



10th WEDC Conference

Water and sanitation in Asia and
the Pacific : Singapore : 1984

Aspects of sanitary engineering works in developing countries

P Sutcliffe

INTRODUCTION

Provided that they ensure that the measures which they take are appropriate the so-called developed countries can contribute a great deal to the betterment of conditions in the developing nations. In the past many of the peoples of these developed countries have suffered similar afflictions to those which now affect their less privileged fellow beings.

The factors affecting the relevant works are many; in principle they are common to the entire world but their individual significances vary from place to place. For those working in developing countries they must be put into proper perspective.

This work requires financing (though appropriate technology designed to adequate, rather than over-adequate, standards need not be unduly expensive) and the money has to come from somewhere. In developing countries the primary sources are (1) the sales of natural produces (subject to fluctuation) and (2) grants/loans from international agencies and richer countries. An additional source of income arises, if manufacturing industry be established, from the export of the resulting products - but it is respectfully suggested that, in the order of planned development, community health and good agriculture/forestry practices should precede industrialisation.

PHASES OF PROJECT

Any engineering project involves three major phases - (1) design, (2) construction and (3) operation - and two preliminary phases - (i) identification of the problem and formulation of the design brief and (ii) collection of data.

Various factors are encountered during each phase, some being peculiar to two phases only whilst others are more widely relevant. Table 1 tabulates the factors and their relevances.

Problem and brief

Generally the problem will be evident; for example, the need to provide potable water or to eradicate some source of infection. But the possible solution(s) may not be as evident as the problem - alternatives may well be available. Any solution must be

TABLE 1

Factor	Problem and brief phase	Data collection phase	Design phase	Construction phase	Operation phase
Climate	x	x	x	x	x
Hydrology	x	x	x		
Geology	x	x	x		
Site conditions/investigations			x	x	
Ecological considerations	x	x	x	x	x
Natural landscape				x	x
Population patterns	x	x	x		
Disease patterns	x	x	x		
The existing built environment	x	x	x		
Available finance				x	x
Planned life of scheme				x	
Availability of materials				x	x
Labour problems				x	x
Local customs and society				x	x
Contractor's experience				x	x
Availability and use of plant				x	x
Communications				x	x
Contract documents and specifications				x	x
Supervision/contract organisation					x
Simplicity/complexity of equipment				x	x
Problems of handing over				x	x

relevant - environmentally, technologically, financially and sociologically.

Collection of data

It is essential that design be based upon adequate information. For public health engineering projects long-term records are desirable - typically rainfall, run-off and groundwater variation figures and information on vegetal patterns and changes therein. Distribution patterns of water-borne diseases must be known.

Other data required include the geographical and historical backgrounds to the affected areas, the economic position, physical planning proposals, water supply needs and sources, geology, flora and fauna and land drainage.

THE FACTORS CONSIDERED

These will be reviewed in turn.

Climate

The climate ambient to a public health engineering project is critical. Climate exhibits temperature variations, wind, precipitation and humidity; these can affect:

Materials - e.g. high and low temperatures affect setting and curing of concrete and have expansion/contraction effects.

Construction procedures - progress may be delayed by rain or wind-borne sand; completed work may be damaged.

Transportation - routes may be rendered impassable.

Mechanical plant - wind-blown grits can be a problem.

Working hours - may be varied from "normal" to accommodate climatic conditions.

Labour efficiency - extremes of temperature and rainfall, together with climatic effects upon food and hygiene, may induce sickness and lethargy.

Biology/microbiology - may cause illness or inefficient operation of treatment plants.

Hydrology

Hydrology is an offspring of climate, concerned with precipitation, run-off, groundwater, transpiration, evaporation and infiltration; it has great influence on water supply problems.

Geology

Geology is fundamental to any of man's activities; it is the backcloth on which he builds, dictating the availability of materials and the suitability of sites.

Site conditions/investigations

Thorough investigations must be made of the site of any proposed works so as to confirm its suitability and also to determine local availability of building materials and to reveal the degree of skill of local labour.

Ecological considerations

The ecological consequences of projects can be considered; damage to the ecology may endanger the livelihood of local people and lead to bad feeling between them and the promoter of the work.

Natural landscape

The completed project structures should

either blend in with the pre-existing scene or contrast suitably with it. Sometimes there may be a case for disguising the work.

Population patterns

Upwards of seventy per cent of the people of the developing countries dwell in the countryside and so problems of providing sanitation and water resemble those in the rural areas of so-called developed countries - dispersal, long service lines serving small numbers and supervision difficulties. But dispersal can have advantages - concentrations of putrefying matter are not so intense as in built-up areas. The extent to which people are mobile or static is important, as is population growth potential.

Disease patterns

Areas which are particularly subject to (water-borne) diseases obviously deserve urgent attention in terms of remedial works, but relatively healthy zones, when subject to urbanisation and increasing concentration of population, may suffer outbreaks of illness.

Existing built environment

Localities which have become urbanised may have done so at a rate which has outpaced the rate of provision of sanitary services. Moreover, where services are initially adequate they may become overloaded and so impending increased needs should be anticipated. Ideally, the provision of sanitary services should precede full development.

Available finance

When the funding of a project is under consideration there can arise a "chicken and egg" situation - "which comes first - the design or the money?" Should the design solution be formulated and costed and a request made for funding or should the maximum amount of money likely to be available be the first determined and then a design produced to fit this cash?

Planned life of scheme

Conditions in developing countries are liable to rapid change; hence construction in these countries may be better based upon the short term rather than the longer. Traditionally the civil engineer builds work which will last for many years; implied is the need for a change in philosophy on the part of the engineer, introducing a new requirement into the training of a person who is to serve in a developing country.

