units	Quantity	Unit Bid Rate (Birr)	Amount (Birr)
1	Publicity Sign Boards	No.			
	Total Carried Forward to Summary:				

Bill of quantities checklist

Road Code ------------------------

Section Name---------------------

Contractor------------------------

Bill of Quantities					Page: 1
Bill No.4	SITE CLEARANCE				Project
Item No.	Description	Units	Quantity	Unit Bid Rate (Birr)	Amount (Birr)
1	Heavy Bush Clearing	M^2	6000		
	Total Carried Forward to Summary:				

Bill of quantities checklist

Road Code -------------------------------

Section Name---------------------------

Contractor------------------------------

Bill of Quantities					Page: 1
Bill No.8	CULVERT AND DRAINAGE WORKS				Project
Item No.	Description	Units	Quantity	Unit Bid Rate (Birr)	Amount (Birr)
1	Culvert Cleaning- Fully Blocked - 600mm	MT	21		
	Stone Culvert Installation 600 mm with surround	MT	14		
	Total Carried Forward to Summary:				

Bill of quantities checklist

Road Code -------------------------

Section Name---------------------

Contractor------------------------

Bill of Quantities					Page: 1
Bill No.10	COMPACTION AND GRAVELLING WORKS				Project
Item No.	Description	Units	Quantity	Unit Bid Rate (Birr)	Amount (Birr)
01-60-019	Compaction	M2	21,000		
01-60-020	Provide gravel, excavation, free haul, spread, water and compact gravel to specifications	M3	740		
	Total Carried Forward to Summary:				

Bill of quantities checklist

Road Code -------------------------

Section Name----------------------

Contractor--------------------------

		Page: 1
Bill No.10	Summary	Project
Item No.	Description	Amount (Birr)
1	General: Office administration and overheads/Preliminaries	
4	SITE CLEARANCE	
8	CULVERT AND DRAINAGE WORKS	
10	COMPACTION AND GRAVELLING WORKS	
	Total Carried Forward to Summary:	

LABOUR RECRUIMENT FORM checklist

Name of footpath ……………………………………………
Region ………………Zone ………………...Woreda…………Kebele ….

No	Name	Age	Sex		village	Parish	Signature
			M	F			

Signature	Signature	Signature
Contractor Representative	Local leader (LCI)	S/C works committee member
…………………………	………………….	……………………………
Date……………………	Date…………….	Date……………………….

WEEKLY MUSTER ROLL checklist

Name of footPath ………………………………………………

Contract Number ………………………………………………

Sub-county and District ……………………………..……………….

No	Name	Sex	M	T	W	TH	F	S	No. of Days worked	Signature & Date

PAY ROLL checklist for laborers

Name of Footpath ……………………………………………

Contract Number ……………………………………………

Region, Zone, woreda and Kebele …………………………

No	Name	Sex	Labour category	Wage per Task/Day	No. Days worked	Amount earned	Labourers Signature

Environmental Compliance Monitoring and Evaluation Valuation Checklist

1. Background information:

(i) Name of contractor: ….………………………………………….

(ii) Contract Identification: …………………………………………...

(iii) Location: ...……………………………………………

(iv) Total Distance (km**):** ...…………………………………………….

(v) Distance (km) monitored/evaluated: ……………….……………………………...

2. Nature and extent of work:

……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
………………………………………………………………………………….. . . . . ……………

3. Significant environmental concerns:

i. Risk to protected areas (Forest, wildlife reserve, heritage site).

None: ………………………………………………………………….

Significant……………………………………………………………………

Highly significant………………………….. (Specify)……………………..…………..…

…………………………………………………………………..………………………...

ii. Impact on Wetland Ecology:

None: ………………………………………………………………….

Significant…………………………………………………………….

Highly significant………………………….. (Specify)……………………..…………..…

…………………………………………………………………..………………………...

iii. Impact on domestic Water Supply.

None: ………………………………………………………………….

