Arba Minch University

Arba Minch Water Technology Institute

Faculty of Water Supply and Environmental Engineering

Course Title: **Community Water Supply & Sanitation**

Course Code: **WSEE- 3143**

Target groups: 3rd year Water Supply and Environmental Engineering Students

Instructors: **Zenebe A. & Feven k.**

Academic year; **2019/20**

Semester; **II**

Course outline

- **General about the course**
  - Course title: community water supply and sanitation
  - Course code: WSEE 3143
  - Total ECTS : 3
  - Contact hours per semester;-
    - Lectures = 32 hours
    - Tutorials = 32 hours
    - Home study =17 hours,

Course outline…

- **Course Objectives**
  - The objective of this course is to give students a broad understanding of techniques used to survey the community and to identify demand responsive approaches.
  - To give the way how to work with water supply and sanitation schemes by developing different community organizations.
- **Competences to be Acquired;** On Successful completion of the course the students will be able;
  - To describe Community Organization, demand responsive approaches, community survey techniques and also able
  - To describe & work with water supply & sanitation schemes.

Course outline…

- **Course Contents; There are six chapters included under this course**

1. Introduction
2. Planning and Management
3. Spring Water Tapping
4. Rain Water Harvesting
5. Gravity Flow Water Supply System
6. Sanitation Systems

Course outline…

- **Assessments**
  - Continuous assessment (quiz, assignment and mid exam) =50%
  - Final exam = 50%
- **References:**
  - Paper Series 40, IRC International Water and Sanitation Centre, Delft, The Netherlands.
  - Whyte, A. (1986) Guidelines for planning community participation activities in water supply and sanitation activities, WHO, Geneva
  - Christian M. and Karl Wehrle, Series of manuals on drinking water supply, volume 4; spring catchment

Chapter 1: Introduction

1.1. Small community water supplies in developing countries

A community is a group of people who form **relationships** over time by **interacting** regularly around shared experiences

More over; these interactions lead to the formation of relationship having strong bonds in the form of culture, norms, values, etc.

Community Led Development:

In order to understand what community led development we need to consider the following assumptions:

- ✓ It is a **community's right** to be able to influence decisions made about it;
- ✓ As the **community knows its own issues best**, then their involvement in planning and delivering solutions makes their development **most effective;**
- ✓ Developing ownership and capacity at community level make development **more sustainable** and usually more **cost effective**.

Communities in developing countries that want to establish and run an improved domestic water supplies very greatly:

Some are small and rather isolated

- Scattered population, Limited demand for water
- Strong social unity
- Subsistence economy
- strong self help and mutual support

Others are busy trading centres

- Cash economy and on major roads etc..

- **In the past** (so called blanket approaches)
  - ✓ Every project and programmes have often ignored the different nature and history of small communities, Was using the same technology and service level, and the same maintenance, management and financial systems
- Implementation was followed:
  - The Same national design criteria
  - The same technical and social processes everywhere
  - Regardless of local, social and economic conditions
- ➢ As a result services were often **unsustainable**

- **Nowadays,**

- Water projects and programmes increasingly organize that different types of **communities want** and can sustain different solutions

  not only for technologies and service levels, but also with regard to local maintenance, management and financing arrangements.

- The technology options may range from the **improvement** of the existing indigenous water sources and water transport systems to the **installation of new** water supplies with public facilities, group facilities and/or private facilities.

- Other options are a combination of **traditional** and **improved systems** for complementary use or a sequence of different systems during the rainy and wet season.

In the past, external projects have unfairly decided not to give such options to the users and sustainers of water supplies, because of the risk of contamination.

This has only meant that when hand-pumps on drilled wells broke down and could not be repaired either immediately or at all, the wells became useless.

Because of this the women's and children's had either to use another well with problems of distance, queuing, conflict and a lower water use, or turn to other, and riskier water sources.

- If it is community water supply system, helping communities to match their choice to their current needs and potentials, it is also possible to choose designs that allow moving up or down the climbing frame

- A user group may decide on dug wells rather than drilled wells with hand-pumps, because this makes it possible to open the well or use the manhole when for one reason or another a hand-pump cannot be repaired

- In such a case, the users should be made well aware of the risks of contamination and be ready and able to protect the water quality through a safe alternative way of drawing (e.g. with clean buckets and ropes) and well chlorination.

- Where **user groups** decide to go for wells that are only operated through hand-pumps, the responsibility for **operation** and **maintenance** should be given to the community.

- **Unfortunately,** many boreholes world-wide are no longer working because simple repairs have not carried out.

- **Consequently**, if a borehole is drilled in a village, it is important that maintenance costs and activities can be meet by the community.
- For major repairs beyond the skills of the community, clear information as to how these repairs will be carried out should be requested from the relevant agency.
- If the agency is unable or unwilling to provide this information, the community may not wish to commit to working with the agency, since failure of the project may not be seen as the fault of the agency, and may bar the community from future support.

1.2. Community survey and community participation

❖Nature and scope of community surveys

A community survey is an evaluation of all the factors and resources (physical and human) that affect the water-supply service, sanitation, and environmental health of a community

A community survey is required as the foundation of a comprehensive database.

The complete community survey should be conducted by the local surveillance agency office (or the area authority in small countries)

- Community survey should include the following four components:

1. Basic data on water-supply and sanitation facilities
   - The water-supply data (and, in some circumstances, sanitation data) are ideally the responsibility of the water-supply agency,
   - The surveillance agency's field officer should only have to confirm the information
2. Sanitary inspection (comprising sanitary inspection and water-quality analysis).
   - Sanitary inspection may be conducted by both the water-supply agency and the surveillance agency;

3. A quantitative diagnostic summary of the five key water-supply service indicators (quality, quantity, coverage, continuity, and cost). Which is the responsibility of both.

4. Hygiene survey. Hygiene surveys are, ideally, the surveillance agency's responsibility.

Community Participation

- Community participation can be loosely defined as the involvement of peoples in a community in projects to solve their own problems.
- People can not be forced to “participate” in projects which affect their lives but should be given the opportunity where possible.
- Participation, here, does not simply mean being involved in the construction of facilities, it means contributing ideas, making decisions and taking responsibility

The involvement of all community members including women, youth and the poor is of critical importance in rural water supply and sanitation projects from the beginning, to maintain the system.

The community members must learn skills to analyze the sources of the problems to come up with viable solutions.

Community participation can take place during any of the following activities:

- **Needs assessment** – expressing opinions about desirable improvements, prioritizing goals and negotiating with agencies
- **Planning** – formulating objectives, setting goals, criticizing plans
- **Mobilizing** – raising awareness in a community about needs, establishing or supporting organizational structures within the community
- **Training** – participation in formal or informal training activities to enhance communication, construction, maintenance and financial management skills
- **Implementing** – engaging in management activities; contributing directly to construction, operation and maintenance with labor and materials; contributing cash towards costs, paying of services or membership fees of community organizations
- **Monitoring and evaluation** – Participating in the appraisal of work done, recognizing improvements that can be made and redefining needs

Stakeholder analysis

- ***Stakeholders;*** are people, groups, or institutions which are likely to be affected by a proposed intervention (either negatively or positively), or those which can affect the outcome of the intervention.
- A useful tool to assess whom the programme will affect(positively or negatively) and therefore who should have a stake in the programme is stakeholder analysis.

This should be used to identify key stakeholders and their interests.

Stakeholders may include different people from within the affected population, as well as local authorities and agencies

It may not be possible for each and every member of the affected population to contribute to a programme equally but attempts can be made to identify key groups and individuals that can be actively involved.

Three Categories of Stakeholders

Primary	Secondary	Tertiary
• Users / Beneficiaries (male, females, children, elderly, etc.)	• Local authority • Direction of municipality technical services • Traditional authorities • NGO and development projects • Businesses and suppliers • Decentralised government services • Research institutions • School and university • Services providers	• Financial institutions and donors • National authorities (at all levels) • Opinion leaders • Civil society • Foreign cooperation agencies • Media

1. Primary *stakeholders* such as direct beneficiaries and direct concerned person (end users, farmers, urban poor, etc.)
2. Secondary *stakeholders*, i.e. intermediaries in the process of delivering aid to primary *stakeholders* (e.g. professionals, advisers, practitioners, consultants, experts, governmental, NGO and private sector organizations etc.)
3. Tertiary *stakeholders* such as decision, policy makers (politicians, senior civil servants, district level bodies, governmental bodies, etc.)

Gender and vulnerable groups

It is very important to make sure that minority groups, low status groups and poorer groups in a community are not left out and that women, men and children are specified in consultation processes.

1. Gender

- ✓ Gender is based on sex but is more to do with socially constructed distinctions (work, dress, behavior, expectations, etc.) than purely biological differences.
- ✓ Gender-related differences can be split into three categories:

  Differing needs and priorities

  Power and vulnerability differences

  Equity or equality issues

- Many donors focus on the vulnerabilities of the intended beneficiaries there often tends to be a focus on women in programme activities
- This is because in most scenarios women have less influence than men
- It is important to recognize, that gender does not automatically mean a bias towards women; the emphasis should be on the pursuit of equity of opportunity.

2. People with disabilities

- People with physical and mental disabilities can often be overlooked in many emergency situations.

- They are among the most vulnerable in most societies and are often unable to present their own needs and priorities clearly.

For this reason they should be given special attention where possible.

- This may include the construction of special sanitation facilities, assistance in community activities and the formation of focus groups for people with disabilities.

3. Elderly people

- Elderly people may have specific needs which should be considered

For example, elderly people living without younger family members may be unable to participate in physical activities such as pit excavation or latrine construction.

Such vulnerable households should be identified and solutions to their problems implemented

Thankyou Very much…

Chapter 2: Planning and Management

Planning for community managed water supply systems

- Project encompasses all the preparations for the construction of a particular scheme or water supply system
- Programme is a series of integrated activities directed at the establishment and continued functioning and use of considerable number of similar water supply services.
- Community water supply projects should involve from the community members right from the beginning and the community involvement should also increase for O&M

Demand- responsive programmes

- Demand responsive programmes give all locally relevant groups (stakeholders) get information on all relevant aspects and implication of the various water supply options.
- The information may include:
  - The amount and quality of water provided
  - The purposes for which this water will be adequate;
  - Potential implications for health and socio-economic development;
  - Investment and recurrent costs involved;
  - Approximate walking distances;
  - Requirements and possibilities for sharing of service and costs
  - Service regulation and reliability
  - Ease of maintenance (technical skills) and administration

Comprehensive planning

The **local solutions** for an improved water supply system is the product of comprehensive planning, by considering all community, technical, environmental, financial and institutional aspects.

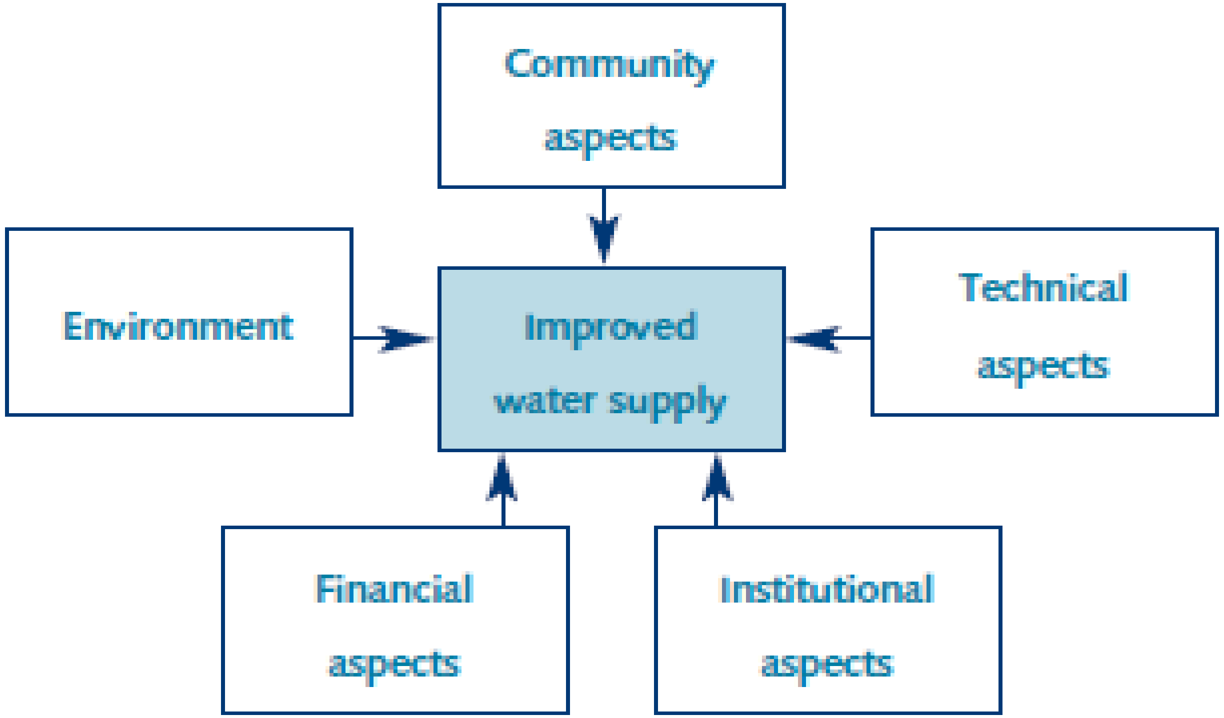


Fig: Comprehensive planning

Planning and assessment

- **Participatory planning** involves assessment and consultations on wider range of different aspects
- All communities has at least one way of getting water and new systems designed or some improvement are made, they can be seen in this comprehensive participatory planning process.

Fig: Assessment criteria for effective planning

Assessment criteria	Key components
Community aspects	• Demand for water supply improvement and desired service level (men and women, including marginalised groups) • Perception of benefits related to an improvement of water supply (men and women, including marginalised groups) • Responsibility and ownership feelings • Culture, habits, beliefs related to water and hygiene • Presence of alternative water sources • Organised and elected community group to be responsible for operation and maintenance (representative of the community social structure, including men and women) • Managerial and technical capacity of the community group, and availability of tools • Possibility of grouping several communities for a single water supply scheme (in the case of small piped systems)
Technical aspects	• Present and future water consumption • Need to include water treatment • Technical standards and complexity of O&M procedures, with a preference for technologies that can be operated and maintained at community level • Quality, longevity and cost of equipment • Cost and availability/accessibility of spare parts, and potential for local manufacture of spare parts, as well as standardisation • Dependence on and cost of fuel, power and chemicals, if needed, with a preference for reducing this dependency

Environmental aspects	• Quantity and quality of water resource, including the need for water treatment, water resource management and seasonal variations • Water source protection and wastewater management
Financial aspects	• Cost – benefit analysis • Ability and willingness to pay • Tariff structure (covering O&M and replacement costs), with due consideration for marginalised groups • Cost-recovery procedures and financial management capacity • Alternative financial mechanisms, in case of major problems • Economies of scale
Institutional aspects	• Legal framework and national strategy • Training availability and capacity • Follow-up support, including monitoring • Availability of technical assistance to the communities (NGOs, municipal and/or district level) • Availability and capacity of local craftsmanship • Involvement of formal and informal private sector • Capacity of technical staff to deal with community development and knowledge of participatory processes

Designing for current and future needs

- To serve the needs of all groups, small community water supply designs must further be holistic, expandable and upgradable

- In **a *holistic* design**, the local water supply system or combination of systems meets all the basic water needs of the people.

  - Like the needs for drinking, cooking, bathing, sanitation and hygiene, both women and men often need domestic water for small-scale productive uses within the household, such as raising animals, growing vegetables and trees, processing food and making bricks.

- Designing for **expandability** is required, to install new water points for new households and neighborhoods.

The community and its advisers also consider the system's expandability within the locally available technical and financial means.

- **Upgradability** means possible needs of the extra community investment.

Which is an issue because improvements in basic services can be expected to lead to socio-economic growth.

Standardization

- ✓ Several countries have chosen to standardize their choice of technology.

- ✓ There are positive and negative aspects that should be carefully considered before making a decision to standardize
- ✓ Standardization can only last a certain number of years, as technological progress, price factors and new life styles/patterns will influence the level of service and choice of technology.

Participatory processes

- Participatory planning and design is an intensive and crucial process
- Mostly it continues through focus group discussion
- Necessary to consult separately with the different community groups about the different options.

A programme fund to (co-)finance locally planned projects

- Small communities frequently find it difficult to obtain the capital to construct improved water supplies
- The communities that agree to take a loan, contribute to the costs of planning, design and construction with their time, cash, local knowledge and expertise, materials and labour.

Participatory assessment during the pre-planning stage

- To help and get support from all, it is important to identify the various groups at the very start of the process and ensure their equitable participation. FGD is preferable to identify the interests of all community groups.

Preliminary project selection

- No community exists without having some kind of water supply system
- Assessment of existing water supplies and their technical, financial, administrative, social and environmental shortcomings is therefore a part of any rapid feasibility/baseline study
- After baseline studies and laid down the demands, needs and potentials for improvement, the community submit its preliminary plans or pre-proposal to the programme level.

Detailed planning and decision-making

- Once a proposal has been selected and resources have been assigned, the next stage is detailed planning and design
- Programme support teams make their informed choices based on the social and technical knowhow of the community.

The choices cover wider range:

- Types of technology
- Number and location of the facilities
- Extent of involvement of different community group (Women)-cash labor, materials
- Monitoring quality of work
- Local arrangements for operation and maintenance
- Local financing system involvement
- Regulation needed for the management

Example of a planning process

An effective planning process comprises the following steps:

Step 1 **Demand from the communities** for support in improving their water supply

Step 2 **Initial service level assumption,** during which the support agency makes a preliminary overview of hydrological, population, technical and institutional aspects

Step 3 **Participatory community baseline survey**, during which a situation analysis is done with the communities

Step 4 **Assessment of operations support capacity**, during which an investigation is made among local, municipal and district public bodies, private formal/informal bodies or individuals, and NGOs

Step 5 **Analysis of results with the communities**

Step 6 **Formal agreement** between the community, the local authorities and the support agency

Implementation

- Under this approach, procurement and construction are fully community implemented and controlled
- During this stage the local project committee also monitors and accounts for the fair implementation of contributions from individual householders
- Care and monitoring ensure that both women and men from the different sections are trained

The post-construction stage

- Small community water supplies are often more difficult to keep running than to construct.

- The selected technicians and management committee greatly benefit from technical and managerial experience and training during and after the construction

Programme organizational aspects

- Small community water supply success is combining local skills and energy with proper programme support
- This section addresses some of the main organizational and staff requirements, and management models, that help communities to establish and run small, decentralized water services.

Function divisions

Level	Functions
National/state	• Establishment of technical and administrative policies • Formulation of measurable objectives, strategies, guidelines and standards • Long-term programme planning • Legislation • Regulation • Management of national funds, and matching these to local contributions • Monitoring and evaluation • Accounting to Parliament, etc. • Adjustments to policy, strategies, etc. based on evaluation and public accountability • General financial control. • Interdepartmental coordination • Donor coordination • Adjustment of education curricula • Provisions for in-service training

Provincial/District	• Planning and execution of implementation programme(s) • Allocation of individual community projects • Resources support (financial and human) • Capacity building and training • Monitoring and evaluation of implementation and post-implementation results in relation to support approaches, with corrective action • Financial and quality control • Backstopping of established community services • Coordination for water resources management
Community	• Planning and implementation of local water projects • Process management • Service management (incl. O&M and financial management) • Monitoring and evaluation of services, with corrective action • Accounting for project implementation and service management to community male and female household heads • Coordination with other communities/water resources management

Management models

The following management models can be applied for community managed water supply systems:

- **Tap or neighborhood committee** responsible for operating and maintaining a specific water point
- **Water committee** responsible for all managerial, financial and technical activities of a scheme that covers a larger area than a neighborhood, and possibly the whole community
- **Water committee contracting a private body**. The committee remains responsible for general management and control of mechanic, plumber, etc.
- **Multi-village water committee**, responsible for the management of water supply in several communities.
- **Village association**, responsible for all development activities concerning the village,

Supporting the process of change

- Community-based management and governing boards of most small water supply systems need external support and advice in areas such as planning, implementation, management, accounting, audits, monitoring, training, special repairs, etc.
- For larger and more complicated piped water supply schemes, the actual management is best done by a professional team consisting of a manager, accountant and technicians

Thankyou Very much…

Chapter 3: Spring water tapping

- Springs occur where water from an underground aquifer flows out of the ground to the surface
  - ✓ The spring can occur where the water flows out of the ground by gravity, or
  - ✓ it could be an artesian spring where the water appears at the surface under pressure from a confined aquifer below
  - ✓ The point at which the water reaches the ground surface is known as **'the eye of the spring'.**
  - ✓ The water may emerge either in the open as a spring, or invisibly as an outflow into a river, stream, lake or the sea

Spring water can be of good quality microbiologically, if the spring is well protected

Most natural springs have been developed in one way or another as drinking water sources.

