# 49. Choosing an appropriate technology

**The initial selection of an appropriate technology from a range of possibilities is the key to the successful operation of any facility — technologies are unlikely to function adequately if inappropriate choices are made at the outset. Although this is understood by many, people often underestimate how difficult the choice can be.**

This technical brief is intended as a guide to selecting the most appropriate options, taking as its example the selection of water-treatment facilities. It should *not* be seen as a guide for the design of individual treatment processes.

The process contained in this brief can be applied to the selection of single treatment facilities, or as a guide to the development of a *strategy* for a whole area. The process can be used both by people with direct responsibility for making the decisions, and also by other parties to ensure that the right issues are addressed by the decision-makers.

The method described below can be applied to any decision-making process — for example, to identify the technologies for a development project, such as a water supply, sanitation, or refuse-collection scheme.

## Case study: water treatment (see, for example, Schulz and Okun, 1984)

There are many different types of water-treatment process to choose from. Table 1 describes some of the more common. Many of the treatment processes used in the South, however, do not work properly.

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### Table 1. Common water-treatment processes

| Water-treatment process | Description | Comments |
|---|---|---|
| **Plain sedimentation** | Allows settlement of heavier particles, which may include much of the solid pollution, and animal (including some very small pathogenic (disease-causing) material). | Very simple and requires no power or chemicals. At its most basic, can be simple storage. |
| **Roughing filter** | Filtration though a coarse bed of gravel or coarse sand. | Good for removal of major solid particles and for highly turbid waters. |
| **Slow sand filter** | Filtration through a sand bed. Slow flows through the bed ensuring the build-up of a biological layer on the surface of the sand which is an essential part of process. | Removes solid materials and pathogens effectively. Simple to operate. Requires no backwashing of sand to clean — usually only drainage of water and scraping off top biological layer when filtration rate is too slow. |
| **Rapid sand filter** | Faster filtration rates through a sand bed — does not have biological-growth layer. | Removal of pathogens not as good as slow sand filter. Requires cleaning by backwashing — passing of water up through filter to remove solid particles that are blocking the flow. Sometimes cleaning by air scouring is also necessary. |
| **Aeration** | Water aerated, usually by artificial means — a mechanical device in the tank agitates water — or by spraying. | Good for removal of certain pollutants such as iron and manganese. Requires power. |
| **Coagulation** | Addition of chemicals such as alum or lime to bring out pollutants in water — pollutants stick to chemicals and fall to bottom of the tank when allowed to settle. | Requires chemical and power input and control. |
| **Disinfection** | Addition of chemicals such as chlorine to kill off disease-causing organisms. | Requires chemical input and control. |

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## Water-treatment process selection

The problem is that many of the treatment processes are *inappropriate* for their use and/or their location. For example, many were developed in the cooler climates of the North, making direct transfer to tropical climates unsuitable. The spare parts, maintenance, and power consumption required by many treatment processes makes them unrealistic options for many parts of the world.

All locations are unique; what is required is not a common *solution* to a problem, but a methodology for the *analysis* of problems.

Figure 1 shows three stages for the selection procedure.

### Stage 1: Objectives

The *purpose* of the treatment process must be established. What are you trying to achieve, and why? Is it achievable, is it a realistic goal, is it the main problem? There may be a need to *prioritize* the problems. This stage is often underestimated or taken for granted. For example, in the case of water treatment, the priority in developing countries often should be a low-cost, low-maintenance system.
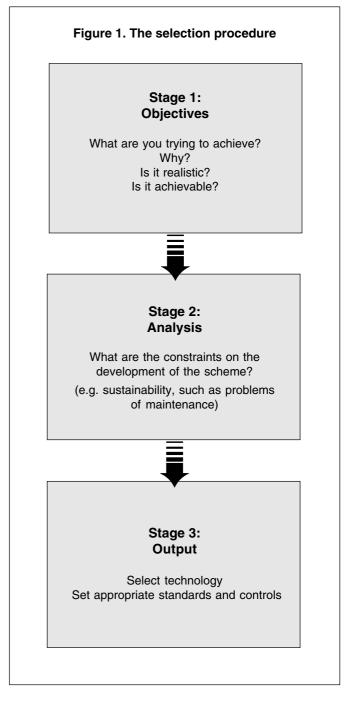
### Stage 2: Analysis

The *constraints* on the proposed development have to be identified and this can only be done by looking at the particularities of the individual case. Often, physical constraints such as water resources and land availability will be taken into account, but other fundamental factors which contribute to the success or failure of a scheme are not adequately addressed.

For analysis purposes we can group the issues to be addressed into the **'SHTEFIE'** criteria, developed at WEDC by Richard Franceys, Margaret Ince and others as a tool to help with analysis of development programmes.

**S** — **SOCIAL**

**H** — **HEALTH**

**T** — **TECHNOLOGICAL**

**E** — **ECONOMIC**

**F** — **FINANCIAL**

**I** — **INSTITUTIONAL**

**E** — **ENVIRONMENTAL**

From these groupings, a checklist of factors to consider may be drawn up. Table 2 shows an example of the sorts of issues that could be used for selecting water-treatment options (you should be able to draw up one of your own for your own situation). Think of it as a thought-provoker to ensure that all the relevant factors are taken into account; the SHTEFIE criteria can be useful in this context.

**Figure 1. The selection procedure**



**Stage 1: Objectives**

What are you trying to achieve?
Why?
Is it realistic?
Is it achievable?