Significant: .…………………………………………………………………

Highly significant…………………………...(Specify)……………………..…………..…

…………………………………………………………………..………………………...

iv. Changes in air quality due to vehicle emissions and dust.

None: ………………………………………………………………….

Significant: .…………………………………………………………………

Highly significant…………………………..(Specify)……………………..…………..…

…………………………………………………………………..………………………...

v. Increased run off and changes in drainage pattern.

None: ………………………………………………………………….

Significant: .…………………………………………………………………

Highly significant…………………………...(Specify)……………………..…………..…

…………………………………………………………………..………………………...

vi. Changes in soil stability and erosion

None: ………………………………………………………………….

Significant: .…………………………………………………………………

Highly significant…………………………..(Specify)……………………..…………..…

…………………………………………………………………..………………………...

vii. Changes in land use pattern and intensification of land use.

None: ………………………………………………………………….

Significant: .…………………………………………………………………

Highly significant…………………………..(Specify)……………………..…………..…

…………………………………………………………………..………………………...

viii. Human Population impact (increased density, congesting, and relocation?

None: ………………………………………………………………….

Significant: .…………………………………………………………………

Highly significant…………………………..(Specify)…………………….………….…
……………………………………………………………..………………………...

ix. Effects of working environment on workers' health.

None: ……………………………………………………………….

Significant: ..…………………………………………………………

Highly significant…………………………...(Specify)…………………….………….…
……………………………………………………………..………………………...

x. Traffic Accidents.

None: ……………………………………………………………….

Significant: ..…………………………………………………………

Highly significant…………………………..(Specify)…………………….………….…
……………………………………………………………..………………………...

xi. Public health impacts.

None: ……………………………………………………………….

Significant: ..…………………………………………………………

Highly significant…………………………..(Specify)…………………….………….…
……………………………………………………………..………………………...

xii. Social disruptions.

None: ……………………………………………………………….

Significant: ..…………………………………………………………

Highly significant…………………………..(Specify)…………………….………….…
……………………………………………………………..………………………...

xiii. Depletion of forest, fauna, other natural resources.

None: ……………………………………………………………….

Significant: ..…………………………………………………………

Highly significant…………………………..(Specify)…………………….………….…
……………………………………………………………..………………………...

4. Mitigation Measures Applied

i. Involvement of rural communities: (Poor, Fair, Good, Very Good).
ii. Erosion and sedimentation (Drainage Channel protection): (Poor, Fair, Good, very Good).
iii. Restoration of borrow pits: (Poor, Fair, Good, very Good).
iv. Destruction of vegetation and soil.
Harvest of vegetation: (None, Significant, Highly significant)
Site restoration: (None, Significant, Highly significant)
v. Disruption of biodiversity: (None, Significant, Highly significant)

Specify ……………..……………………………………………………………………

vi. Cross Drainage (Poor, Fair, Good, Very Good).
vii. Health Hazard: Dust control (Poor, Fair, Good, Very Good).
viii. Erosion of land receiving concentrated outflow (None, Significant, Highly significant)

Specify**:** ………………………………………………………………………………….

ix. Conformity to existing policy and legal framework (Poor, fair, Very Good).
x. Conformity to EMAP (Poor, Fair, Good, Very Good).
xi. Conformity to environmental standards (Poor, Fair, Good, Very Good).

V. General comments/Recommendations

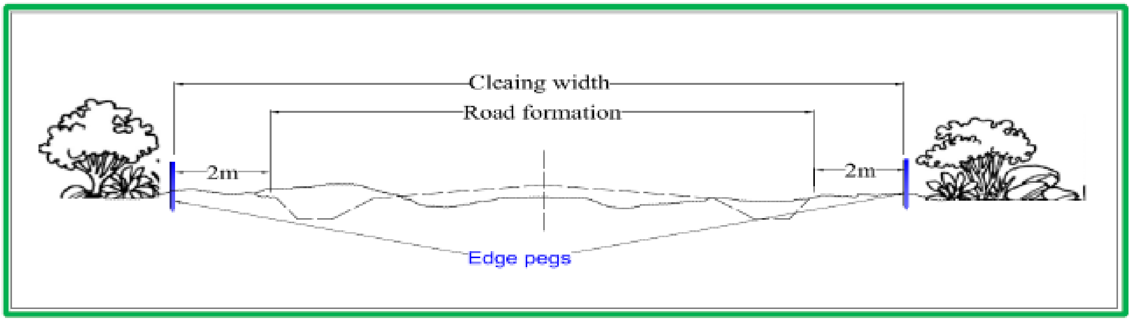
………………………………………………………………………………………...……..
………………………………………………………………………………………...……..
………………………………………………………………………………………...……..
………………………………………………………………………………………...……..