- ✓ Proper feasibility study, application basic design principles and awareness in protecting the spring and its catchment area will usually lead to improvements in the quantity, quality and sustainability of many such supplies

Identification of spring source

- **Consulting local peoples**

  Local people, especially women (as drawers of water), but also farmers, hunters and grazers, have a good knowledge of the location of springs and their characteristics.

  These people are the primary sources of information in the identification process

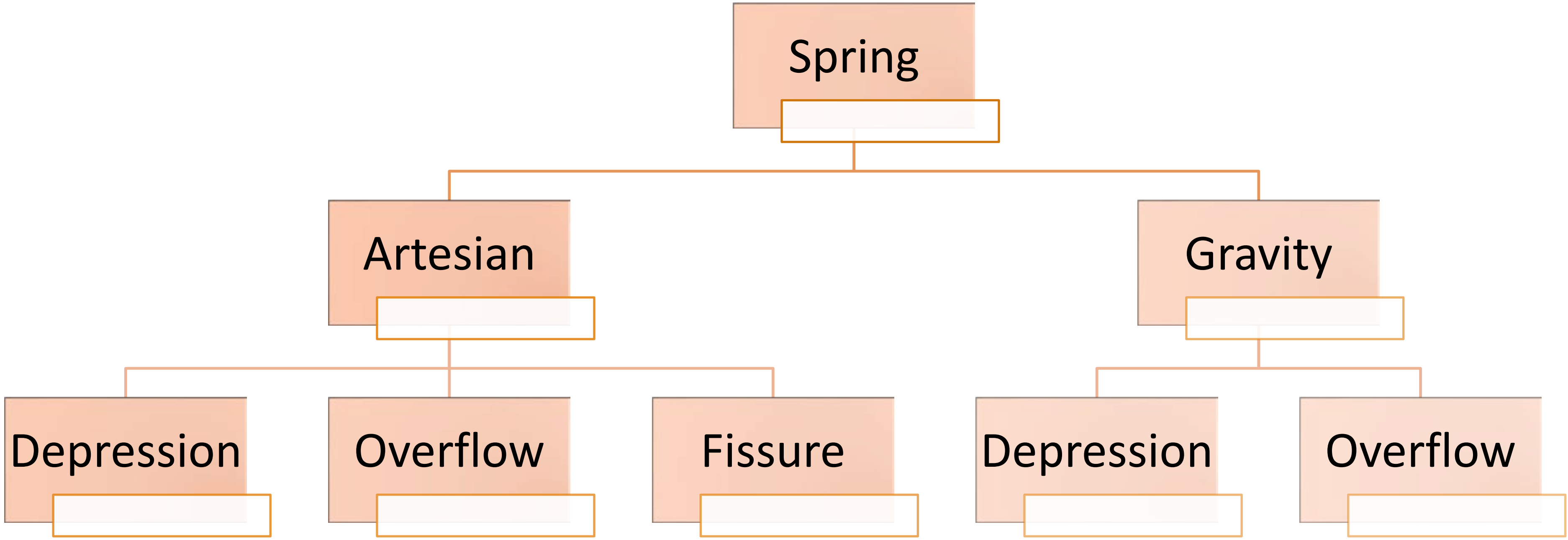
- **Physical indicators**

  In the dry season, green vegetation in a dry area may also be an indication of a spring source

  Some springs form small ponds where Others flow as small streams in valleys

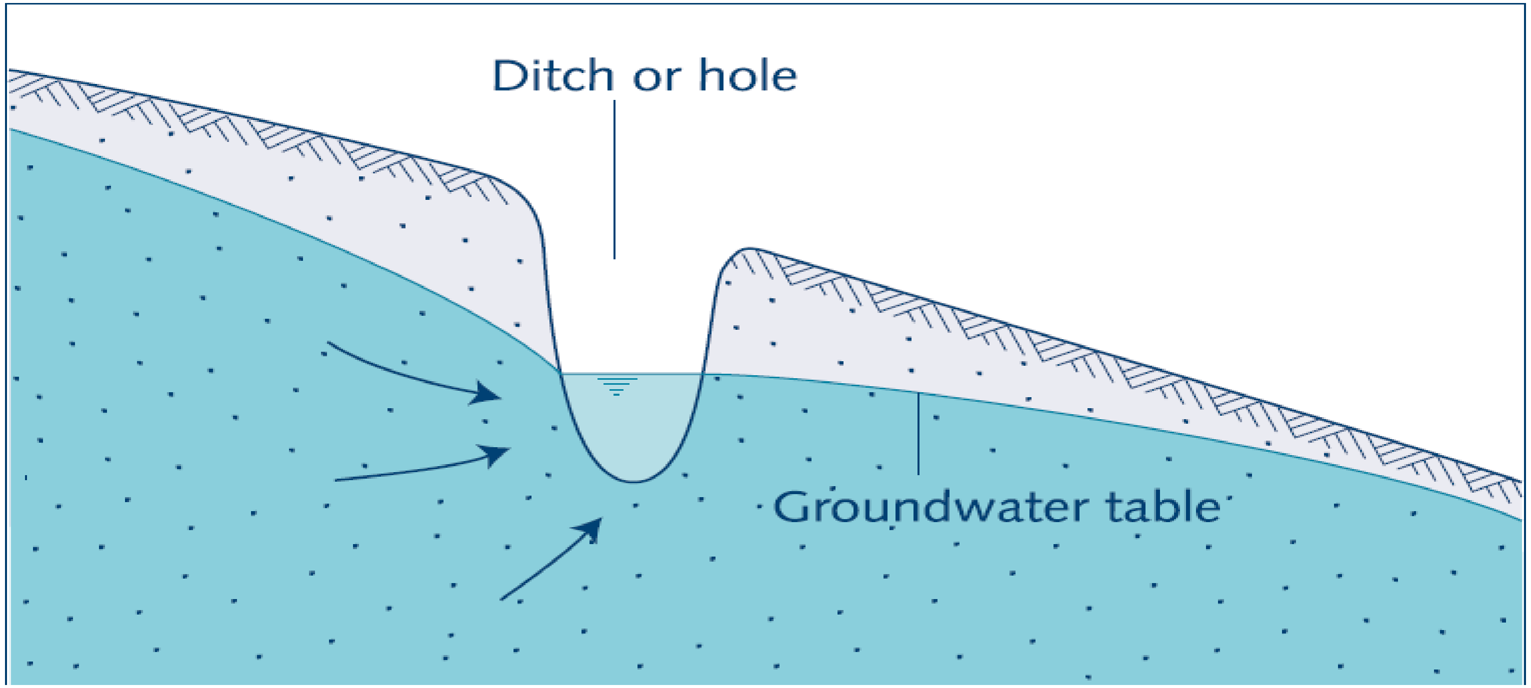
Types of spring sources

- Springs are classified according to the conditions under which water flows to them
- Some surface under pressure, while others do so as a result of discontinuities in the strata that held the water underground



Gravity depression springs

- Gravity springs occur in unconfined aquifers.
- Where the ground surface dips below the water table, any such depression will be filled with water
- Gravity depression springs usually have a small yield and a further reduction occurs when dry season conditions

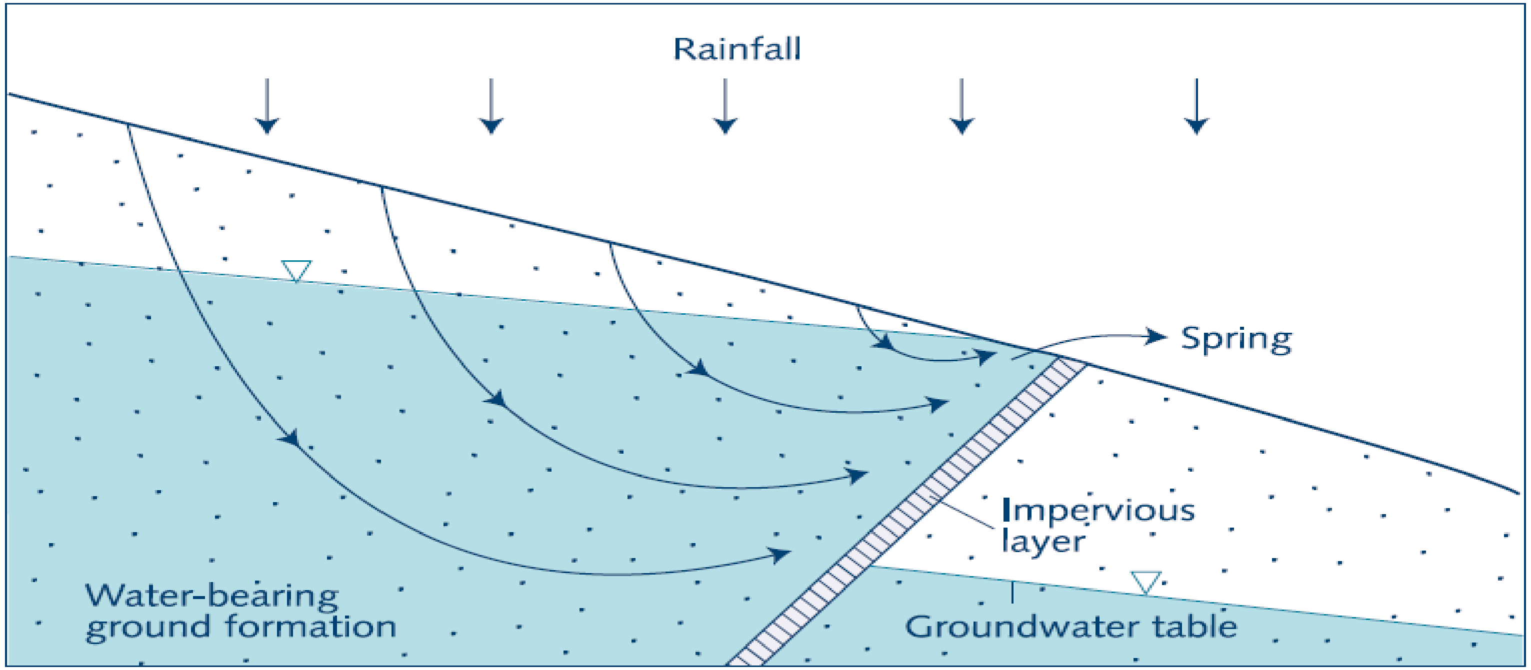


Gravity overflow springs

A larger and less variable yield from gravity springs is obtained where an outcrop of impervious soil

All the water from the recharge area is discharged.

Even so, an appreciable fluctuation of the discharge may occur and in periods of drought some springs may cease to flow completely.

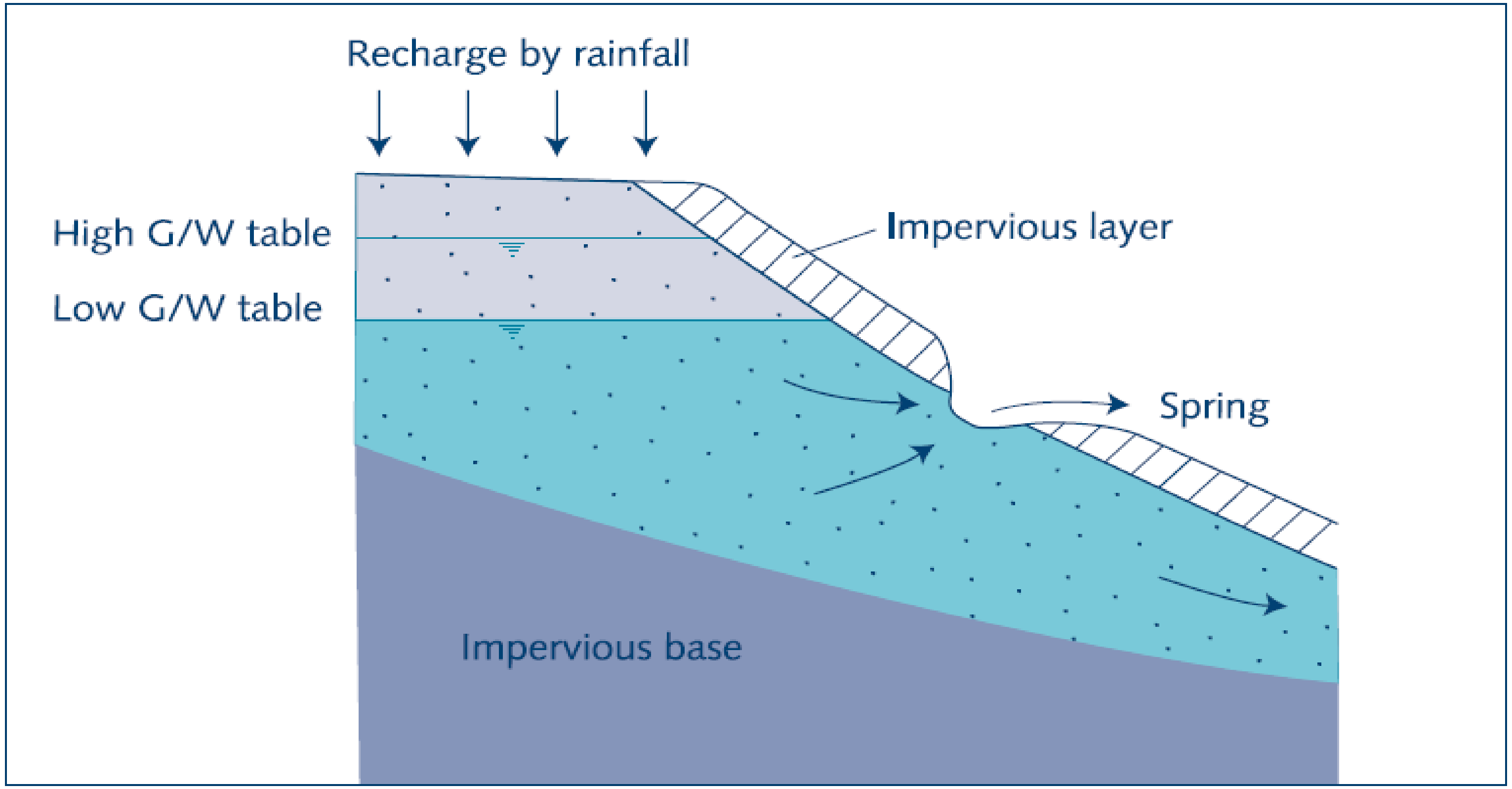


Artesian depression spring

Artesian groundwater is prevented from rising to its free water table level by the presence of an overlaying impervious layer.

Similar in appearance to gravity depression springs

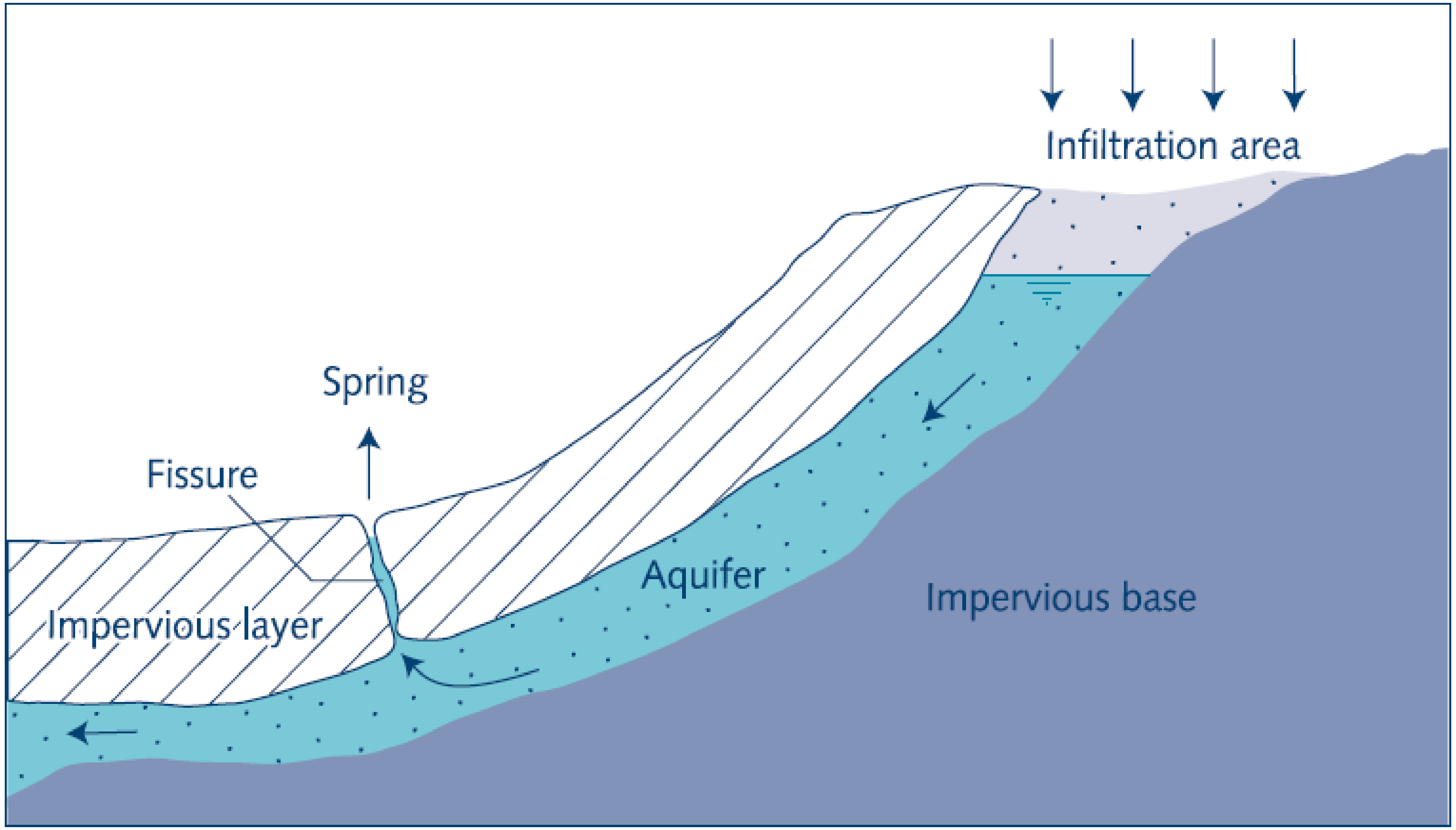
However, the water isforced out under pressure so that the discharge is higher and there is less fluctuation



Artesian fissure spring

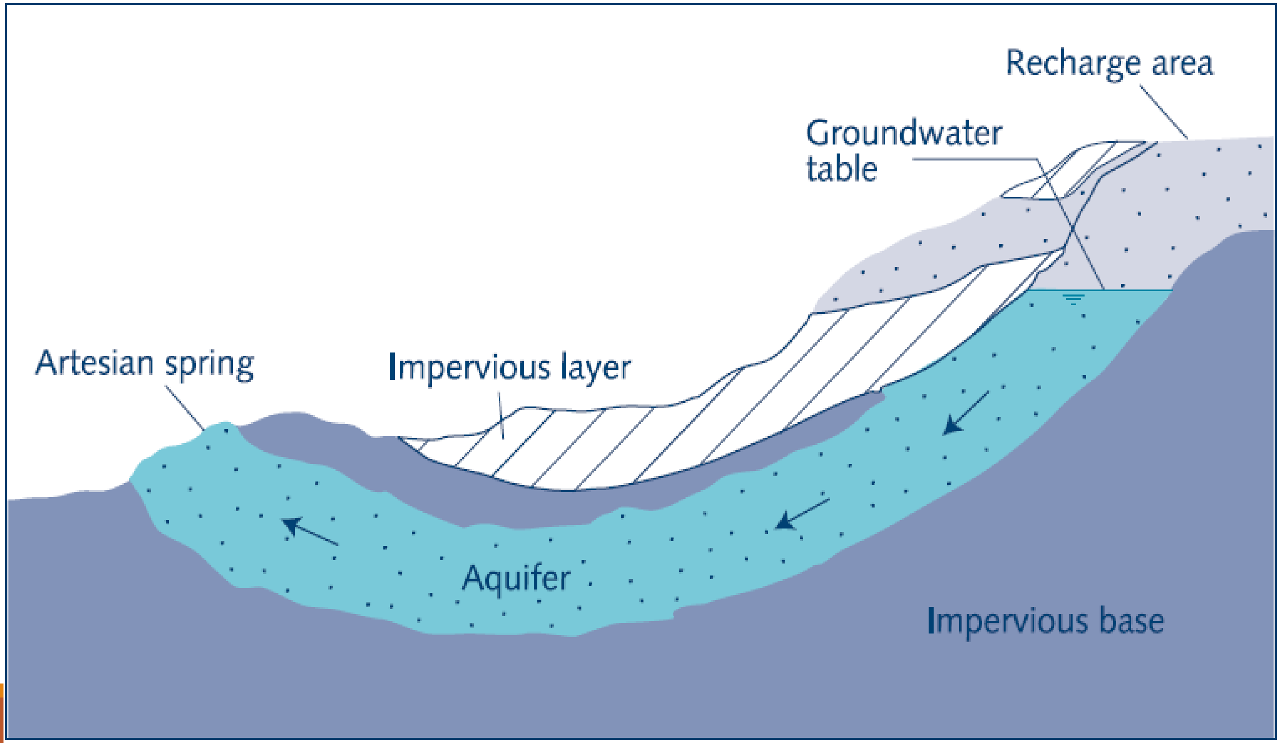
- The water emerges under pressure, this time through a fissure in the impervious overburden

- Fissure springs exist in many countries and are widely used for community wate



Artesian overflow spring

- ✓ Artesian overflow springs often have a large recharge area, sometimes a great distance away
- ✓ The water is forced out under pressure; the discharge is often considerable and shows little or no seasonal fluctuation



- ✓ These springs are very well suited for community water supply purposes

- **Artesian springs** have the advantage that the impervious cover protects the water in the aquifer against contamination
- The water from these springs is usually bacteriologically safe.