Availability of materials

Normally locally available materials are

utilised to the greatest possible extent. But there can be disadvantages to this approach - the local materials may be different to those to which the engineer is accustomed and so a flexible attitude is needed. Local materials may be difficult to exploit; much time can be expended in bargaining for and opening up quarries and sandpits. Simple methods of materials testing are required.

Importation brings problems; proximity of ports and railheads, existence of roads and co-ordination of deliveries from various places. Again the qualities of flexibility of approach and ability to improvise are essential in the engineer if he is to cope satisfactorily with delays and other snags.

Materials bought from a number of sources will vary in quality and specifications must allow for this. Pipes, steel items, mechanical and electrical equipment etc. will not be available locally because of the absence of manufacturing industry.

Labour problems

Labour is needed in terms of both numbers and skills. Three broad approaches are available for construction - (1) by an expatriate contractor with his own labour force, (2) by an ex-patriate contractor using, at least in part, local labour, and (3) by a local organisation using local labour. Governments of developing countries may require that local labour be utilised as fully as possible, with priority over imported workers; but local labour may require training. Part of the labour force may have to be imported by virtue of special skills - supervisors, plant engineers, skilled craftsmen. There may be administrative complications over work permits and visas. The team may be international with language and social behaviour difficulties, unfamiliar with local customs.

On a large project the feeding, housing and entertainment of the personnel can be a large task; places of rest and worship may be needed. Imported labour may become unhappy, discontented and resented by the indigenous people.

Local customs and society

In all countries there are customs, codes of conduct, accepted practices and varieties of morals and ethics; these vary from place to place. They must be observed, tolerated, respected; courtesy alone dictates this. Festivals and public holidays are a feature of life everywhere; some are held on fixed dates, observed for many years, while others may be called at short notice.

These functions affect project planning and

progress - some can be accommodated from the inception of the scheme but others will cause unforeseen delays. So tolerance is demanded of those in charge.

Long established rights (e.g. of grazing or thoroughfare) must be respected.

Contractor's experience

The contractor should have experience in similar climates and terrain and with similar labour and other constraints. Lack of appreciation of local conditions will lead to delays and friction on site.

Availability and use of plant

Mechanical plant will often have to be imported. If local labour is available the question might be asked ... "Is it morally and financially correct to use mechanical plant?"

Plant must be able to withstand the climate; it should be simple and rugged. Maintenance and spares are vital; the ability of the engineer and operative to improvise is essential.

Communications

Transfer of people and goods is essential; lack of facilities hinders progress. These may have to be created; where inadequate they will have to be improved.

Delays in telephone and post mean that those "on site" have to make major decisions without reference to head office. Late arrival of supplies makes flexible construction programming essential; there may have to be changes in construction sequences and substitution of materials.

Poor roads and handling facilities lead to breakages. Seaports, airstrips, roads and railheads can be vital, whilst the tracked vehicle and helicopter provide invaluable facilities in rough terrain.

Contract documents/specifications

Tenders for international contracts are difficult to draft; language difficulties and legalistic variations may cause unintentional or intentional differences in interpretation by contractors from different countries. Considerable flexibility is needed. Allowance should be made for the possibility of using locally made items (maybe fabricated on site) instead of the more normal units which may have to be brought thousands of miles at great expense and with risk of delay. Conditions of contract must also allow for local conditions, customs and requirements.

Supervision/contract organisation

Often the supervision of work in developing countries has to be more detailed than elsewhere. Labour tends to be inexperienced and unfamiliar materials may be used. The contractor may be from a third country.

Engineers will often have to work directly alongside the labour force, training them as the job proceeds. This has advantages; workers are keen to learn new skills and good workmanship can be instilled. At the outset as much responsibility as possible should be given to indigenous personnel; this gives them a sense of pride in the scheme with which they are going to live in subsequent years.

Simplicity/complexity of equipment

Permanent equipment incorporated into a project requires three major qualities:-

- ruggedness;
- simplicity in mechanism/operation;
- ease of maintenance.

Training of staff

Training of staff is required at two stages-
 training for construction, and
 training for operation of the completed project.

Problems of handing over

Neither engineer nor contractor should quit the site until they are satisfied that those persons who are to be responsible for the operation of the scheme are fully trained. There should be a period of "co-existence" before final handover.

CONCLUSIONS

The conditions surrounding the promotion, design, construction and operation of sanitary engineering projects in developing countries can be very different to those pertaining in the developed countries.

Whereas in the latter areas the engineer is frequently effectively subservient to a pre-existing political, social and economic "establishment", in the developing countries he has a chance to be an influencing factor from the inception of a project.

So he must possess a broader outlook than if he were working in a "western" context.

Technological training and ability are but two necessary qualities; they form only part of his required expertise. Additionally he must be able to understand the totality of the environment within which he is designing, building and operating. This

total environment has several facets - physical, cultural and economic to mention but three. He must rise above the normal confines of his profession - he becomes a practical sociologist.

The engineer must inherently possess or consciously develop qualities of flexibility, adaptability, initiative and independence, patience, prudence, tact, understanding, tolerance and compassion - a very "tall order" which is exceptionally demanding. The engineer is being asked to become a kind of alternative missionary.

In all that he undertakes the engineer must bear in mind that he is a transient person; eventually he will move away from the scene of his endeavours and the project will be inherited by the local people and so he must, at all times, encourage them to take pride in the project, to respect and protect it. They are more likely to do this if they have worked on its construction for they will then know why it is there and how it was built; it becomes a part of the local history as it takes its place in the environment.