Name of monitoring/Evaluation
Personnel…………………………………………………………………….
Designation……………………………………………………….…….
Signature…………………………………………………...……………
Date……………………………………………………..………………

Appendix F

Work Sheets

<table>
<tr><td>HELVETAS</td><td align="right">Worksheet</td></tr>
<tr><td>Site clearing / bush and grass clearing</td><td align="right">WS-01</td></tr>
<tr><td colspan="2"> Specification: Before actual road work activities can start, the road section must be cleared from vegetation. Clearing work consists of the removal of trees, bushes, other vegetation, rubbish and all other superfluous material including the disposal of all material resulting of the grubbing. For new road construction, the road alignment shall be adjusted where possible to minimize the destruction of trees and no tree of more than 0.5-meter girth shall be cut without the approval of the contract supervisor. All debris shall be stored and disposed of in a manner acceptable to the contract supervisor </td></tr>
<tr><td>Work Method:
Set out pegs for the clearing width at 10 m intervals between pegs. Use centre line pegs as reference. Tie a string along the set pegs.
Clear all existing bush, grass and rubbish within the road section width set by the pegs.
All roots, grass, tree, bushes, debris and big stones have to be removed and deposed out of the road formation or as directed by the contract supervisor.
Areas to be cleared as shown in the drawing or as instructed by the contract supervisor.
If rocks located in the carriage way are too big, heat the rocks with fire, and pour water to break the rocks into smaller pieces. Then remove the pieces from the road carriage way.</td><td></td></tr>
</table>



Manpower:

- 1 Supervisor (part time)
- 2 Workers for setting out (part
- time)
- 1 Work gang for bush clearing
- 1 Work gang for clearing grass
- □ 1 Work gang for grubbing

Tools + Equipment:

- Tape measures, 30 m and 5 m
- Steel/ wooden pegs
- String
- Bush knives
- Grass cutter
- Hoe
- Baskets
- Axes
- Shovels
- Wheel barrows

Material

Quality Control:

Before activity is carried out:

- Is setting out done correctly?
- Are pegs and string line placed correctly?

While activity is carried out:

- Make sure the deposed material is placed far enough from the road formation.
- Make sure the cleared width is free of roots, tree branches, grass etc. and big rocks.

Final check:

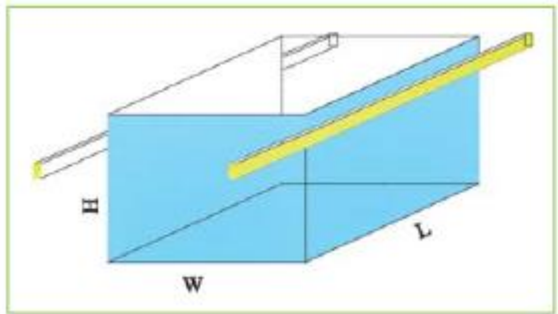
- Final check of above listed activities.

HELVETAS	Worksheet
Stone masonry work	WS-02

Specification: Stone masonry is a collective term describing the assembly of stones using mortar. The work includes supply of all materials, preparation of foundations and all other works necessary to complete the structure in accordance with specifications shown on drawings or as instructed by contract supervisor. Stone masonry can be used for structures such as retaining walls, abutment of small bridges, slab culverts and culvert head walls and wing walls, lining the sides and bottom of ditches and water ways, and of constructing aprons.