Feasibility study

- ✓ The feasibility study of a spring source aims to investigate the quality and the quantity of water from the source
- ✓ Aspects to be considered in feasibility study of a spring source are:-
  - Quantity and quality of the water,
  - Its reliability, current and future uses,
  - Socio-cultural acceptability for a domestic water supply,
  - Possible environmental impacts.
- ✓ A representative feasibility study is therefore best done together with a team of community members.

Feasibility study

- Feasibility study should includes the following parameters:-
  - Rapid environmental assessment
  - The spring water quantity
  - The spring water quality
  - Estimating the spring yield

1. Rapid environmental assessment

- A rapid assessment of potential environmental impact is a sensible first step
  - ✓ Identifying possible environmental consequences of developing a spring
  - ✓ These can include risks of landslides, erosion, contamination of the source
- The environmental assessment includes
  - ✓ Investigating the flow direction of surface run-off above the spring
  - ✓ Human activities and water uses in the catchment area, i.e. habitation, Farming, grazing, etc. and
  - ✓ The type of plants growing in the catchment or recharge area.

2. Spring water quality

- In general, spring water is of good quality.

- Pathogenic contamination is unlikely if the source meets certain criteria
  - These include the thickness of the soil layer, the type of soil and the velocity of infiltration of the surface water

- One of the key signs of a good spring is that the water maintains a constant temperature throughout the day

- This temperature is just below the average air temperature

- The water should also be colorless

- Variation of water temperature during the day and coloration of water shortly after rains are indications of a poor quality spring source

- Laboratory testing of the water quality is a necessary part of the feasibility study even if there are no changes in the water temperature and color

The spring water quantity

- The quantity of water a spring produces is known as its yield

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- Yield is studied in terms of flow rate and consistency
- Variation in the yield of a spring during the dry season and the rainy season is an important criterion to determine whether the spring is a suitable source
- If the ratio between the highest yield in the rainy season and the yield in the dry season is below 20, then the spring has an acceptable consistency and can be regarded as a reliable source in both wet and dry seasons

- Take into account that the highest and the lowest yield do not occur at the beginning of the rainy season and at the end of the dry season but typically a couple of weeks (or even months) later, depending on the soil characteristics.
- A proper feasibility study of a spring source should last for at least one year.
  - the maximum, minimum and estimated average flow

Estimating spring yield

A spring yield is measured in liters per second (l/s).

The measurement of spring discharges can be done with different methods:

1. **bucket/stopwatch:-** The measurement process involves two selected trained villagers who measure the discharge from the spring over the study period

   1. The process starts with the construction of an earth dam.

      Spring water retained by the dam is drained through a pipe.

   2. One villager collects the water with a container of a known volume while the other measures the time needed to fill the container

   3. Repeat the measurement several times and calculate the average, excluding the extremes

   4. This is repeated once every week for the measuring period. In this way, the minimum and maximum yields are determined.

- The pipe diameter and container size are chosen such that the water outflow will not fill the measuring container in less than five seconds

2. **Velocity/area:-** Try to find a downstream stretch with smooth flow and semi-constant cross section (or make one).

   1. Measure the time it takes a leave (or other floating material) to pass a certain distance at the heart of the flow. Distance divided by time gives velocity.

   - The velocity at the surface is to be corrected to get the mean velocity in the central cross section is.

   - Repeat this at least 4 times and determine the average

   2. Determine the average area of cross section, excluding areas with stagnant water (width times average depth)

      - The formulae is now Yield = Area times Velocity

Estimating.........

Measuring of spring yield

Design and construction

The design and construction of a spring-fed water supply for a specific location must

i. Be appropriate for the specific local conditions,

ii. Prevent pathogenic contamination and pollution,

iii. Be reliable in terms of quantity, and

iv. Have no adverse environmental consequences.

- **Gravity depression springs** cannot be recommended for community water supplies because of their small yield and the difficulty of providing adequate sanitary protection
- The presence of such a spring, however, indicates shallow groundwater that may be withdrawn using drains or dug wells. These can be covered and protected against contamination.

Design

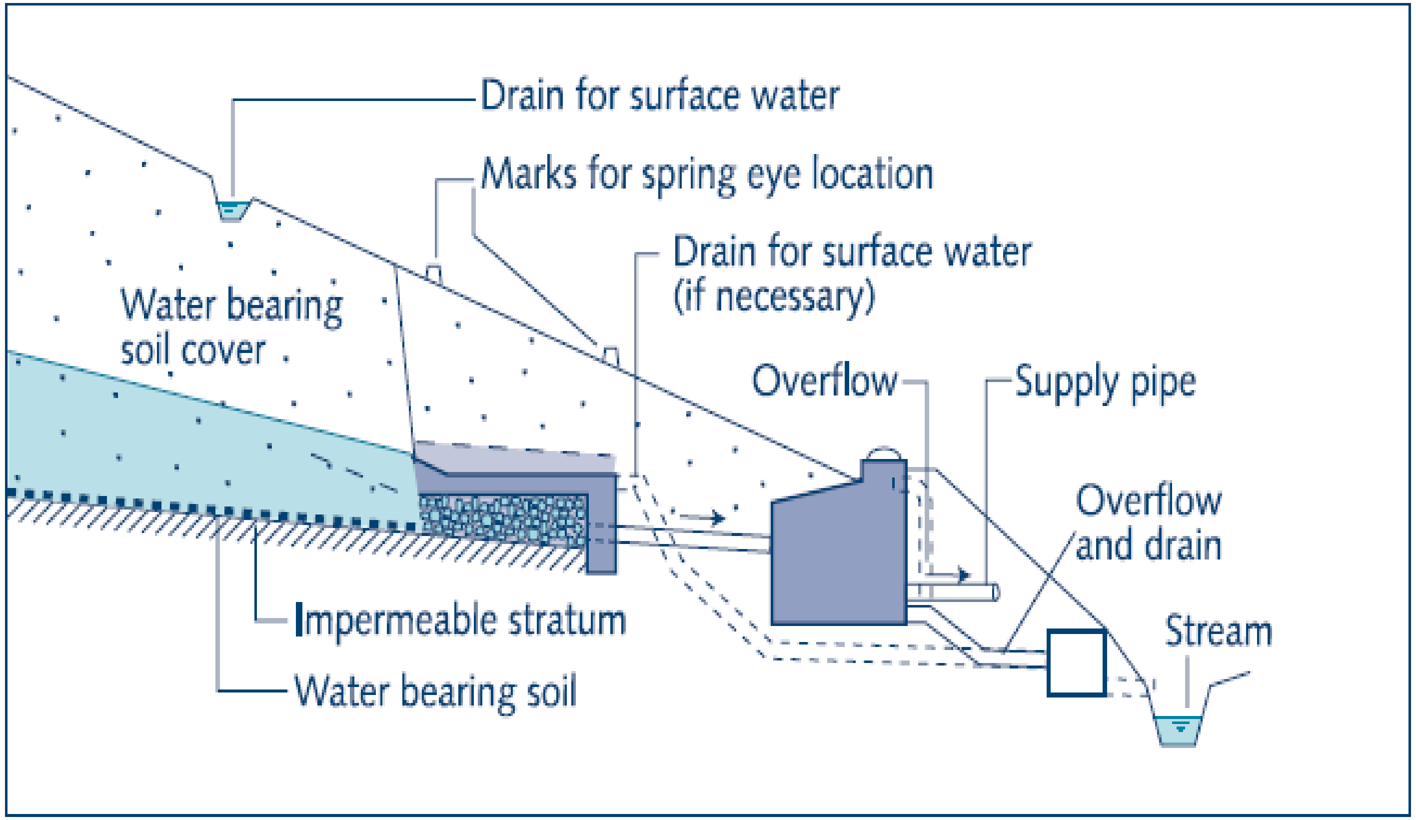
The major components in the design of a spring-source water supply system include:-

i. The actual spring water collection area where water from the aquifer is actually being channeled to a single discharge point

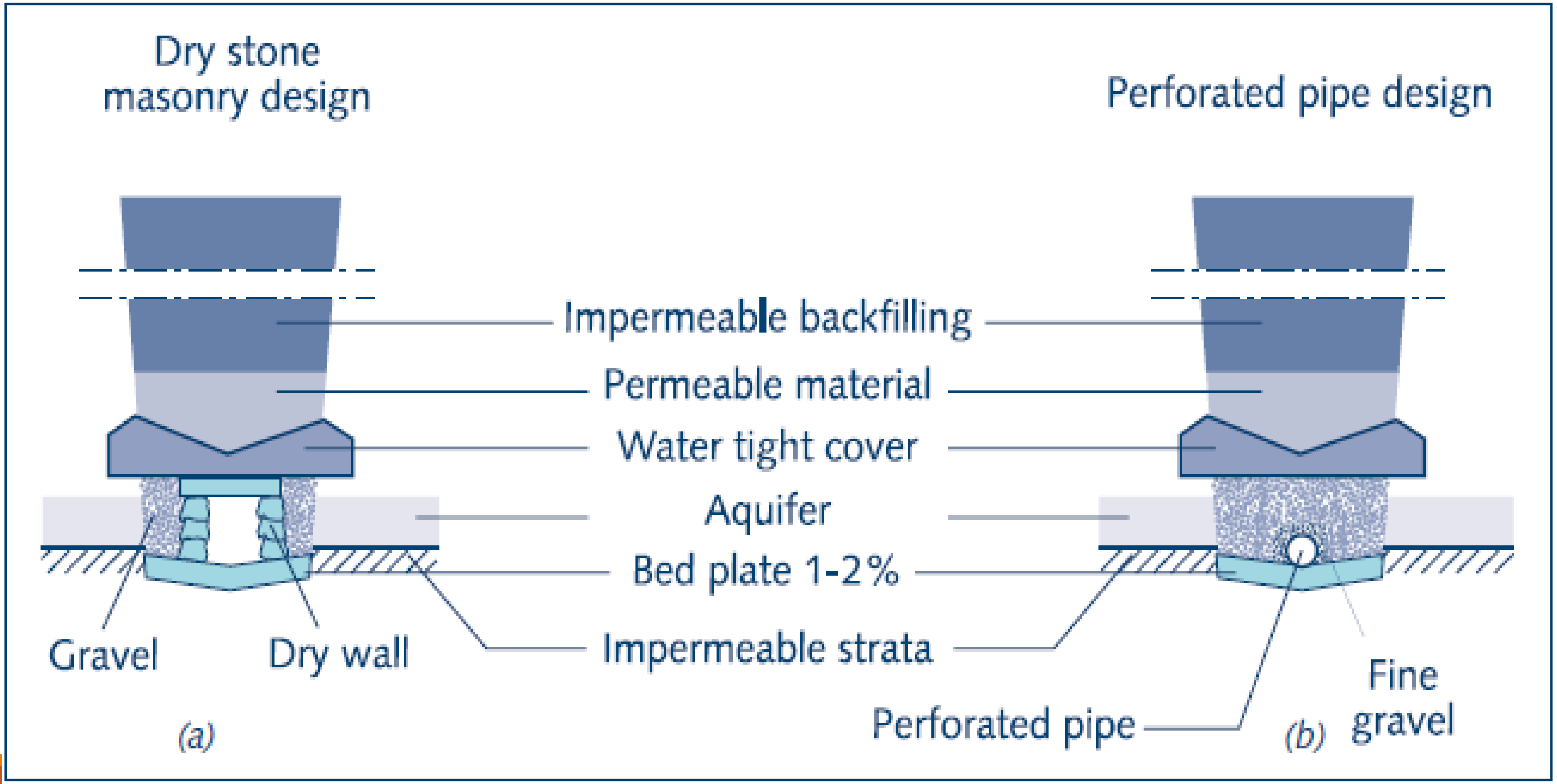
ii. The supply pipe,

iii. The collection chamber, and

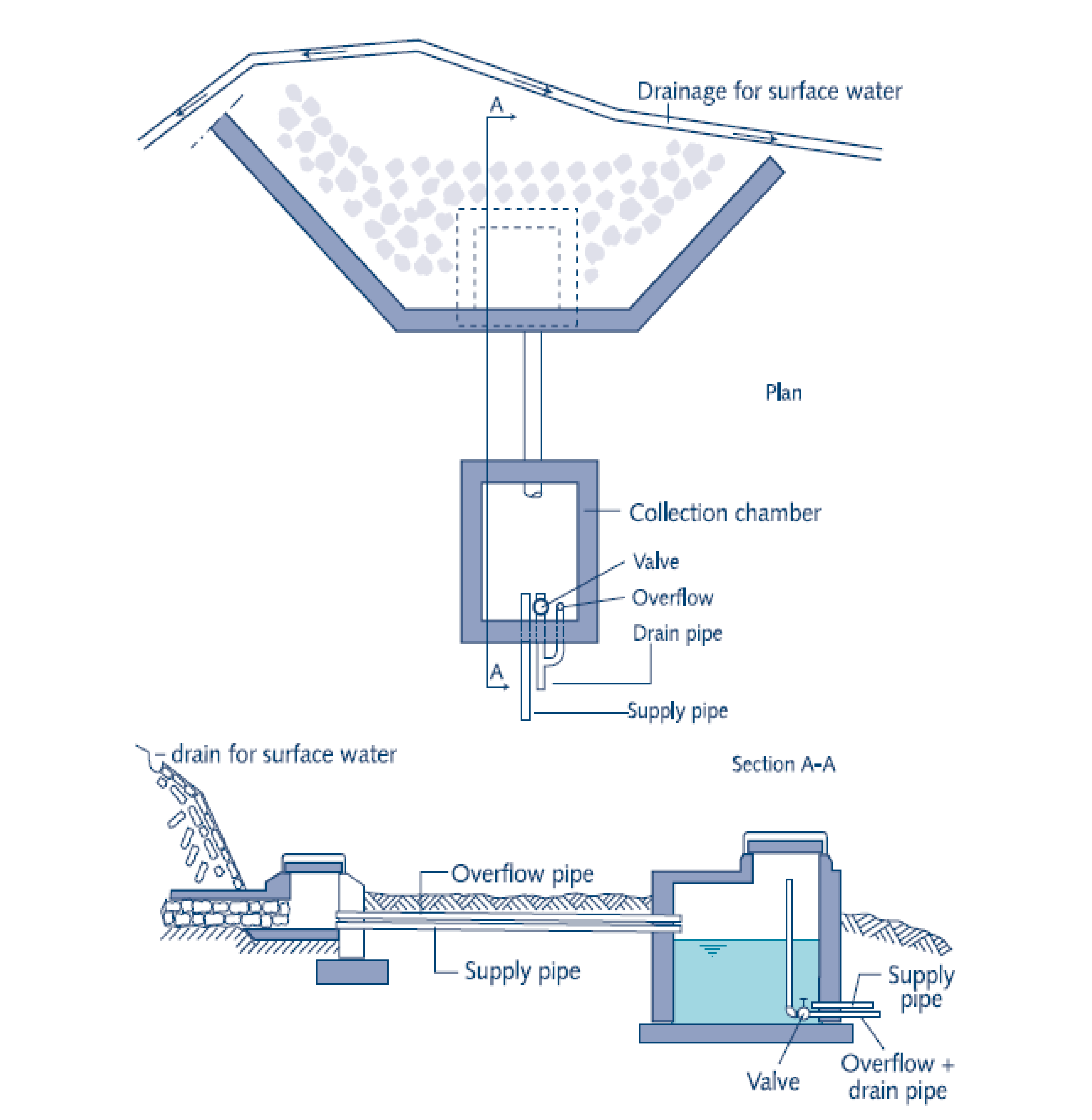
iv. The outlet to a storage tank



- Two methods are used to collect the groundwater
    - One is by dry stone masonry and
    - the other is by perforated pipes



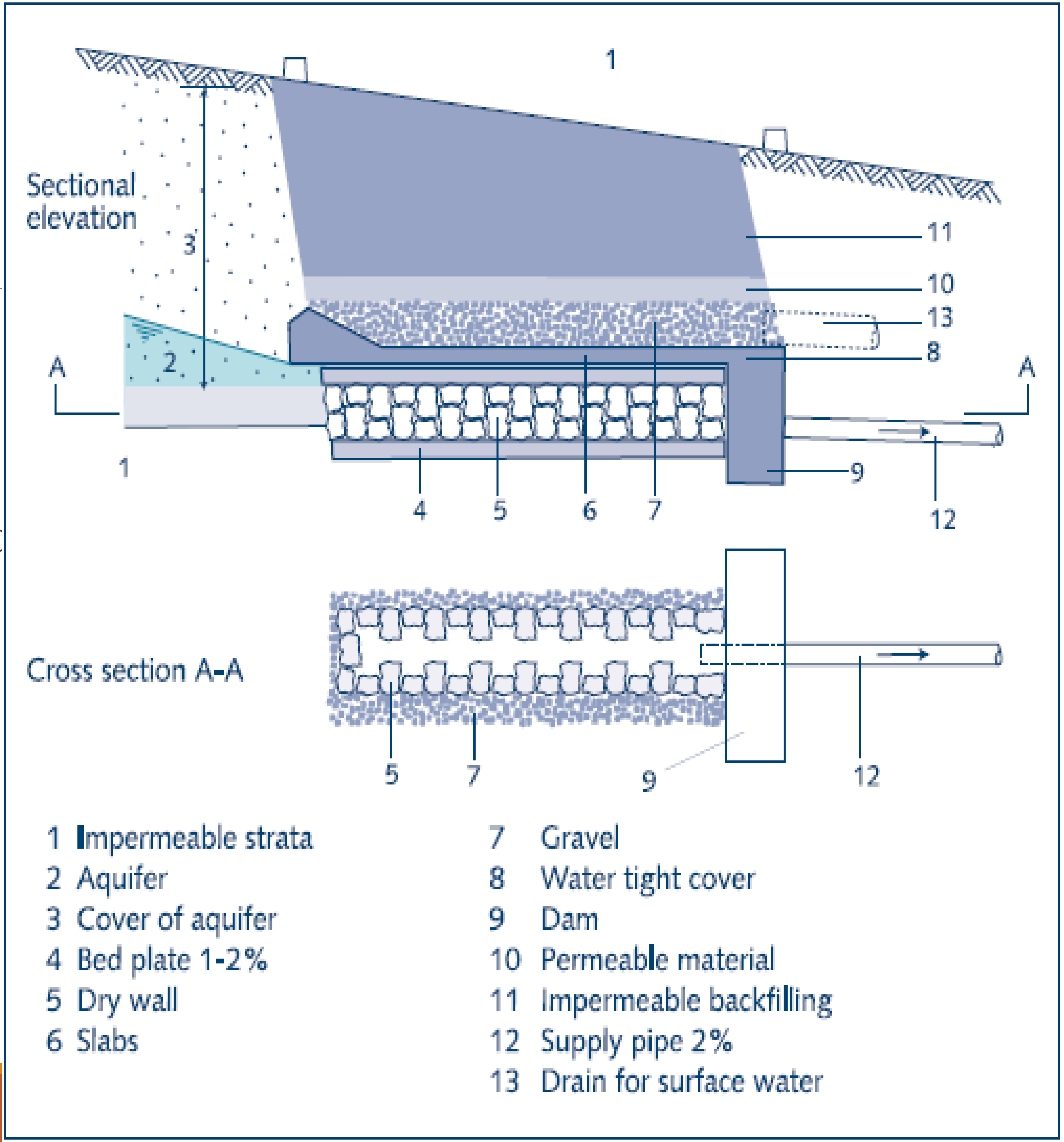
- Other modifications in the design are made mainly to reduce costs and make the system more appropriate
- Two supply pipes are used in the collection area to channel the drain water to the collection chamber
- The first pipe channels all the discharge during times of low yield
- The second ensures that there is no excess water backing up in the collection area during maximum yields, as this could obstruct the natural flow in the aquifer and create back pressure.