**Stage 2: Analysis**

What are the constraints on the development of the scheme?
(e.g. sustainability, such as problems of maintenance)

**Stage 3: Output**

Select technology
Set appropriate standards and controls

### Stage 3: Output

After all the relevant issues have been addressed, the *output* can be evaluated. In the case of water-treatment and most other processes, it is important to realize that there will be *two* main outputs. The first is the technological options themselves. But these are dependent on the methods used to implement and regulate them — usually the water-quality standards set. Often, unrealistic and unattainable standards are laid down with the severely detrimental effect of encouraging people to invest in technologies which are inappropriate for their community. *Options* and *targets/standards* must be considered together, therefore; only then will *appropriate technologies* be selected.

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**Table 2. The 'SHTEFIE' criteria**

## S — SOCIAL factors

- Housing facilities; type, distribution
- Public desires and preferences; aesthetic considerations, pressure groups
- Welfare and equity considerations
- Willingness to pay; ability to pay
- Water tariffs, methods and ability to pay
- Population distribution (age, location; growth rates)
- Migration, urbanization
- Cultural and religious aspects, including attitude towards water recycling and sanitation practices
  *All of above may affect consumption*
- Education levels; structure of workforce; training
- Influence ability to operate and maintain

## H — HEALTH factors

- Health statistics, morbidity and mortality rates
- Significant faecal-oral (and other) diseases
- Health services available

## T — TECHNOLOGICAL factors

- Water demand and use
- Availability of spare parts and materials
- Availability of local knowledge and expertise
- Present water supply and sanitation facilities; proposed future investments
- Design life of treatment facilities
- Raw water characteristics: source, quantity, quality, availability, and reliability
- Water-quality standards
- Power requirements

## E — ECONOMIC factors

- Structure of economy, output by group, industrial and agricultural component
- Major employment sectors
- Foreign-exchange earnings (exports)
  *All affect priorities for water supply*
- Size of economy, future prospects, balance of payments, trade relations, isolation of economy and vulnerability, distribution of incomes
  *All affect ability to pay*

## F — FINANCIAL factors

- Finance available; method of funding
- Ability and willingness to pay

## I — INSTITUTIONAL factors

- Existing roles and responsibilities for organization and management
- Relationships between organizations
- Legislation, policing and regulations

## E — ENVIRONMENTAL factors

- Climate, rainfall, hydrology
- Soil conditions, geology, groundwater characteristics
- Water-resource availability
- Impact of any plant: noise, smell, insects, visual impact, health considerations
- Sustainability

## Example

A village currently obtains its water from a large stream, source 1, about 50m away. Although the stream water is highly turbid, and the incidence of diarrhoeal disease is high, villagers are used to obtaining their water from this supply because it is close by.



The local health worker has recommended that a 'cleaner' water supply should be sought, as she believes that this would improve the health of the villagers significantly. There is a second water source on the other side of the village, about 500m away (source 2). This source is not used very often because of the distance, but it appears to be much less turbid than the first source.

What would you recommend as a suitable course of action?

*Note that the example given here is simplified. In normal situations more factors will usually have to be considered. It is used only to illustrate how the selection process may be applied.*

### Stage 1: Objectives

To improve the health of the villagers. Requires a cleaner water supply, probably requiring treatment to remove pathogens — but all at an acceptable cost.

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## Stage 2: Analysis — using SHTEFIE

| Factor | Effect | Outcome |
|---|---|---|
| **Social** Social desires for increased convenience of supply mean that many villagers want a piped water supply to standposts — to be of better quality than the existing supply | New water supply must appear better than old or people will not accept it | Removal of turbidity is a priority so new source appears to be better — sedimentation, filtration or coagulation may be suitable |
| **Health** High incidence of diarrhoeal diseases in village | Pathogen removal required | Process needs to include pathogen removal — possibly slow sand filtration and/or chlorination |
| **Technological** Chemicals and spare parts difficult to obtain | Process to be simple and not reliant on chemicals or power | Rules out coagulation and possibly chlorination. Also rules out rapid sand filters |
| **Economic** Large amount of agriculture in area requiring irrigation water | Large amount of reasonable (not drinking-water standard) quality water required | Possibility of using higher-quality source for drinking-water supply and lower-quality source for irrigation |
| **Financial** Income levels still low in village | Ability to pay is low | Need for inexpensive options |
| **Institutional** There is little involvement of water agencies in the area | Operation and maintenance capabilities are likely to be low | Need for simple options |
| **Environmental** Rainfall is fairly even throughout the year | Need to check reliability of flow in streams | May need to have further source of water supply if flow is low. |

## Stage 3: Output

Of the main treatment options listed in Table 1, the analysis has revealed that sedimentation and slow sand filtration are probably the most appropriate treatment options because of the operational and maintenance requirements. Chlorination could be considered if completely safe drinking-water were required, but the chemical requirement might mean that this option is not appropriate. Water from source 2 could be used for drinking-water supplies after treatment, leaving the water from source 1 for irrigation purposes. Otherwise, the very high turbidity in water source 1 would mean that a pre-treatment stage such as roughing filtration may have to be employed. Water-quality targets should be to remove turbidity and pathogens to acceptable levels, and to perform the routine operational tasks for the slow sand filter when required. (For further details about the operational requirements of slow sand filters, refer to *The Worth of Water.*)

## Conclusions

So, when selecting any technology, consider the following:

**Objectives:** *What is required? Why? Is it realistic?*
**Analysis:** *Can it be achieved? What are the limitations?*
**Output:** *What technologies and controls are appropriate given the problem and the constraints?*

### Further reading
Pickford, J. (ed.), *The Worth of Water,* IT Publications, London, 1991.
Shulz, C.R. and Okun, D.A., *Surface Water Treatment for Communities in Developing Countries,* John Wiley & Sons/IT Publications, London, 1984.
WELL, *Guidance Manual on Water Supply and Sanitation Programmes,* WEDC for DFID, Loughborough, 1998.

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