Work Method:

- Set pegs as reference for foundation, and tie a string along the pegs
- Excavate for foundation to designed depth. Excavation to any other depth shall be approved by the supervisor.
- Compacted stone shall be placed at the bottom of foundation, followed by a lean concrete layer.
- When mixing cement mortar, proportion of the cement shall be in accordance with the manufacturer's specification. Cement mortar shall be mixed using a concrete mixer. To measure the correct mixing proportions, a measuring wooden box should be used.
- Water cement ratio should be 0.4 0.5= 20 to 25 liters of water for 50 kg of cement.

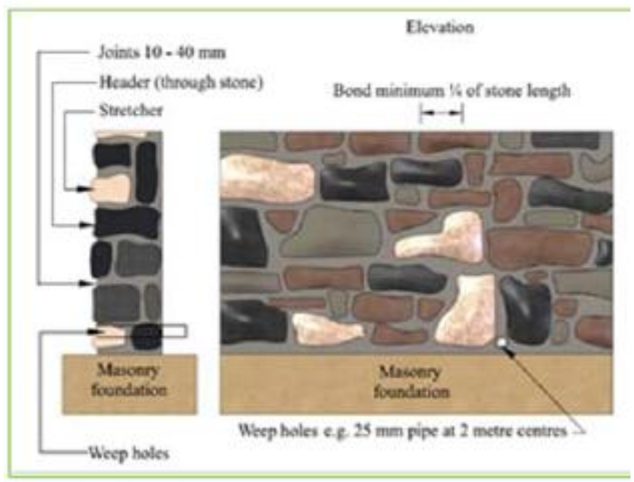


Placing of Stone

- Set pegs and strings to provide the correct levels and to get the stone surface even. Large stones shall select and be used for the bottom layer and in the corners. Stones shall be laid with their longest face horizontal and the exposed face of individual stones shall be set parallel to the face of the wall in which the stones are set.

Placing of Mortar

- Prior to being placed, the stones shall be cleaned and thoroughly wetted. The cement mortar shall be placed before and after placing each piece of stone. In big gaps between stones, small hard stones should be fitted and filled along with cement mortar. The thickness of cement mortar shall be in the range of 2 to 5 cm and shall be the minimum necessary to ensure the filling of all voids between the placed stones.



Curing

- Finished surfaces shall be cured immediately after mortar has started to harden by spraying with water. The total time period of curing shall be applied as specified in the specification, or as instructed by the contract supervisor

Plastering Works

- If instructed by the contract supervisor or if it is indicated in the drawing, the finished stone masonry surface should be covered with a smooth plaster. Generally, a 15 mm thick plaster layer, with cement mortar proportion of minimum 1:3 (1 unit of cement to 3 units of sand), is sufficient.

Manpower:	**Tools + Equipment:**	**Material**
• 1 Supervisor (part time)	• Tape measures, 30 m and 5 m	• Sand

<table>
<tr>
<td>• Masons for stone masonry work
• Mason helpers (unskilled workers</td>
<td>• String line and pegs
• Concrete mixer
• Shovels
• Hoe
• Hammers
• Buckets
• Measuring box
• Wheel barrows</td>
<td>• Hard stone
• Portland cement
• Water</td>
</tr>
<tr>
<td colspan="3">Quality Control:
Before activity is carried out:
• □ Is setting out done correctly?
• □ Are pegs and string line placed correctly?
• □ Is camber board used?
• □ Make sure to use cleaned and durable sand and stones.
• □ Make sure the cement is in good quality.
While activity is carried out:
• Make sure the excavated trench is dry before starting foundation structure works.
• □ Make sure mortar mixture proportions are correct (cement, sand and water).
• □ Make sure a strong pattern of placing stones is used.
• □ Make sure all gaps are filled with mortar.
• □ Give special attention to joints/ pointing. If those are properly done, the technique can be alternative to plastering.
Final check:
• Make sure pointing or plastering is properly done.
• Make sure curing is made before cement mortar has dried</td>
</tr>
<tr>
<td colspan="3">Suggested Productivity range: 1.5 - 2 m^3 / wd</td>
</tr>
</table>