Low cost option for collection area

Tapping of gravity springs

- The spring collection area is the heart of a water supply system that uses a spring source
- Once constructed and backfilled, access to collection area, for instance to correct errors, is very cumbersome Thus, care and experience is needed for proper spring construction



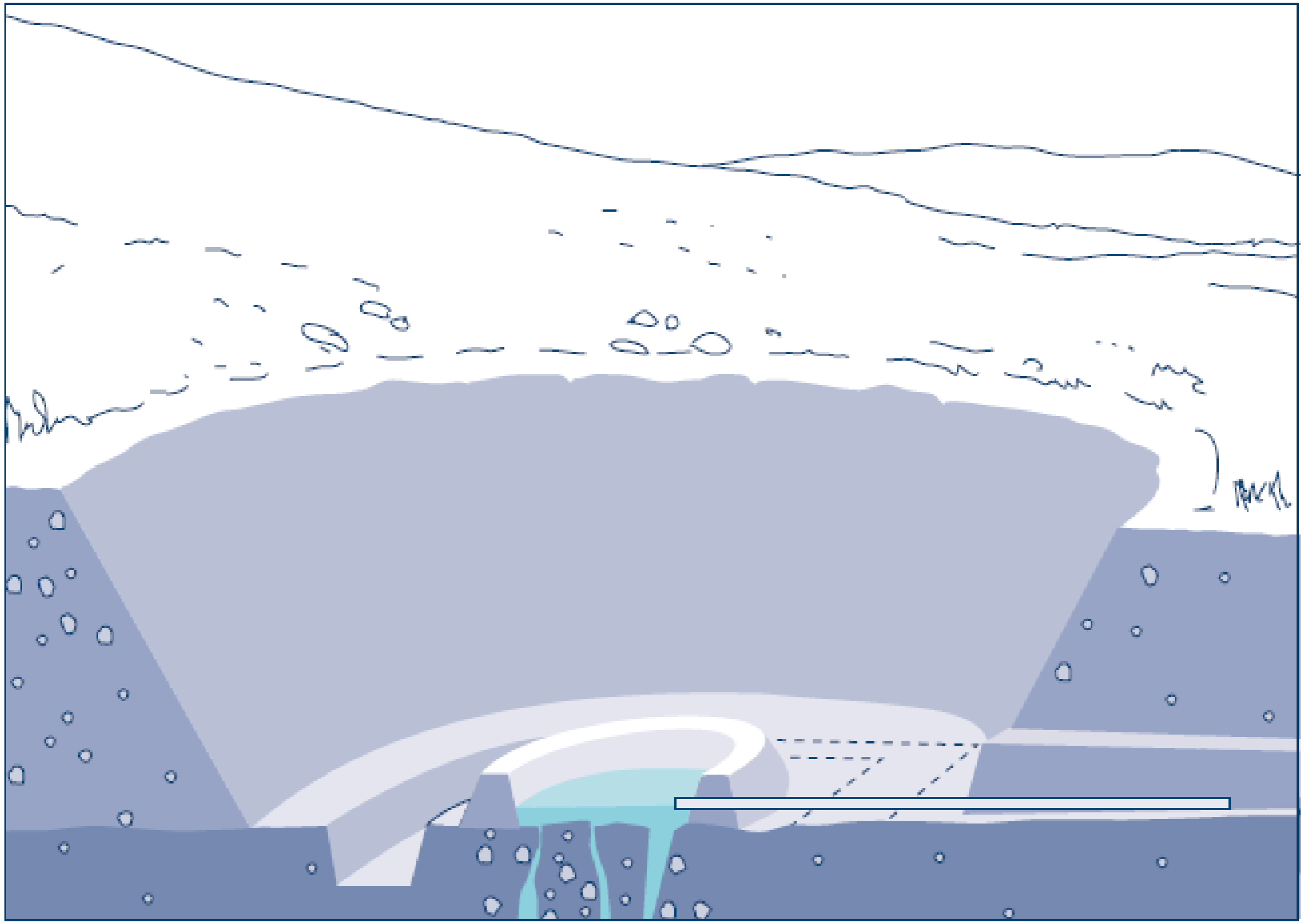
- The major parts of the construction are
  A. The permeable construction and
  B. The barrage (dam)

- The permeable construction is a package of filter material made of rocks, stones and gravel that allows water to drain into the supply pipes.
- Perforated pipes surrounded by a gravel filter package are sometimes used instead of dry stone masonry but the latter is preferable
- The barrage can be a concrete dam or a stone masonry construction controlling the drain and directing water into the supply pipes. It also carries the load of the backfilling
- The floor of the permeable construction and the perforated pipes slopes at about 2%.

Tapping artesian springs

Artesian depression springs are quite similar to gravity depression springs but their yield is greater and less fluctuating, as the water is forced out under pressure

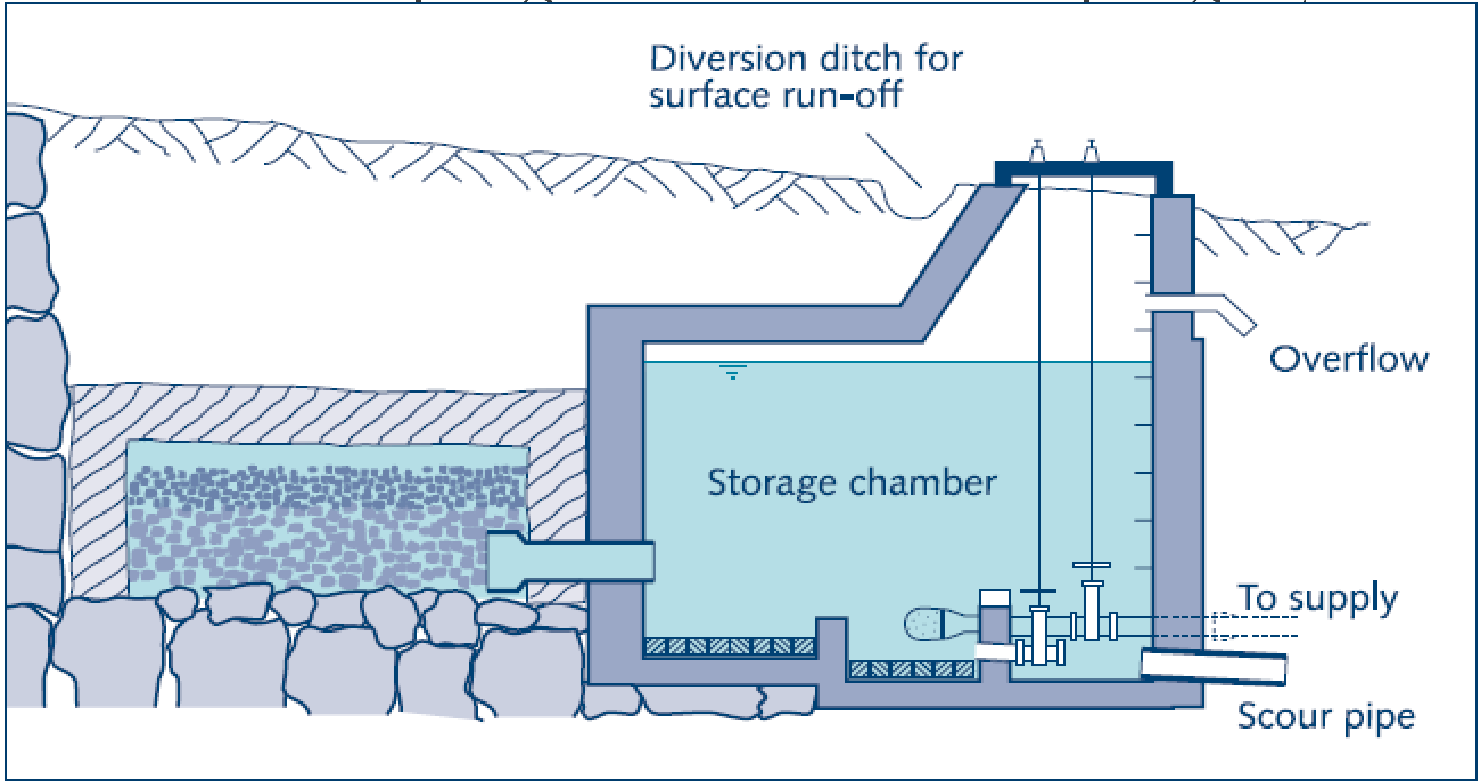
Excavation and construction of artesian springs



Artesian depression springs

To tap water from an artesian depression spring, a wall extending a little above the maximum level to which the water rises under static conditions should surround the seepage area.

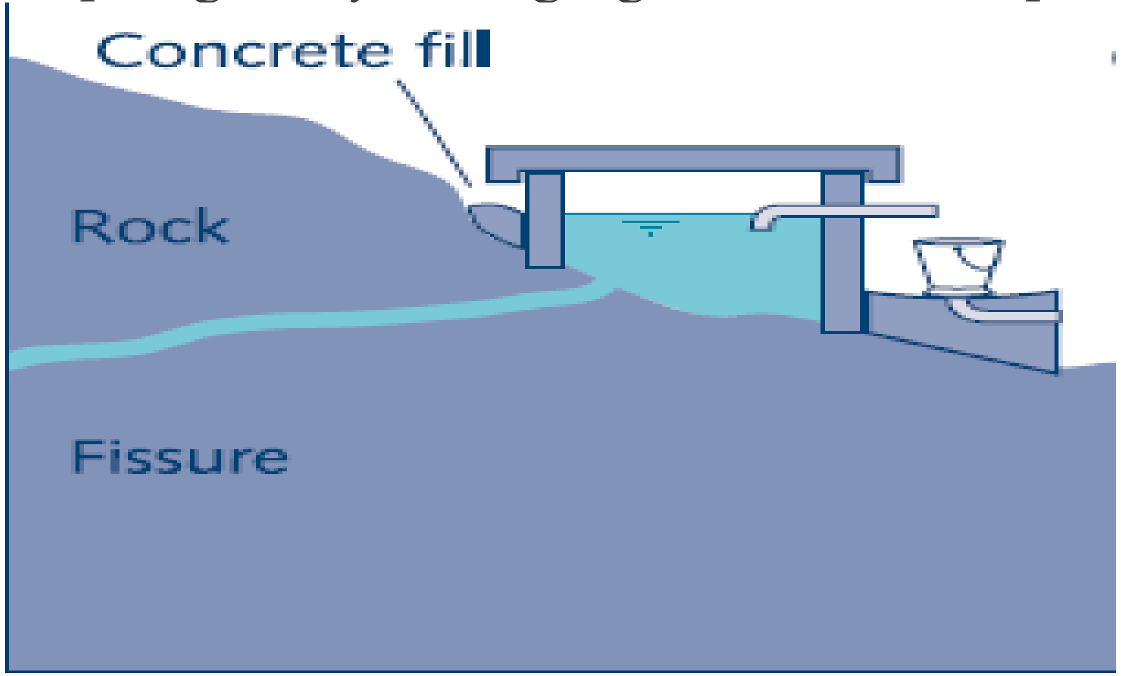
For sanitary protection the spring collection area or spring “eye” should be covered



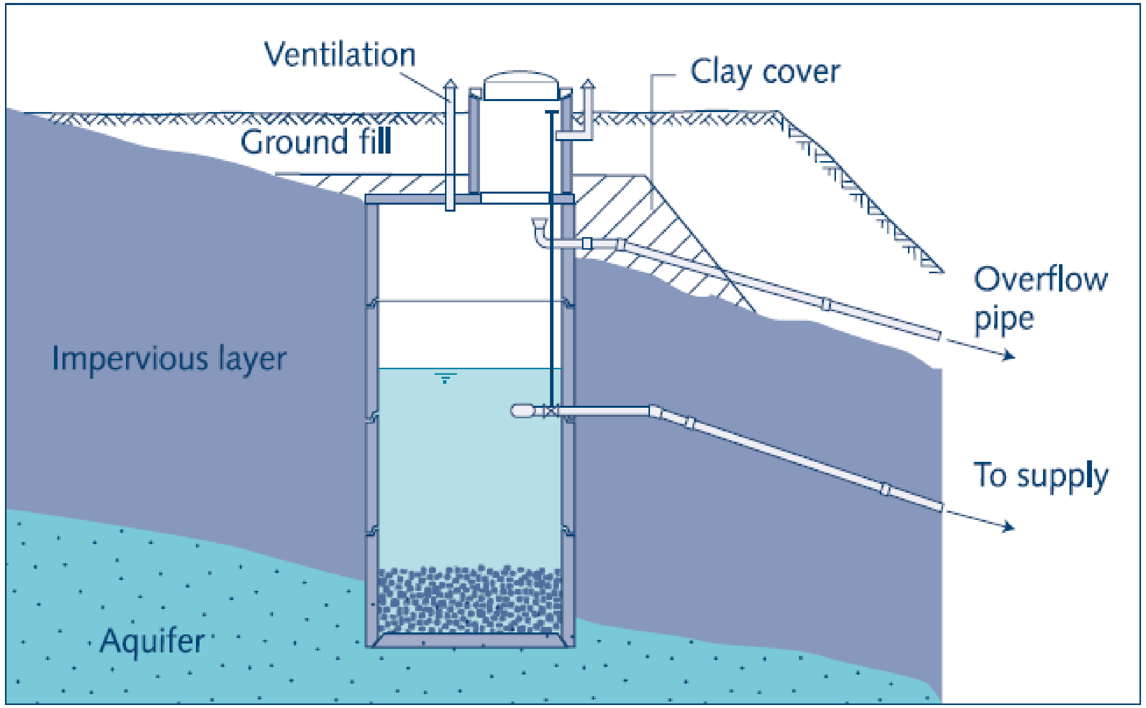
- For artesian depression springs that cover a large area, a system of drains is commonly used to channel the collected water into a storage chamber.
- To protect the water quality, the recharge area should be cleared and kept clear of all debris.
- For granular top layers, it may be necessary to cover the recharge area with layers of graded gravel to trap fine suspended solids.

Fissure springs

- Fissure springs are similar to artesian depression springs, but the water rises from a single opening, so that the intake works can be small
- Some increase in capacity may be obtained by removing obstacles from the mouth of the spring or by enlarging the outflow opening



Fissure spring of small capacity



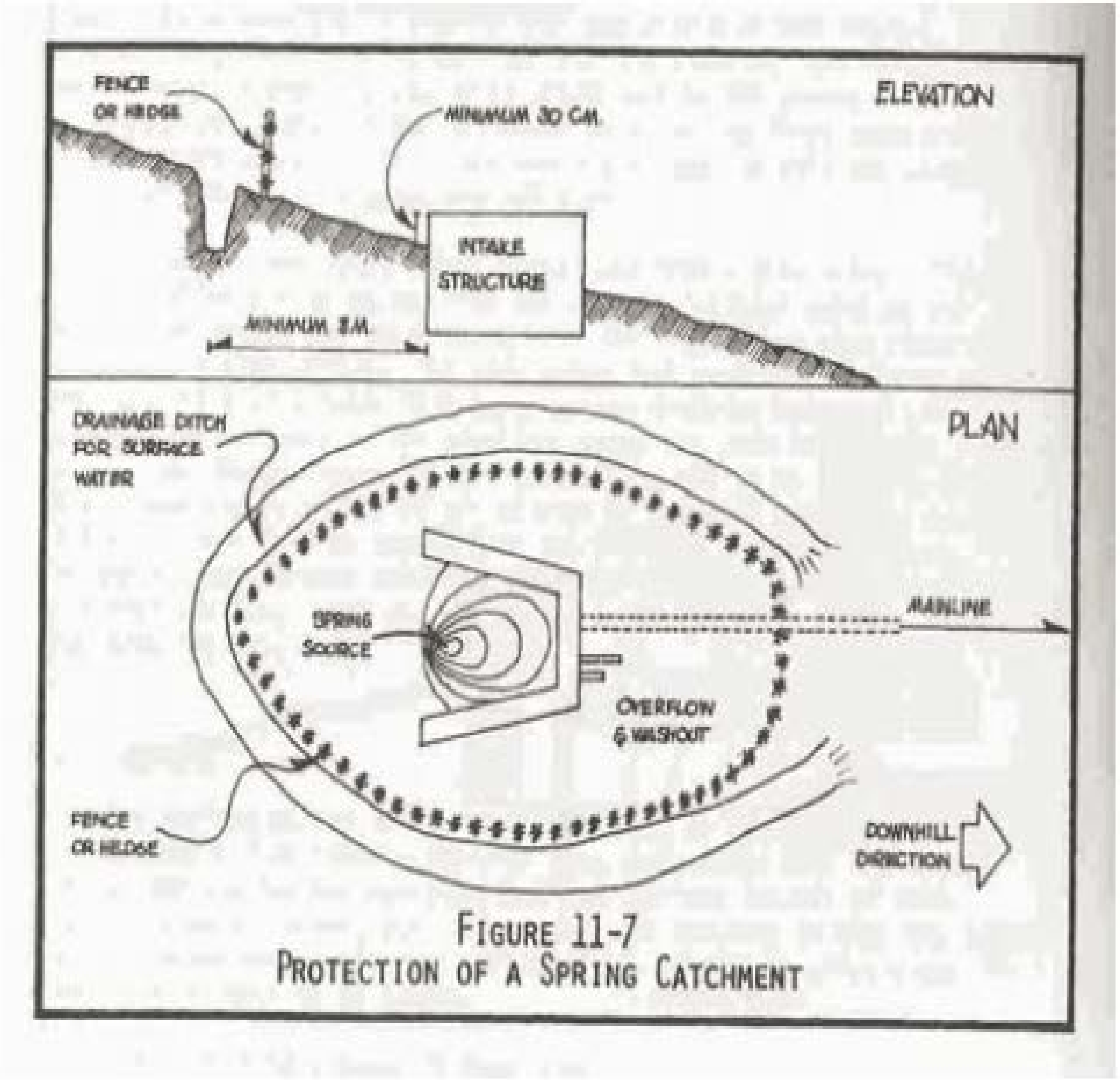
Fissure spring of large capacity

Protection of catchment and direct spring surroundings

- Protection of the catchment has two main objectives:
  i. To improve the recharge of the aquifer, and
  ii. To prevent contamination of the groundwater
- A surface water drainage ditch is dug above and around the spring area to divert surface water run off from polluting the source. This should be dug a minimum of 8m from the source and ideally further away
- The area should then be fenced to keep animals and people out of the area.
- Earth should also be mounded up against the collection tank walls to divert any surface water away

- Ideally an area leaving a minimum distance of 50m above the spring should be left where there is no human habitation and animals are not allowed to graze

- Reforesting and the planting of grass and bushes in the area directly above a spring can help to protect the catchment area, to reduce run-off and erosion

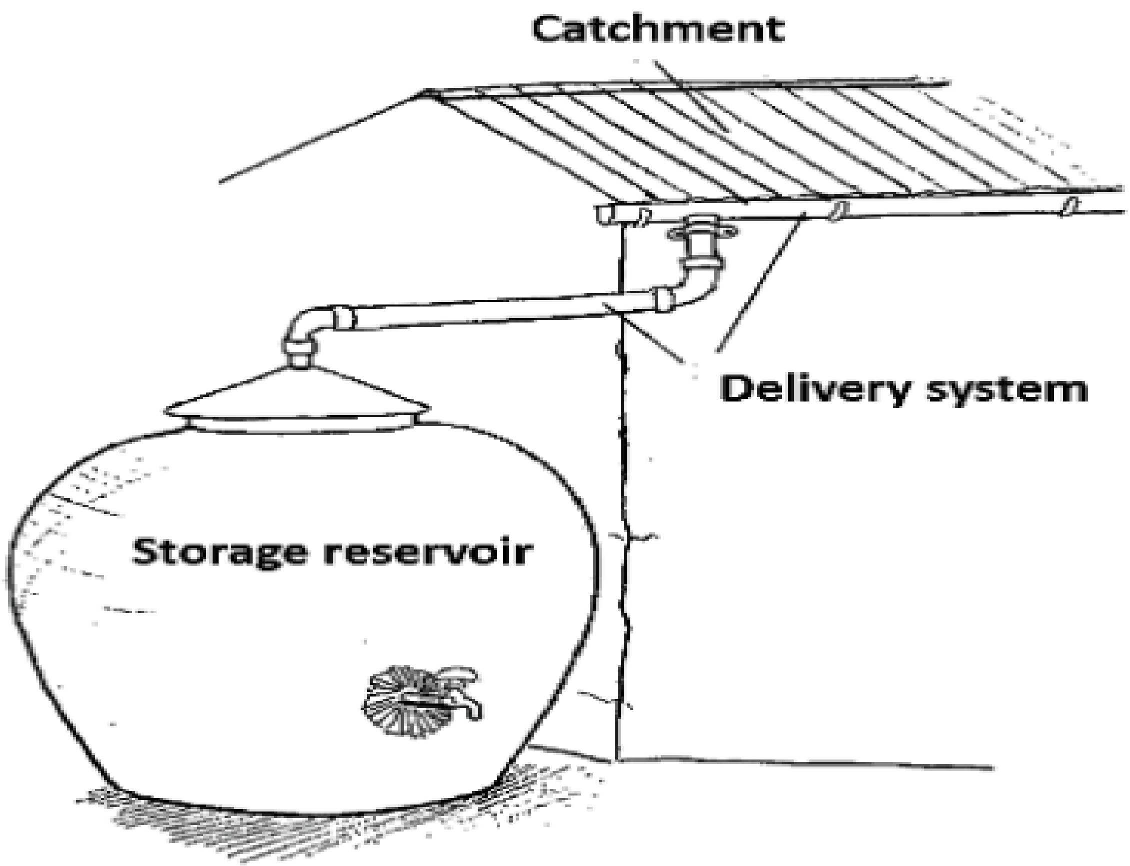


Protection of a spring catchment

Thankyou Very much…

Chapter 4:

Rain Water Harvesting



Introduction

- **Rainwater harvesting** means capturing the rain where it falls or capturing the runoff in farms, villages or towns and taking measures to store that water and keep it clean
- It is a means of taking water from Hydrologic cycle for either human or agricultural use
- Rainwater harvesting can be undertaken through a variety of ways:
  - Capturing run-off from roof tops
  - Capturing run-off from local catchments
  - Capturing seasonal floodwater from local streams
  - Conserving water through watershed management

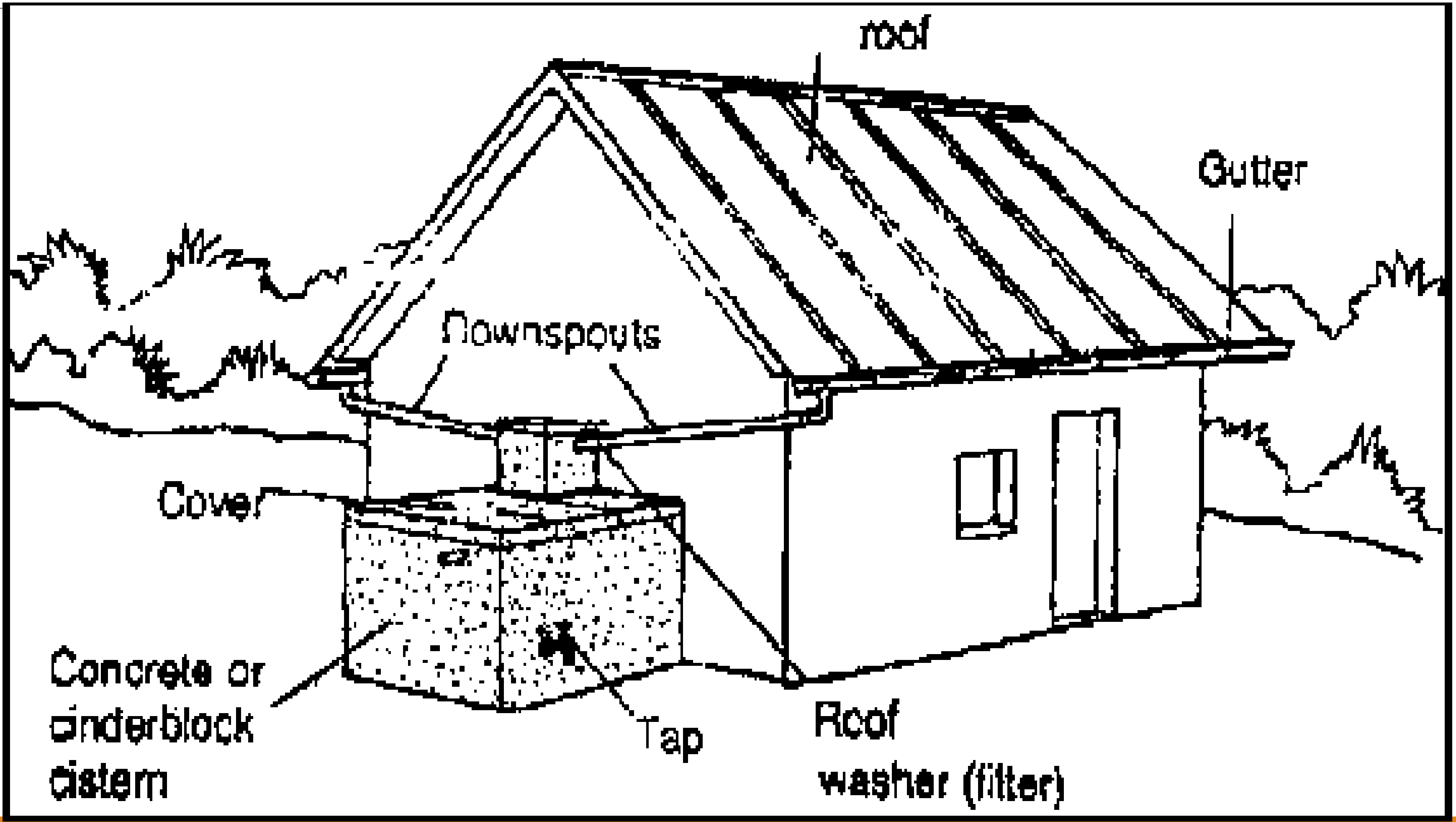
Harvesting rainwater has several functions:

- Providing water to people and livestock
- Providing water for food and cash crops
- Increasing groundwater recharge
- Reducing storm water discharges, urban floods and overloading of sewage treatment plants reducing seawater ingress in coastal areas

Roofs are preferred because

- Elevated catchment surface (free from contamination and ease for gravity flow)

Rainwater Roof catchment system (RRCS)



Where we use R.R.C.S.?

- We use R.R.C.S. under either of the following case(s)
  - Where ground water is contaminated by salt intrusion and runoff in streams is minimal.
  - Where there is limited rainfall, poor river quality and distance between individual consumers make this attractive option
  - Where annual rainfall is plentiful but a long dray season exists
  - Where clean water is needed for drinking purpose

The roof catchment are selectively cleaner when compared to the ground level catchment

- Losses from roof catchment are minimum
- Built & Maintained by local communities
- No Chemical contamination & only required filtration
- Available at door step with least cost

Rain water harvesting-Advantage

1. Provides self-sufficiency to water supply
2. Reduces the cost of pumping of ground water
3. Provides good quality water
4. Reduces soil erosion and flooding in urban areas
5. Less expensive & easy to construct, operate and maintain
6. The system is independent, so suitable for scattered settlement
7. Valuable time is saved in collecting water

Rain water harvesting-Disadvantage

1. High initial/capital cost

2. Water availability is limited by rainfall and roof area

3. Mineral free water has a flat taste

4. Mineral free water may cause nutrition deficiency

The typical roof top rain water harvesting system Components

a) Roof catchment (Collection surface)

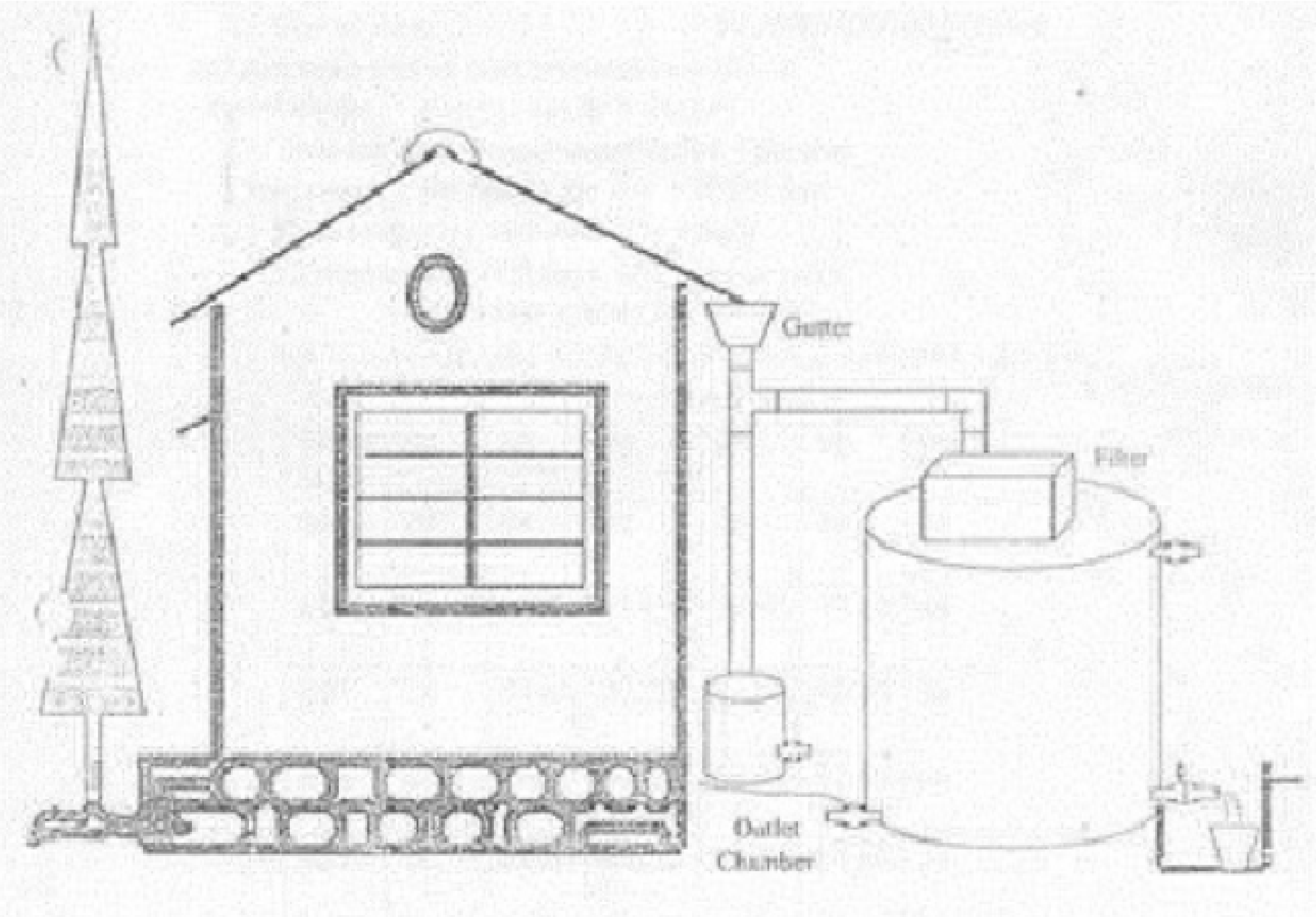
b) Gutters

c) Down pipe & first flushing pipe

d) Filter Unit

e) Storage Tank

Components of roof top rain water harvesting system



Collection surface

- The surface that receives rainfall directly is the catchment of rainwater harvesting system

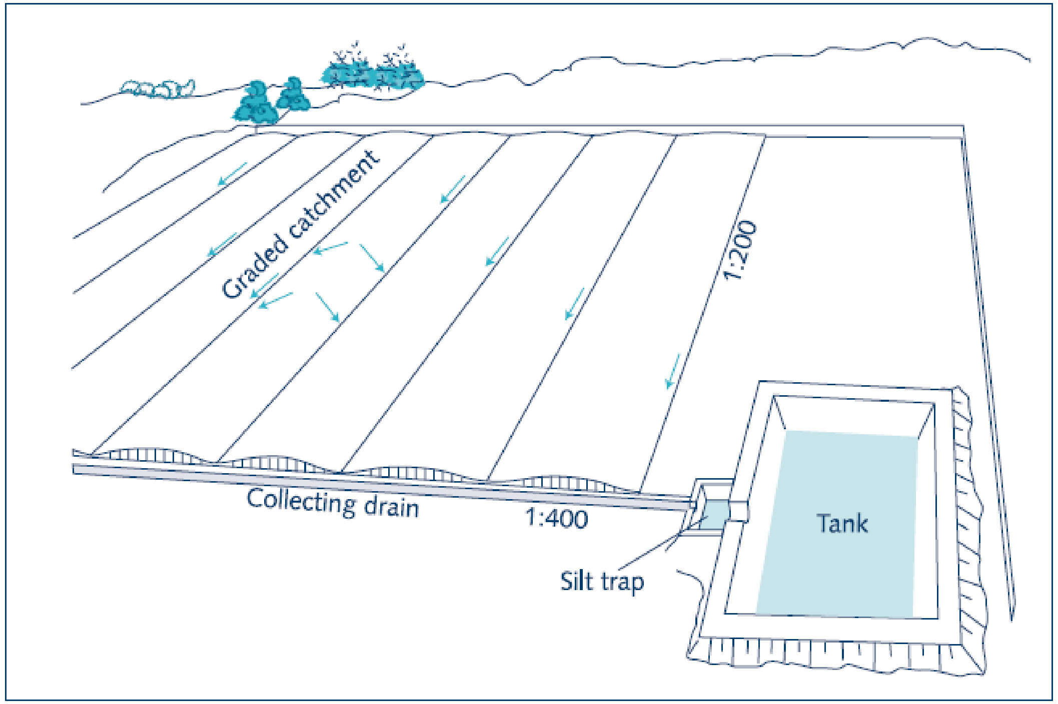
Roof of a house/dwelling

- For domestic rainwater harvesting the most common surface for collecting water is the roof of the dwelling
- Reasonably pure rainwater can be collected from house roofs made of tiles, slates, (corrugated) galvanised iron, aluminium or asbestos cement sheeting
- Most thatched roofs are not suitable because of the colouring and increased turbidity of the water caused by organic material
- Plastic sheeting is economic but often not durable
- Painting the roof for water-proofing may impart taste or colour to the collected rainwater, and should be avoided

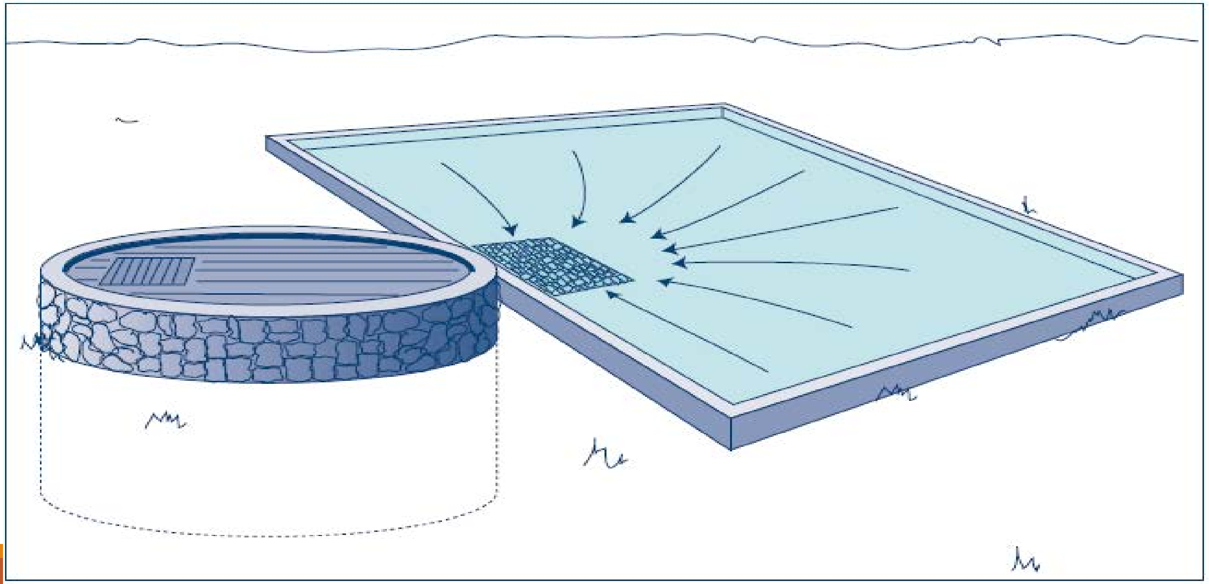
Ground catchment

- Used for collecting rainwater run-off
- Part of the rainfall will be lost as it serves to wet the ground, is stored in depressions, or disappears through evaporation
- Laying tiles, concrete, asphalt, or plastic sheeting to form a smooth impervious surface on the ground can reduce such losses considerably
- Harvesting ranges from about 10% for a pervious, flat ground catchment, to some 90% for a sloping strip catchment covered with impervious materials.

Simple roof catchment and storage



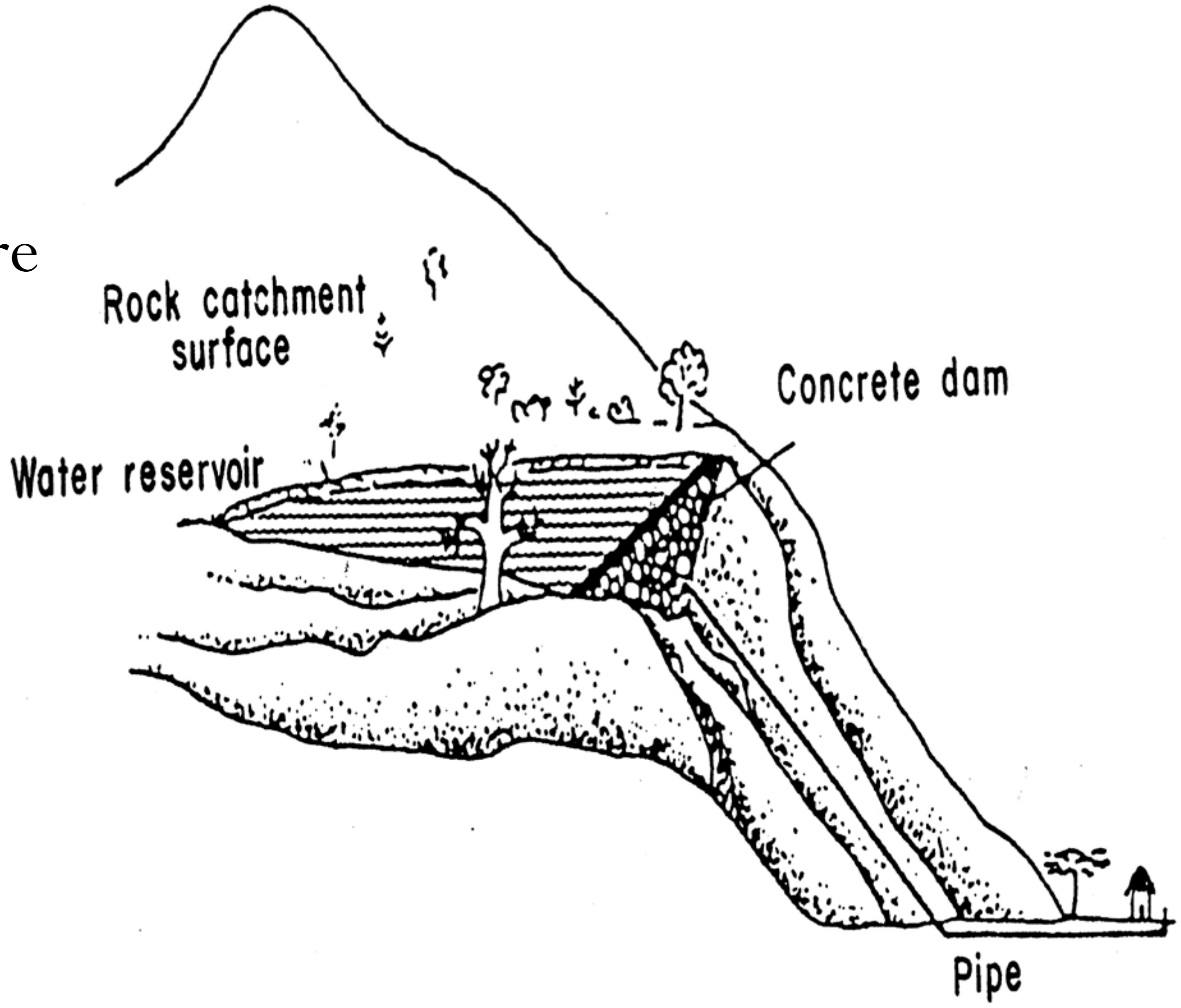
Large ground catchment



Small ground catchment

Rock Catchment System

- ✓Run-off water intercepted by the rock is channeled through stone gutters and bunds across contours of the slopes to reservoirs where water is stored for use.
- ✓From the reservoir, water may be channeled by gravity to communities living downstream
- ✓The type, size and shape of the storage facility depend on site characteristics and water demands



Construction

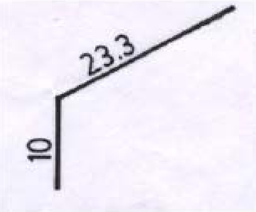
- Roof: it have to be from appropriate material, sufficient surface area and adequate slope
  - Horizontal dimensions are considered for area calculation

Transport of rainwater (Gutters)

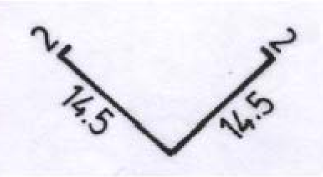
- Gutters are channels fixed to the edges of roof all around to collect & transport the rainwater from the roof
- Guttering comes in a wide variety of shapes and forms, ranging from the factory type made of PVC, zinc, copper or aluminum to home-made guttering using bamboo, ferro-cement, timber or folded metal sheets
- Use of locally available material reduce the overall cost of the system
- The roof guttering should slope evenly towards the down-pipe (at 0.8-1% slope)

Construction

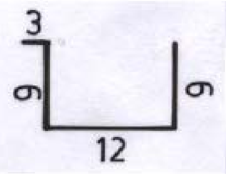
- A good gutter material should be:-
  - Light in weight
  - Water resistance and
  - Easy to join
- It can be from Bamboo, Wood and sheet metal.
- Metal Gutters are most durable and require the least maintenance but expensive
- Bamboo and wood gutters are widely available and inexpensive, but they will deteriorate
- A properly fitted and maintained gutter-downpipe system is capable of diverting more than 80% of all runoff into the storage tank, the remainder being lost through evaporation, leakage, rain splash and overflow



Splash-guard.



V-shaped gutter.



Square gutter.

Semi-circular gutter.

V-shaped gutter suspended from a splash-guard.

Square gutter fixed without splash-guard.

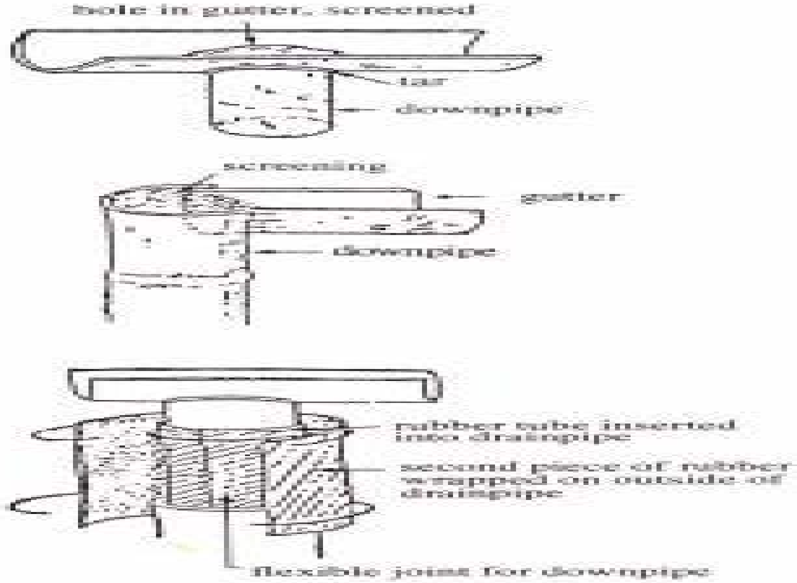
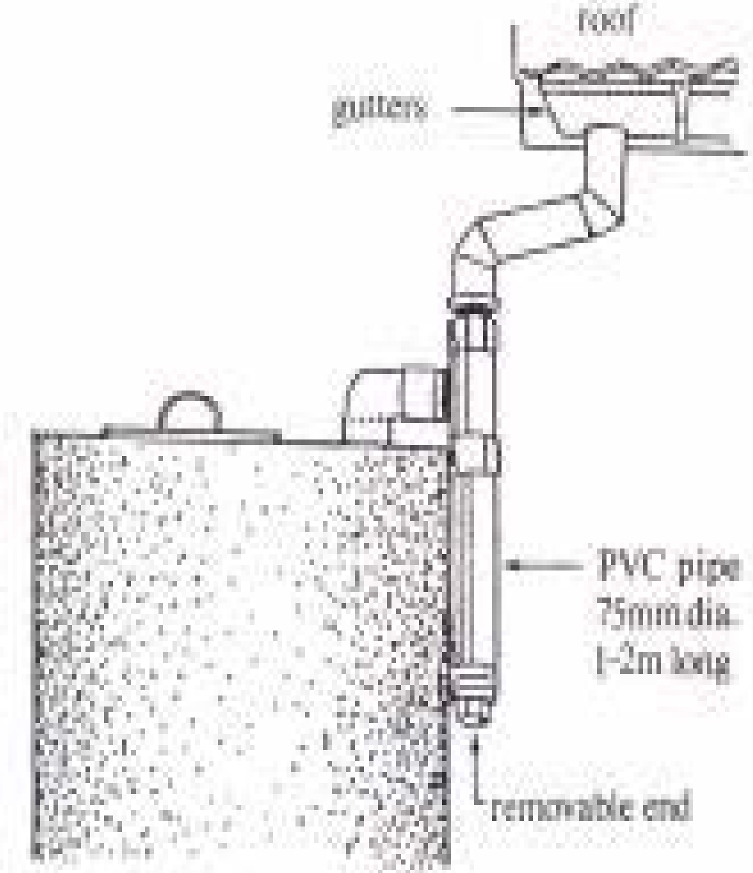


Figure 9: First Flush Trap[1]



Run-off coefficient

- The run-off coefficient is the ratio of the volume of rainwater that runs off a surface to the volume of rainwater that falls on that surface
- This includes also losses from spillage in the gutter system
- A properly fitted and maintained gutter down-pipe system is capable of diverting more than 90% of all rainwater run-off from a good roof catchment made of corrugated iron into the storage tank but the long-term collection efficiency is usually between 80 and 90%

Run-off coefficients for selected surfaces

Roof catchments	
Sheet metal	0.8-0.9
Cement tile	0.60-0.70
Clay tile (machine made)	0.30-0.40
Clay tile (hand-made)	0.25-0.30
Ground catchments	
Concrete-lined	0.75
Cement soil mix	0.30-0.40
Buried plastic sheet	0.30-0.35
Compacted loess soil	0.10-0.20

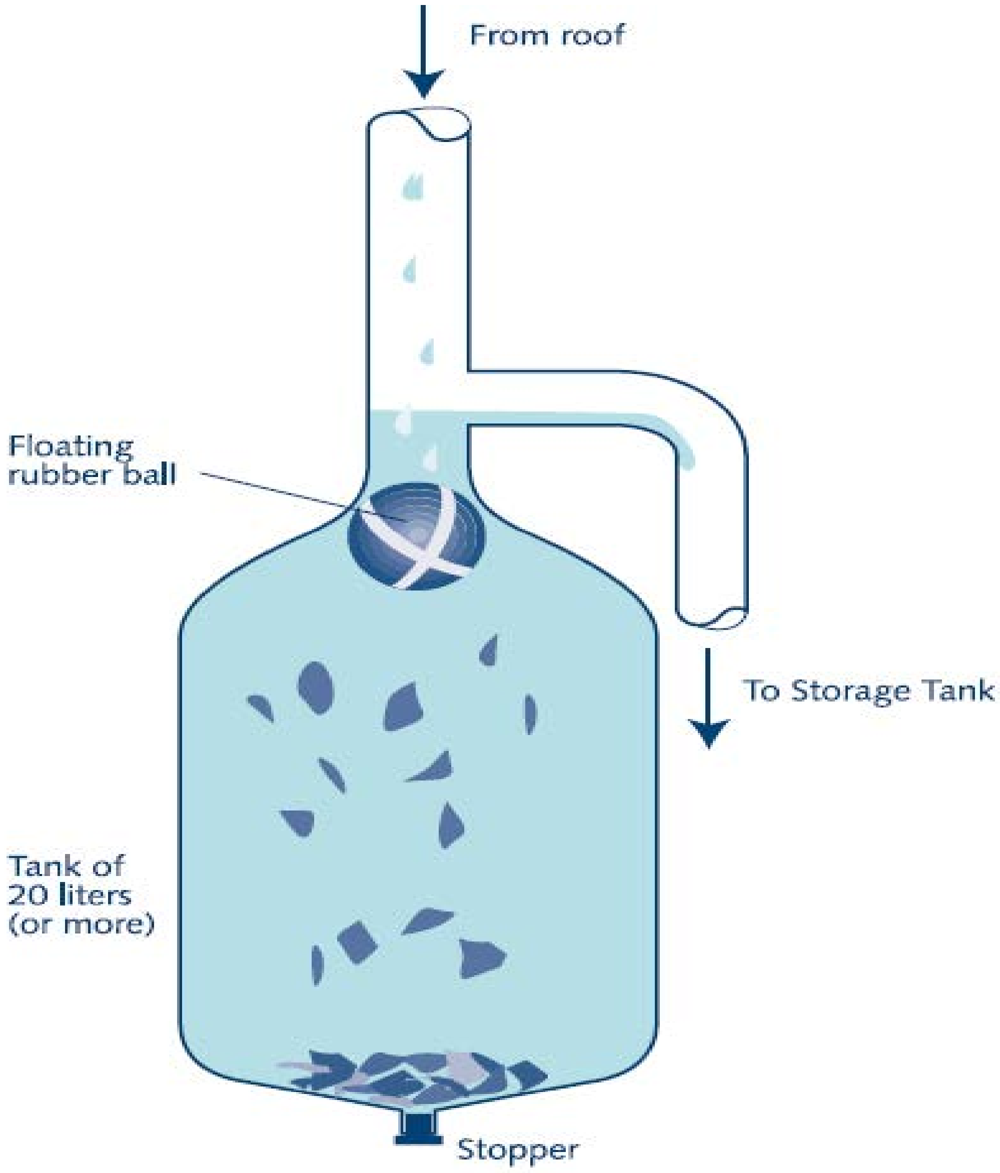
Down pipe & first flushing pipe

Down Pipe

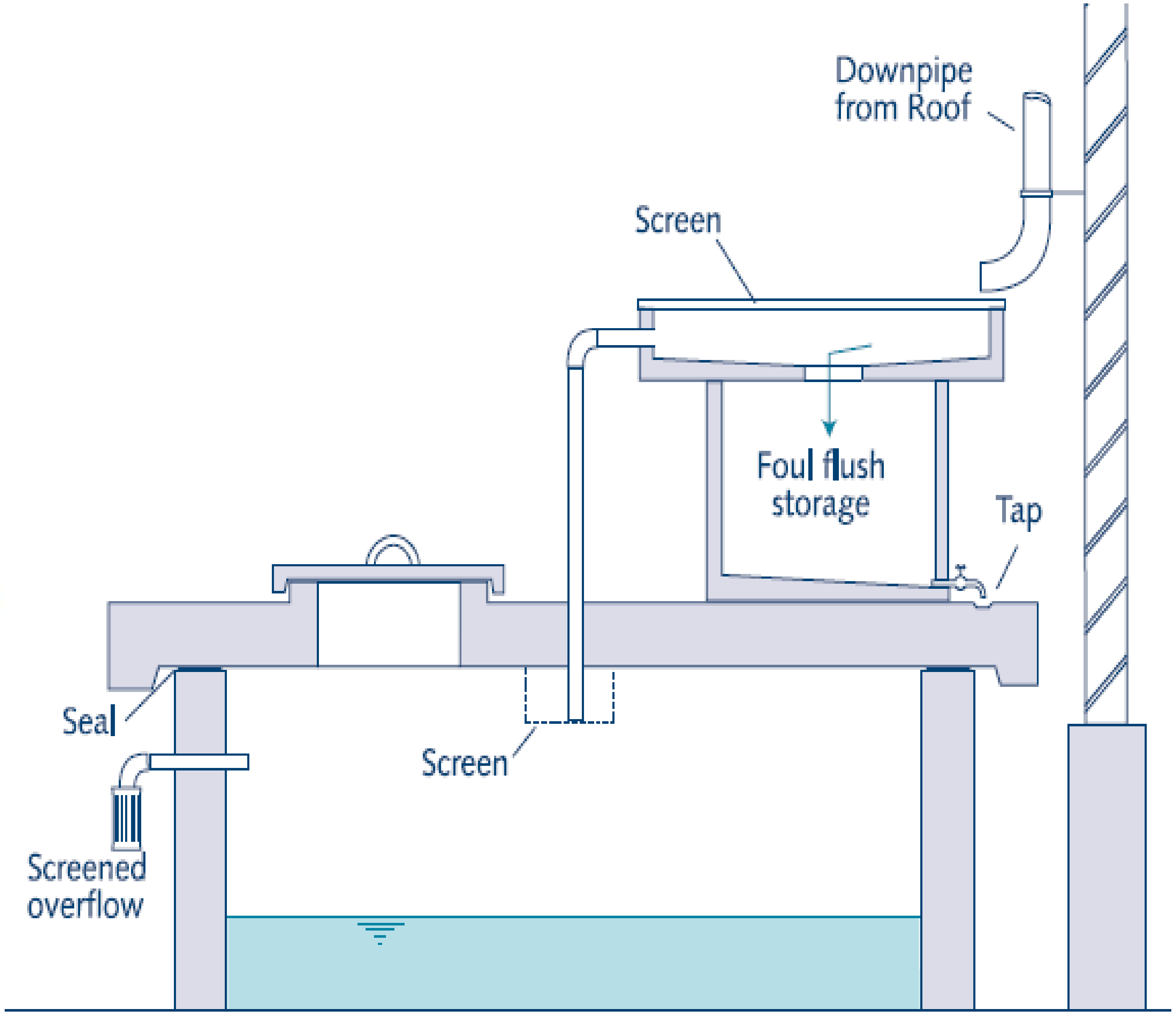
- It is the pipe which carries the rainwater from the gutters to the filter & storage tank.
- Down pipe is joined with the gutters at one end & the other end is connected to the filter unit of the storage tank.
- PVC or GI pipe of 50 mm to 75mm are commonly used for down pipe.
- Bamboo can be also used wherever available and possible

First Flush Pipe

- Dust, dead leaves and bird droppings will accumulate on the roof during dry periods.
- When the first rains arrive, this unwanted matter will be washed into the tank. This will cause contamination of the water and the quality will be deteriorated.
- Many RWH systems therefore incorporate a system for diverting this 'first flush' or 'foul flush" water so that it does not enter the storage tank.
- The first water from each shower (the "foul flush") can be diverted from the clear water container and allowed to run to waste
- To safeguard the quality of the collected rainwater, the roof and guttering should be cleaned regularly
- The simplest way of diverting the first flush is to turn the inflow pipe away from the inlet of the storage tank, and put it back when the water is clean



Simple first flush diversion system



Arrangement for diverting the first foul flush

Filter Unit

- After first flushing of rainfall, water should pass through filters or directly stored in tank and filter before use
- The filter unit is a container or chamber filled with filter media such as coarse sand, charcoal, coconut fiber, pebbles & gravels to remove the debris & dirt from water that enters the tank.
- The filter unit is placed over the storage tank or separately.

Storage Tank

- It is used to store the water that is collected from the roof through filter
- For small scale water storage plastic buckets, jerry cans, clay or cement jars, ceramic jars, drums may be used
- For larger quantities of water, the system will require a bigger tank with cylindrical or rectangular or square in shape
- The storage tank is provided with a cover on the top to avoid the contamination of water from external sources

Requirements are:-

- ✓ It have to be appropriate to local condition
- ✓ It have to be Water tight
- ✓ It have to be below the eave of the house
- ✓ It have to be well covered
- ✓ It need to have manhole, over flow pipe , entry pipe and tap at the bottom

Storage tanks are classified as

- In general, there can be two basic types of storage system
  i. Above-ground storage tanks and
  ii. Cisterns or underground storage
- ✓ The choice of the system will depend on several technical and economic considerations like, space availability, materials and skill available, costs of buying a new tank or construction on site, ground conditions, local traditions for water storage etc.
- ✓ The storage tank is the most expensive part of any RWH system and the most appropriate capacity for any given locality is affected by its cost and amount of water it is able to supply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Size of Storage Tank (Storage capacity)

- When using rainwater, it is important to recognize that the rainfall is not constant through out the year; therefore, planning the storage system with an adequate capacity is required for constant use of rainwater, even during the dry period.
- Knowledge of the rainfall quantity and seasonality, the area of the catchment surface and volume of the storage tank, and quantity and period of use required for water supply purposes is critical.
- There are **two** commonly used method to estimate storage requirements.

Method 1 – Storage required for dry period

A rough estimate of the maximum storage requirement can be made based on the:

(i) Per capita consumption

(ii) Number of users and

(iii) Length of the longest dry period

Example

Drinking water requirement for a household with 5 family members, assuming water use of 20 lpcd and if longest dry period is 30 days and rainwater is the only water source,

Storage required = 5 x 20 x 30 = 3000 litres

✓ It is a method for acquiring rough estimates of tank size.

Method 2 – Based on rainfall and water demand pattern

- A better estimate of storage requirement can be made using the mass curve technique based on rainfall and water demand pattern.
- Cumulative rainfall runoff and cumulative water demand in year is calculated and plotted on the same curve.
- The sum of the maximum differences, on the either side, between the rainfall curve and water demand curve gives the size of the storage required

Example 2

Calculate the size of the storage tank required for a school with 65 students and 5 staff, assuming average water consumption of 5 liters/day.

Roof area = 200 m^2.

Assume runoff coefficient of 0.9.