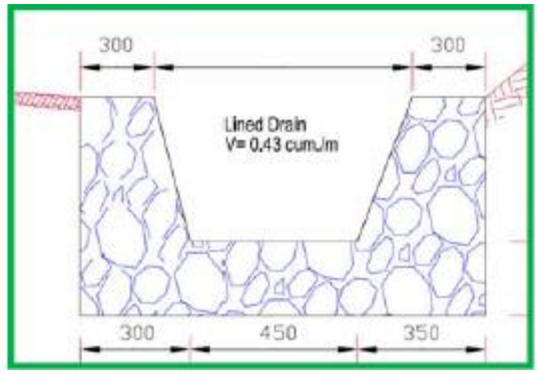
HELVETAS	Worksheet
Stone masonry lined drain	WS-03

Specification: The stone masonry lined drain is constructed to drain out water from road carriage way along the road, to a designated water stream or road cross drainage structures The work consists of supplying all materials, excavating side drain and stone masonry wall and bedding. The work shall be performed in accordance with specifications and drawings, or as required in writing by the contract supervisor.

Work Method:

- Survey and choose gradient to ensure free drainage.
- Set pegs as reference for foundation and tie string along the pegs.
- Excavate side drain walls and foundation to designed width and dept.
- When mixing cement mortar, proportion of the cement shall be in accordance with the manufacturer's specification. Cement mortar shall be mixed using a concrete mixer. To measure the correct mixing proportions, a measuring wooden box should be used. To measure the correct mixing proportion, a measuring wooden box should be used. Water cement ratio should be 0.4-0.5= 20 to 25 liters of water for 50 kg of cement.
- Set out pegs and strings for stone masonry works. Large stones shall be selected and used for the bottom slab. Stones shall be laid with their longest face horizontal and the exposed face of individual stones shall be set parallel to the face of the wall in which the stones are set.

- Cement mortar shall be placed before and after placing each piece of stone and fill all the gaps. The thickness of cement mortar shall be in the range of 2 to 5 cm and shall be the minimum necessary to ensure all voids between the placed stones are completely filled.
- In big gaps between stones, small hard stones should be fitted and filled along with cement mortar.
- The finished surface stone masonry work shall be covered with a smooth plaster (if specified in the drawing). Generally, a 15 mm thick plaster layer, with cement mortar proportion of minimum 1:3 (1 unit of cement to 3 units of sand), is sufficient.
- The finished stone masonry work shall be cured immediately after mortar have started harden by application of water and providing cover using cloth bags or sacks. The total time period of curing shall be applied as specified in the specification, or as instructed by the contract supervisor.



Manpower:

- 1 Supervisor (part time)
- 1 Work gang for excavation of side drain
- Masons for stone masonry work
- Mason helpers (unskilled workers)

Tools + Equipment:

- Tape measures, 30 m and 5 m
- String line and pegs
- Concrete mixer
- Shovels
- Hoe
- Hammers
- Buckets
- Measuring box
- Wheel barrows

Material

- Sand
- Hard stone
- Portland cement

Quality Control:

Before activity is carried out:

- Is setting out done correctly?

- Are pegs and string line placed correctly?
- Is camber board used?
- Make sure to use cleaned and durable sand and stones.
- Make sure the cement is in good quality.

While activity is carried out:

- Make sure the excavated trench is dry before starting foundation structure works.
- Make sure mortar mixture proportions are correct (cement, sand and water).
- Make sure all gaps are filled by mortar
- Give special attention to joints/ pointing. If those are properly done, the technique can be an alternative to plastering.

Final check:

- Make sure pointing or plastering is properly done.
- Make sure curing is made before cement mortar has dried.

Suggested Productivity range:

- Excavation: 1.5-2 m^3 / wd
- Stone masonry work: 1.5 – 2 m^3 / wd.