The rainfall pattern in the area is given in the table below

Average daily demand = 70 x 5 = 350 liters

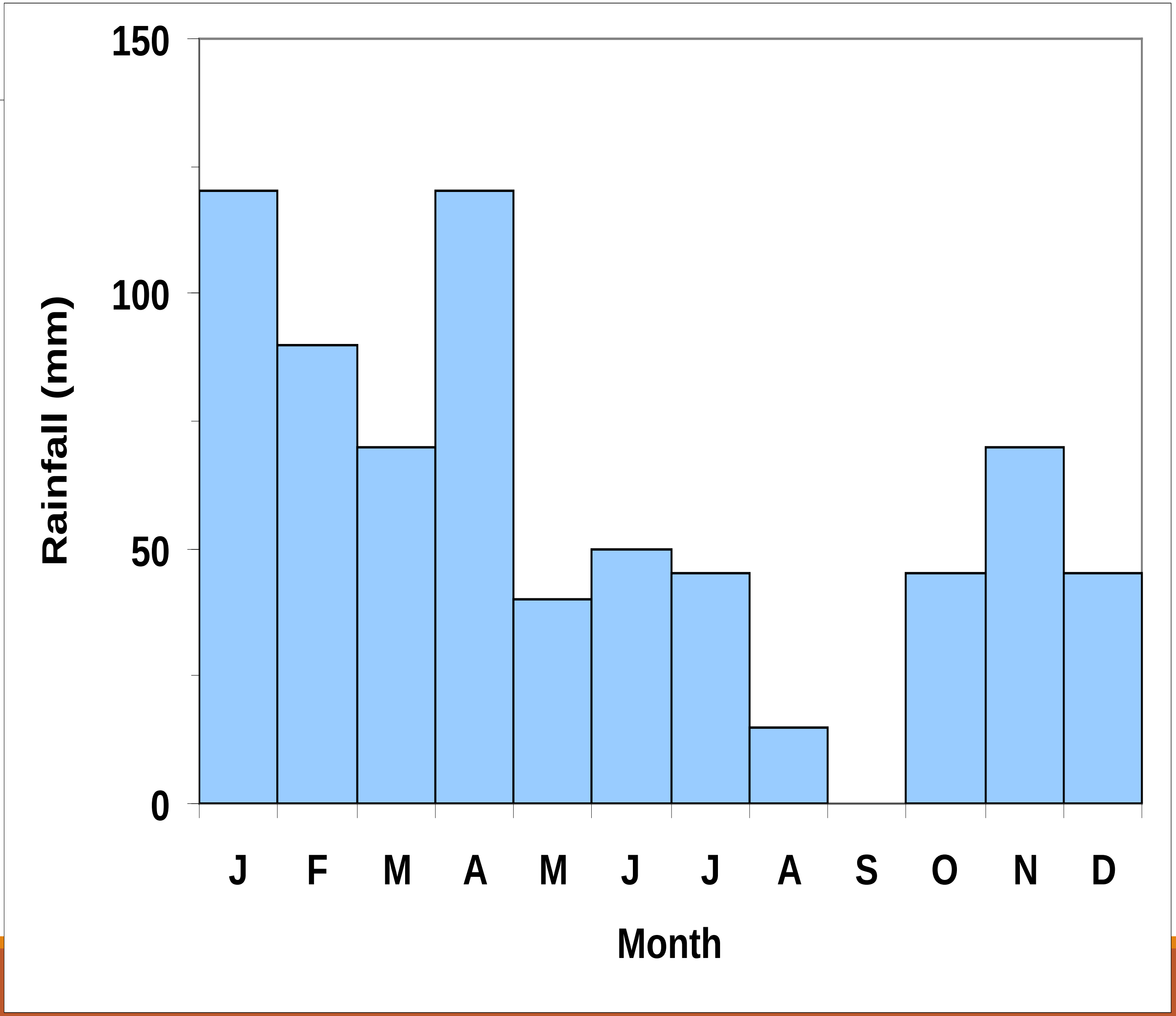
Yearly demand = 350 * 365 = 127750 liters = 127.75 m^3

Average monthly demand = 127.75/12 ~ 10.65 m^3

Storage capacity calculations

(a) Rainfall pattern - I

Month	Rainfall mm
Jan	120
Feb	90
Mar	70
Apr	120
May	40
June	50
July	45
Aug	15
Sep	
Oct	45
Nov	70
Dec	45

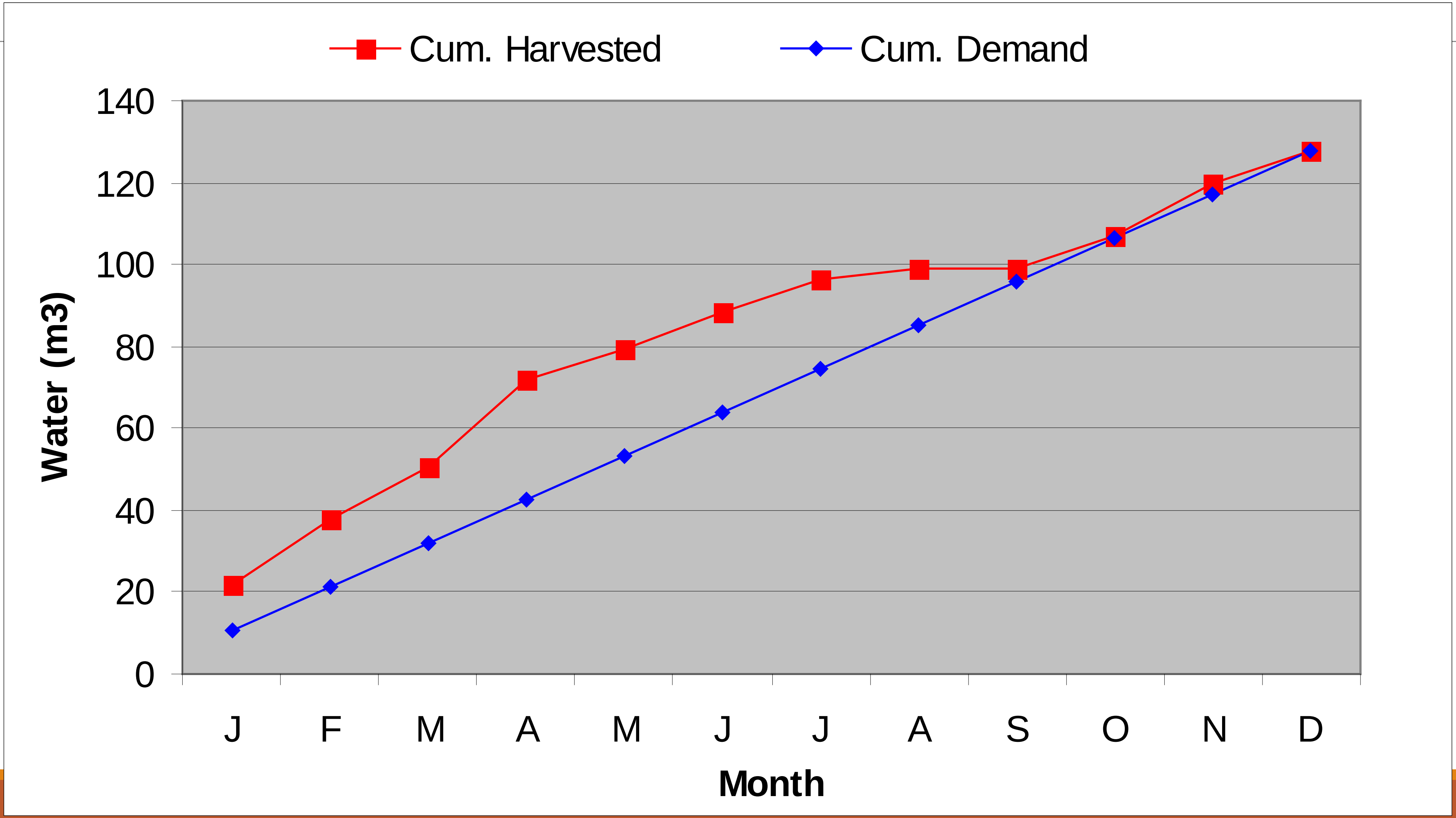


Calculation of required storage capacity

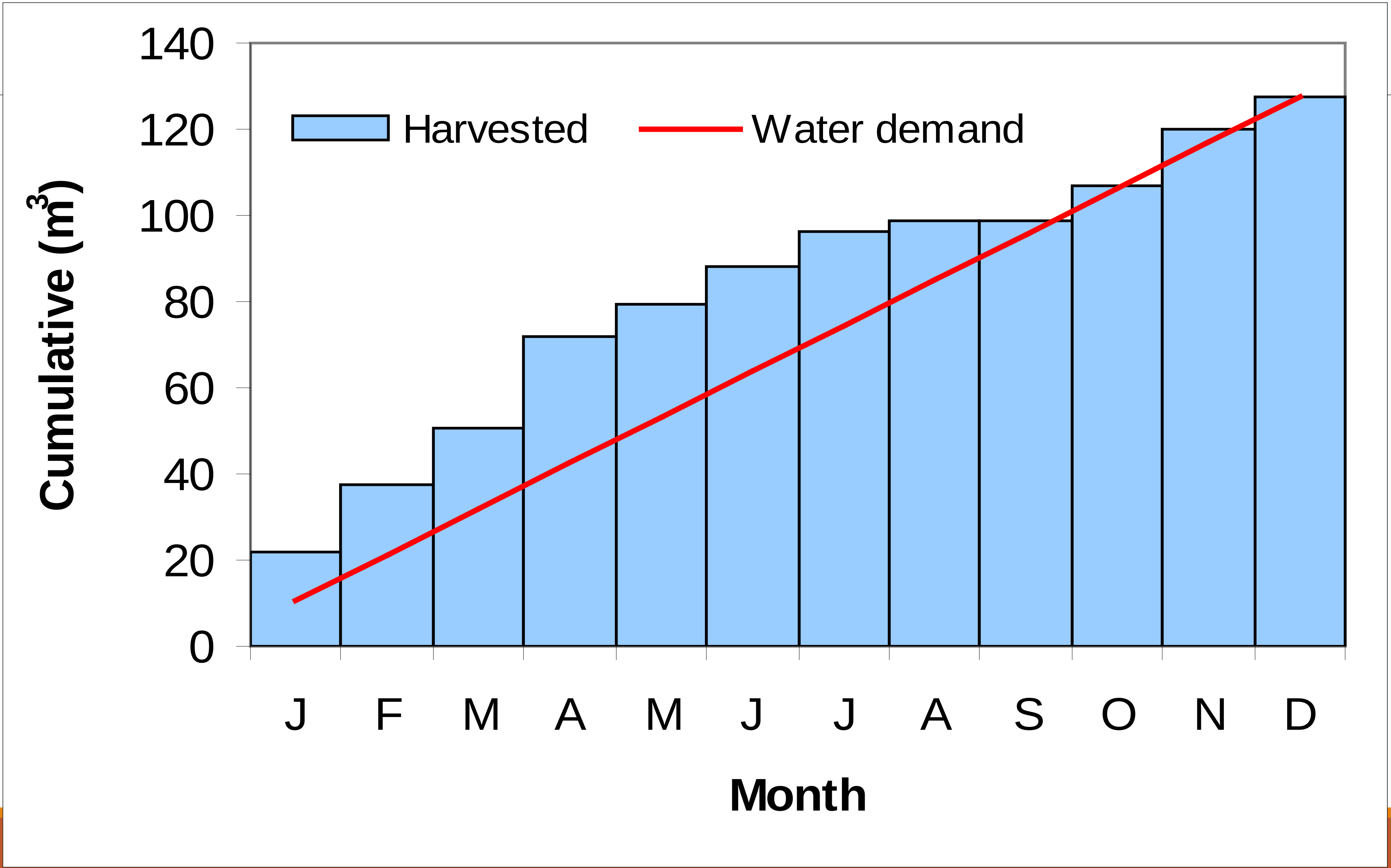
Month	Rainfall (mm)	Rainfall Harvested (m^3)	Water demand (m^3)	Com. Rainfall Harvested CH (m^3)	Com. Water demand CD (m^3)	Difference CH-CD (m^3)
J	120	21.6	10.65	21.6	10.65	10.95
F	90	16.2	10.65	37.8	21.3	16.5
M	70	12.6	10.65	50.4	31.95	18.45
A	120	21.6	10.65	72	42.6	29.4
M	40	7.2	10.65	79.2	53.25	25.95
J	50	9	10.65	88.2	63.9	24.3
J	45	8.1	10.65	96.3	74.55	21.75
A	15	2.7	10.65	99	85.2	13.8
S		0	10.65	99	95.85	3.15
O	45	8.1	10.65	107.1	106.5	0.6
N	70	12.6	10.65	119.7	117.15	2.55
D	45	8.1	10.65	127.8	127.8	0

Required storage capacity = 29.4 m^3 say 30 m^3

Mass curve for calculation of required storage capacity

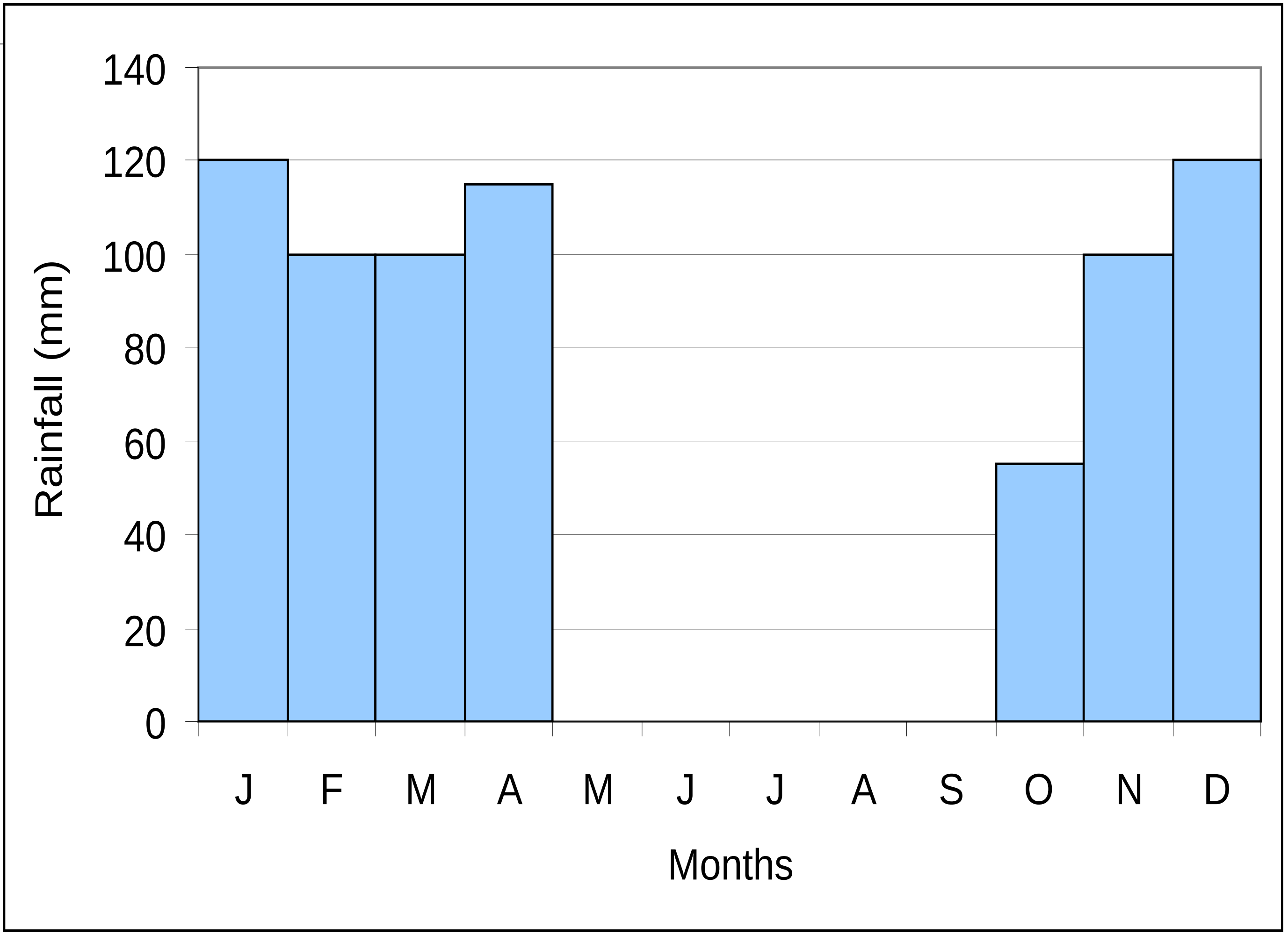


Mass curve for calculation of required storage capacity



(b) Rainfall pattern - 2

Month	Rainfall mm
Jan	120
Feb	100
Mar	100
Apr	115
May	
June	
July	
Aug	
Sep	
Oct	55
Nov	100
Dec	120



Calculation of required storage capacity

Month	Rainfall (mm)	Rainfall Harvested (m3)	Water demand (m3)	Com. Rainfall Harvested CH (m3)	Com. Water demand CD (m3)	Surplus CH-CD (m3)	Deficit CH-CD (m3)
J	120	21.6	10.65	21.6	10.65	10.95	
F	100	18	10.65	39.6	21.3	18.3	
M	100	18	10.65	57.6	31.95	25.65	
A	115	20.7	10.65	78.3	42.6	**35.7**	
M	0	0	10.65	78.3	53.25	25.05	
J	0	0	10.65	78.3	63.9	14.4	
J	0	0	10.65	78.3	74.55	3.75	
A	0	0	10.65	78.3	85.2		6.9
S	0	0	10.65	78.3	95.85		17.55
O	55	9.9	10.65	88.2	106.5		**18.3**
N	100	18	10.65	106.2	117.15		10.95
D	120	21.6	10.65	127.8	127.8	0	0

Required storage capacity = 35.7 + 18.3 = 54 m^3

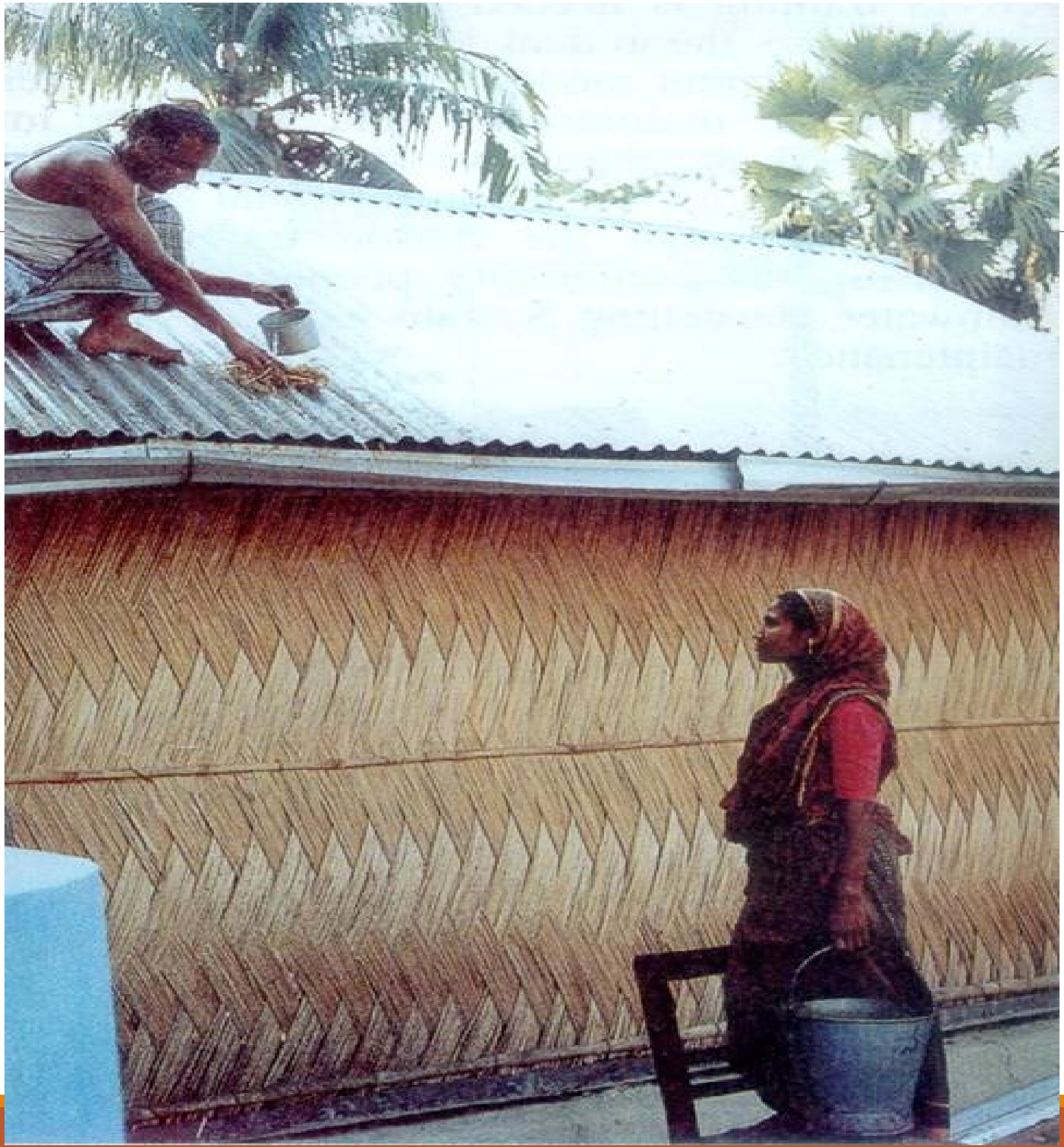
Quality Aspects of RWH

Quality of Rainwater

- The quality of rainwater is relatively good but it is not free from all impurities.
- Analysis of stored rainwater has shown some bacteriological contamination.
- The rainwater is essentially lacking in minerals, the presence of which is considered essential in appropriate proportions.
- Cleanliness of roof and storage tank is critical in maintaining good quality of rainwater.
- The storage tank requires cleaning and disinfection when the tank is empty or at least once in a year.

Quality of Rainwater - Bacteriological

- Dust from the soil, and droppings of birds and animals could be the source of contamination by the bacteria.
- When first flush eliminating devices are absent, all the indicator bacteria are generally present in water samples in numbers beyond what is acceptable by any standards.
- Tree hanging in the vicinity, definitely enhances the possibility of contamination due to increased access of the roof to birds and animals. Also leaves contribute to organic loading of the water samples, which in turn act as nutrient for bacterial growth.



Disinfecting rainwater

- **Rainwater** is generally of very good chemical quality. However, it may not meet WHO drinking water quality standards, specifically microbiological quality standards, hence some disinfection is recommended.

- Rainwater can be used for drinking, if it is clear, has no or very little taste or smell and is from well maintained system.

Disinfection can be done by:

- ✓ boiling the water in before consumption
- ✓ adding chlorine compounds/bleaching powder in required quantity to the water stored in the tank
- ✓ using slow sand filtration
- ✓ solar disinfection (SODIS)

Operation and maintenance

- The simple operation and maintenance of RWH systems is one of the most attractive aspects of the technology.

- The extent of maintenance required by a basic privately owned household RWH system includes
  - Regular cleaning of the roof tops and gutters
  - Frequent cleaning of storage tanks
  - Inspection of gutters and feeder pipes and valve chambers to detect and repair leaks

- When ground catchment is used for collection and/or ground tank is used for storage, proper fencing of both is recommended to keep the children and animals away, thus avoiding contamination and risks of falling into the tank.

Thankyou Very much…

Chapter 5:

Gravity flow water supply system

Introduction

- A major problem in providing adequate amounts of clean water is that safe water is often available only at considerable distances from people's houses.
- Often many hours are needed to carry the water to the home.
- The gravity flow system is the action of gravity is used to move the water downhill from a source to the village.

Intro…..

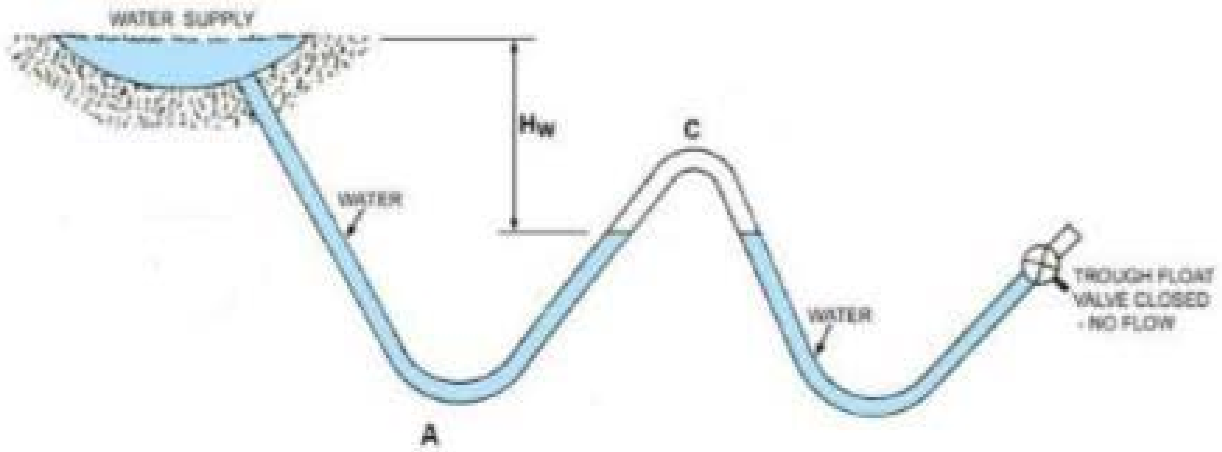
- An intake structure is built to collect the water, which is then piped down to the village through a buried pipeline of High-Density Polyethylene (HDP) pipe
- If needed, a reservoir tank is built above the village. From there, the water is distributed to several public tapstands that are scattered throughout the village, via the mainline, branchlines, and taplines.

The components of a gravity-flow water system are:

- **An elevated source of water**, particularly a spring, or clean river, or stream. In all cases the source should be protected to prevent contamination.
- **A sedimentation tank** (if necessary) near the source which allows suspended solids to settle out of the water.
- **The main pipeline** which transports the water to where it is distributed.

Cont…

- **District reservoirs** that may be required to store water overnight for peak use during the day time.
- **Pipe networks** that distribute the water to the **standpipes.**
- **Standpipes** where the water is made available to the people.
- **Washout valves,**
- **Air release valves** and
- **Break pressure tanks.**



Advantage of GFWS

- A gravity-flow water system requires no energy to operate. Therefore, the O&M is simple.
- Water is delivered when required, close to the user's home.
- Gravity-flow water systems can be built by the village people themselves, if trained and project supervisors are provided.
- Systems of different sizes can be built for different numbers of people. Small systems can serve single households and large ones will serve many villages or towns.

Disadvantage of GFWS

- Usually water quality depends on the quality of water of the source, but if sufficiently clean water is not available, additional treatment facilities may have to be built at additional cost.
- Available sources of water may not provide adequate amounts of water throughout the year. Systems should not be built to handle greater flows than what is available. More abundant sources at a greater distance should be considered.
- **Water rights** cause problems in some areas as villages near the source may object to having "their" water piped to villages below them.
- Gravity-flow water systems do require regular basic maintenance, especially the care of the taps.

Design Procedure

The following steps describe the order of events required to carry out the design of a system

1. Locate a reliable and clean sources

- ✓ A source investigation
- ✓ The intake for the water has to be carefully built
- ✓ a spring box
- ✓ Underground springs need to be covered and
- ✓ surface springs need to be fenced off
- ✓ If the source is a stream the location must be chosen to be as free of contamination as possible.
- ✓ If the water is contaminated, a water treatment system may be installed.

2. Determine consumption of water per person per day

- Per capita demand is the amount of water required by one person.
- Usually the amount used per person per day is determined by a survey of the users.
- An estimate for each use such as drinking, cooking and washing is made, and additional uses such as livestock watering are added in.
- The demand will vary from region to region as it depends on local custom, availability of water, and the uses for piped water.
- Typical values of demand are between 15 and 50 litter per day

3. Establish the locations of standpipes

- It should be done with the advice of the users through the Community Committee.
- The standpipes can be located in common areas to serve a large number of households
- Standpipe locations should be established in order to serve about 100-200 people each
- Additional taps are needed at institutions.
- For high density areas, large standpipes with many taps may be built.
- Taps should be kept away from streams and rivers

4. Determine flow per tap

- The present population is estimated using the collected data and allowance is made for an appropriate increase per year due to possible migration into the area and other population changes.
- The lifetime of the project is estimated. 15 years is suggested, but the maximum is probably 25 years.
- These figures will give the design population of the area.
- Water usage for schools, health centers and other institutions need to be included in the estimates.

5. Choose the Pipe alignment

- With the location of standpipes decided, the location of the pipeline system can be finalized.
- A steady gradient should be maintained wherever possible.
- The length of pipeline should be kept to a minimum.
- Avoid pipeline alignments which will require constant maintenance i.e. steep hillsides and numerous stream crossings.
- Finally, avoid crossing land where legal access cannot be acquired or any land that is outside the control of the government or the user community.

6. Design the main Pipeline

➢ **Polyvinyl Chloride (PVC)**

Fairly low-cost

❖ It can be carried to the site manually or by small vehicles.

❖ Class 10 (max. 100m head) is the recommended minimum class of pipe.

❖ To prevent cracking due to contraction upon cooling in the ground, the pipe should be laid and buried in the morning and laid loosely in the trench

❖ (Hazen's C = 150).

High-density polyethylene (HDPE)

Expensive than PVC.

Maximum head is 60m.

- It comes in 100m flexible rolls and thus it has fewer joints than PVC
- The rolls are heavy and are more expensive to transport by truck, but easier to move around the site than PVC.

Joints are made by applying solvent or heat.

Care must be taken in unrolling it and a check must be made for internal blockages (Hazen's C = 150).

➢ Asbestos Cement (AC)

- ✓ It is the cheapest pipe over 100mm in diameter, but it is not available
- ✓ It is Very easy to clean and maintain and difficult to transport and repair.
- ✓ Class 18 (maximum 90m of head) is recommended as the minimum standard.
- ✓ Jointing is easy and the joints have flexibility (upto 10 degree in Ac coupling) to obtain satisfactory joint. (Hazen's C = 130).

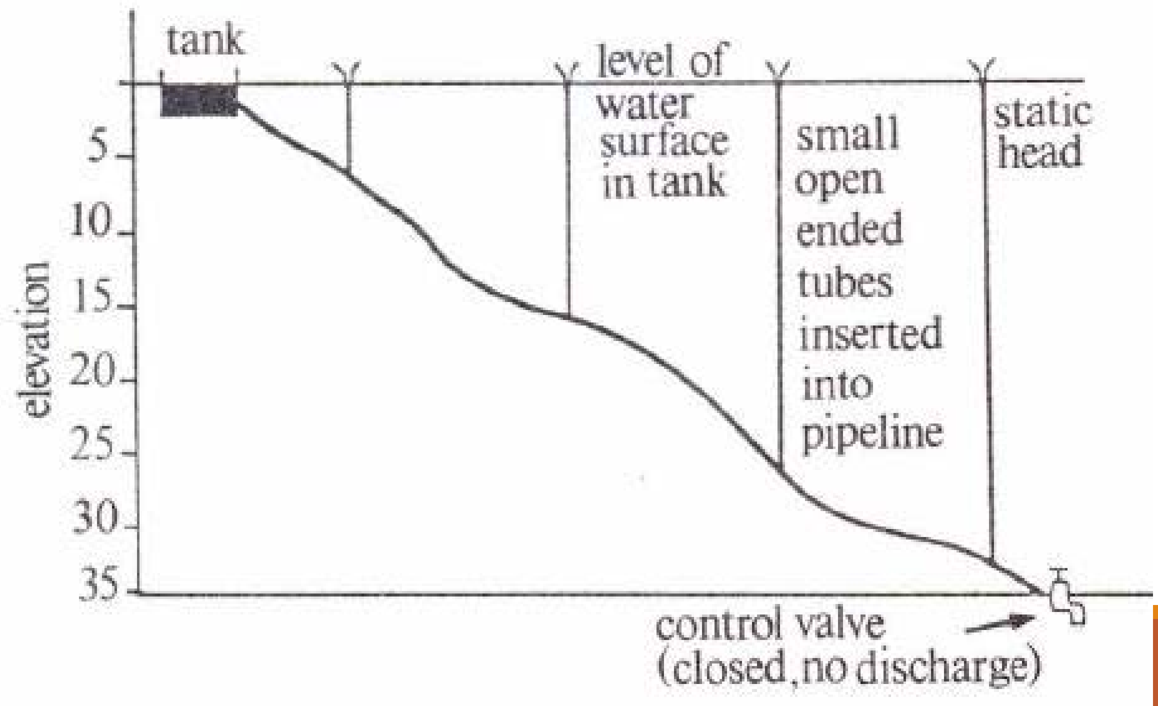
➢ Galvanized iron (GI)

- ✓ It is expensive to buy, hard to transport and subject to corrosion.
- ✓ It is used only where strength is required, such as sections with high hydraulic pressure, river and gully crossings, shallow sections under roads and pipe works at tanks (Hazen's C = 120 (new) - 80 (very old), average 100).

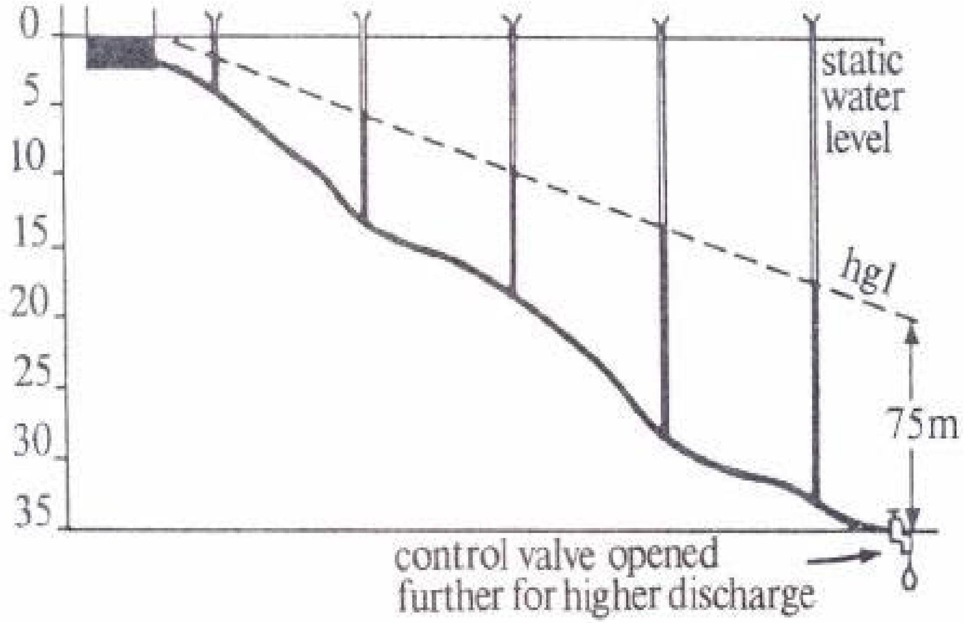
- The purpose of pipeline design is to control frictional losses so as to move the desired flows through the system, by conserving energy at some points and using energy at other points.

- This is done by a careful selection of pipe sizes and proper location of fittings and tanks

- The amount of gravitational energy in a pipeline is called a "**head**".



- At a tap or any point where water leaves the pipe, a minimum head of water is needed.
- The **desired** head is 10 - 30 meters in rural water supply systems, With the suggested minimum and maximum values of 7 and 55 meters respectively.
- Some times during the day, the tap and the system will have to supply more than this average flow



$$P.F. = \frac{\text{maximum hourly flow}}{\text{average hourly flow}}$$

$$\text{design flow} = P.F. \times \text{average flow}$$

7. Calculate reservoir and sedimentation tank dimensions

❖ Reservoirs

- ✓ District reservoirs are placed high enough to give adequate pressure in the pipeline and are situated to divide the network into manageable areas.
- ✓ The decision to build reservoirs depends either on the flow rate of water from the source or its location.
- ✓ A reservoir is needed, if the source cannot supply all of the water needed in a working day, but can supply it in 24 hours.

Reservoir …

- A reservoir may also be installed to save money.
- A study should be undertaken to determine whether it is cheaper to:
  - Put in a large pipe from the source that would supply enough water in a working day, even during peak hours; or
  - Put in a reservoir to cope with peak demands and a smaller and cheaper pipe from the source to the reservoir.

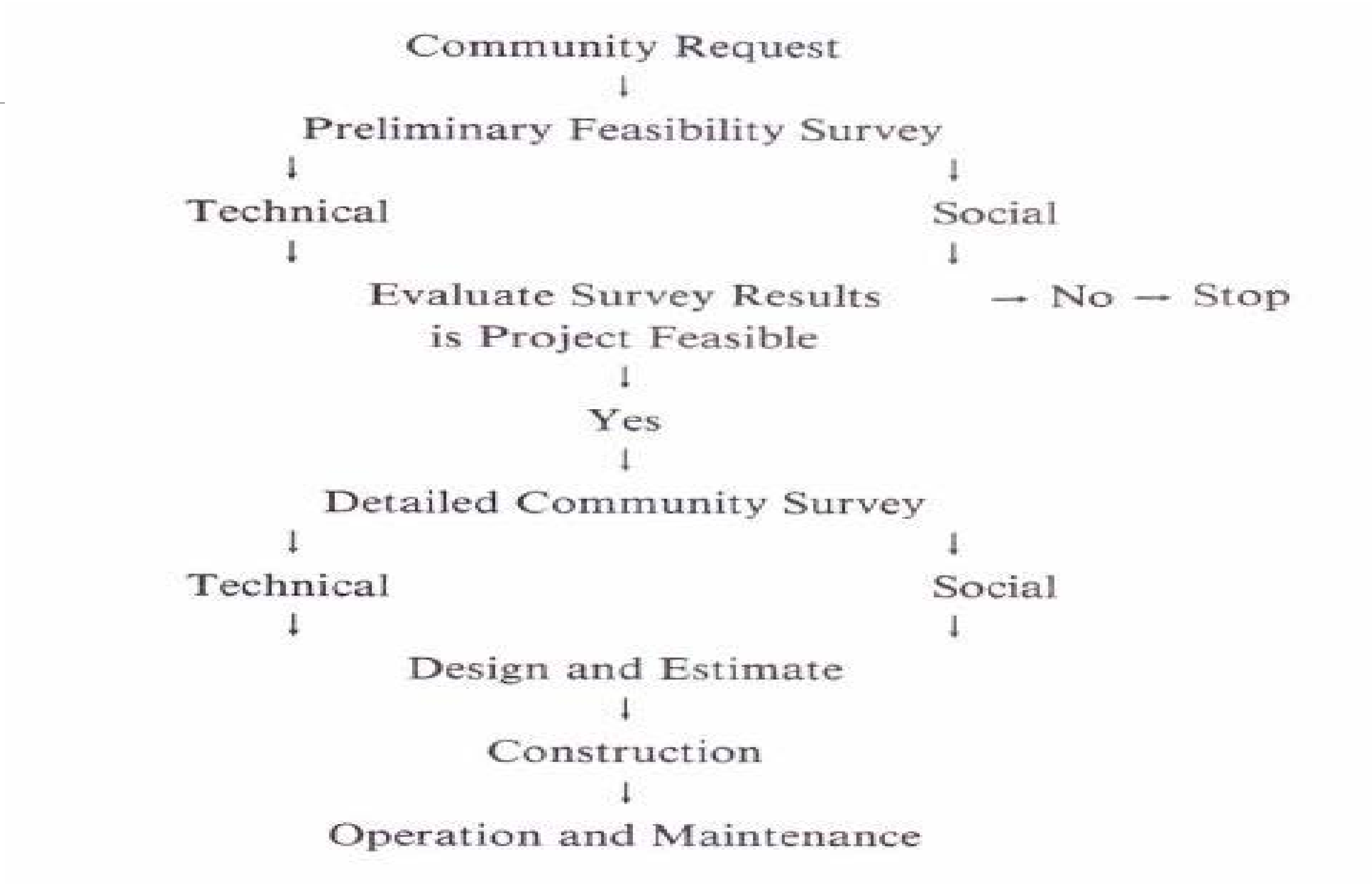
❖ The sedimentation tank

- ✓ This is a rectangular tank that calms the water to allow solids to settle out. It has a minimum volume of water equivalent to the amount of water flowing through it in two hours,
- ✓ A depth of 1m or more and a length to width ratio is 4: 1 or more.
- ✓ Water enters one end at half depth and is removed at the other end at the top.
- ✓ The tank can be built according to the most economical design available.
- ✓ Sedimentation tanks are never considered to be storage for design purposes, and so they are always kept full.

8. Locate air release valves, washouts and break pressure Tanks

- **Air release valves** are located at high points on the pipeline. They release air that collects in the pipe and prevent "air locks", large bubbles of air that block the flow.
- **Washouts** are located at low points, at the ends of pipe sections with low flows and at regular distances along the main pipeline.
  - These consist of a tee joint that has a cap or valve that can be opened to flush settled solids out of the pipe.
- **Break Pressure Tanks** These small tanks reduce the pressure in the pipe to atmospheric pressure. This is done when the pipe elevation is sufficiently below the source to exceed the pressure capacity of the pipe.
- **Valves** should be located at the inlet for every tank, and at every branch and change of pipe size.

Organization of a Gravity-Flow Water project



Cont……

1. Community request

- Communities should be well aware of the technology and its benefits through promotional work undertaken by the government.
- It can be in the form of a survey of the community showing the needs of the people and the input that they are willing to donate to the project.
- The community request should give an idea of whether:-
  - The community needs the technology
  - The technology is appropriate to the abilities and the social and cultural patterns of the community.
  - There is sufficient demand for the technology

2. Preliminary Feasibility survey

- ✓ A preliminary survey is made, It should have two objectives:-
  - To determine whether a gravity-flow water supply system is feasible or not.
  - To get a better understanding of the community structures and to evaluate whether the community request is a true indicator of community interest in the project.

❑ **Preliminary survey tasks:**

1. **Technical:-**
   - Visit all potential water sources
   - Assess the quality and flow of water
   - Attempt to estimate lowest dry season flow
   - Examine potential pipeline routes

2. Social:- **-** Discuss project with community leaders

- Estimate population to be served
- Assess potential of community participation
- If possible, Examine condition of past community participation projects

Design Example

Water demand for a region is 200,000 litres per day and a storage tank is to be built 2km from the water source. The vertical distance from the source to the tank is 20m. The minimum head of water at the outlet to the tank is 5m. Pipe is available in diameters of 25, 50 and 75mm. Assume the standpipes are in use 16 hours per day and the equivalent length for the pipe fittings is 38m. What is the size of the storage tank and what size of asbestos cement pipe should be used from the source to tank?

Time water taps not in use = 8 hours

$$\text{storage tank size} = \frac{8 \times 200{,}000 \text{ l.}}{24}$$

$$= 66{,}667 \text{ l.}$$

$$= 67\text{m}^3$$

Assume main pipeline supplies water continuously to the tank.

Flow rate in main pipeline is:

$$\frac{200{,}000}{24 \times 3600} = 2.31 \text{ l/s}$$

Hydraulic gradient

$$= \frac{\text{fall in elevation of HGL}}{\text{length of pipe minor loss length}}$$

$$= \frac{(20) - 5}{(2000 + 38)/1000} \text{ m/km}$$

$$= 7.4 \text{ m/km}$$

From Table 1, a 75mm diameter pipe is required as a smaller size would give too great a loss of head.

From Table 1, for 75mm asbestos cement pipe,

Flow (l/s)	Frictional Loss (m/km)
2.0	3.9
2.5	5.9

frictional loss is

$$\frac{2038 \times 5.1}{1000}$$

$$= 10.4\text{m}$$

and the height of the HGL above the water level in the tank is 20 - 10.4 = 9.6m which meets the design requirements of 5m minimum.

Thankyou Very much…