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OUTLINE APPROACH TO DISASTER RELIEF

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ENGINEERS FOR DISASTER RELIEF

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FOREWORD

This booklet provides an outline approach to disaster relief. It includes a brief summary of general information that may be of use to an engineer working in a disaster relief situation, already fully contained in the REDR Field Manual. It also provides a bibliography of more detailed information available in the REDR library. Further useful information can be found in the libraries of other relief organisations particularly OXFAM, at 274 Banbury Road, Oxford.

This information has been drawn together from the experience and reports of engineers who have returned from relief missions, and represents the first attempt at summarising this in a handy pocket sized booklet. It is hoped that it can be improved in subsequent editions by the contributions from other REDR engineers. If you wish to propose additions, deletions or corrections, please address your suggestions to the Secretary of REDR so that they may be considered for subsequent editions.

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CHAPTER 1
PERSONAL SURVIVAL AND EFFECTIVENESS

1.1 So that you can make an effective contribution to a relief operation it is essential for you to maintain a high standard of physical and mental fitness, often in physically and emotionally draining conditions. This means that you must adopt a regime of hygiene, feeding, shelter and rest much higher than that available to the refugees that you have come to assist. You must remember that your efforts can save the lives and improve the lot of thousands of people, that you can only achieve this by maintaining good personal health, and that the resources you consume in so doing would have negligible benefit if they were divided among the thousands of refugees you are helping.

1.2 Identify and take particular medical precautions appropriate for the area in which you are working, i.e. obtain the recommended inoculations before entering the area, use a mosquito net and take anti-malarial prophylactics where it is recommended. Also take regular salt and/or haemoglobin supplements if medically desirable. Do not drink untreated water unless it has been boiled, and pay particular attention to personal hygiene -wash yourself and your clothes frequently. Be on the lookout for emotional changes in yourself and your colleagues and seek medical advice if in doubt. Mental breakdown is not uncommon In the abnormal, isolated and highly emotive conditions you may find yourself in. Finally take care when driving and use a carefully selected local driver whenever possible. Conditions will be unfamiliar, and you may well be tired or preoccupied, and this is the climate for accidents. If you have any mechanical skill take a minimum selection of tools to effect emergency repairs to vehicles - skilled assistance is not likely to be available.

1.3 While urgency is clearly necessary when despatching engineers to disaster situations, some time is always available, and indeed must be made available to carry out essential preparations for a mission. Indeed these few days may prove in the long run, to be the most important in your commission, as your future actions and effectiveness may well depend on the preparations you make before you leave the U.K.

1.4 You should seek a briefing from both the REDR officer responsible for your appointment and also, most importantly, from the relief agency to whom you are to be attached. Often the information available is minimal and confused, but you should try to anticipate the likely difficulties and insist on extracting and noting every item you can gleam. A check-list of useful information is as follows:

a) **Geographical.** Obtain general maps of the area you are to work in showing topography, accessibility, and location of major features. Edward Stanford's Map Centre in Covent Garden, London WC2 can obtain most topographical maps including the very useful 1:1 million scale aeronautical charts. Also seek out Consultants' water resources reports, detailed hydrogeological and topographical maps and local plans of camp layout if available.

b) **Climate.** Obtain rainfall and temperature ranges, and seasonal features. This will provide a basic engineering input, and also guide you in the clothing and personal equipment you will need.

c) **Health & Hygiene.** Identify the conditions you are likely to encounter and arrange for medical prophylactics before departure and during your mission. Obtain mosquito nets and water sterilization tablets before leaving the U.K. if possible.

d) **Political.** A political briefing will inform you of the help or hindrance you may expect from authority, and you must ensure you have all the necessary documentation including visas and written authorities to enter and move about the country you are going to. Some knowledge of the religious and social habits would help you avoid pitfalls. A good encyclopædia may provide good background information.

e) **The Disaster Situation.** Determine the objectives of the relief effort and the role you are expected to play in it. This will indicate what information and equipment you will need to take with you. For instance you may need to take out water test kit, simple survey equipment etc.

f) **Logistical.** Establish the numbers involved in the disaster and the availability of finance, labour and materials available both locally and imported.

g) **Administrative.** Identify your position in the organisation and establish your lines of communication for the provision of finance and materials.

h) **Engineering.** What engineering decisions have been taken and what is the current situation. What decisions are needed and what engineering information and assistance are likely to be available. What is the planning horizon for the 'initial relief phase' and what are the outline plans for any consolidation phase.

i) **Personal.** Obtain details of travel arrangements, and transport and accommodation provided at your destination. Obtain sufficient cash and ensure an adequate cash supply to meet your subsistence needs. Ensure you have insurance cover, and locate any back-up assistance that may be helpful - i.e. British Council and fellow expatriates operating in the area. Seek clarification of expected working hours and off duty and leave allowances.

1.5 Seek information regarding local food and its preparation. Prepare a short vocabulary of important words in the local language. An interview with an expatriate from the country you are assigned to would be invaluable.

1.6 Longer term preparation for a mission should include reading reports of returned volunteers, attending REDR lecture sessions (Annual General Meeting and others) and improving your practical abilities by attending evening courses in vehicle mechanics, plumbing, electrical installations etc.

Further information in REDR library:

i) Engineer Field Manual - Chapter 1 and 2 - REDR
ii) Public Health problems in Disaster Areas - Notes by Dr. Maberro.
iii) Medical precautions for tropical travellers. NCF.
iv) Cambridge expedition medical handbook
v) * Refugee camp health care - Ross Institute
vi) * Insect Control - Dr. Stephenson of International Disaster Institute.
vii) * UNHCR Handbook for Emergencies - Chapter 22 - Health
viii) Oxfam's practical guide to refugee health care by OXFAM medical unit - June 1983
ix) Field Engineering. An Introduction - P. Stern

* These publications are principally for medical volunteers but may provide useful background information especially if you are working as a member of what is predominantly a medical team, or where medical attention will not be conveniently available.

1.7 Finally, but most importantly, the relief engineer must be flexible and adaptable. Situations vary greatly from one district to another and the problems keep changing. Even the best briefing will be out of date and more often the information provided by a relief agency will be inaccurate to some degree.

CHAPTER 2
REFUGEE CAMPS AND SHELTER

2.1 This chapter deals with the site where the refugees live, the physical planning and organisation of their community, and the provision of shelters. These factors will have a major influence on the well-being of the refugees and on the effectiveness of the relief support.

2.2 Many factors will govern the location, size, layout and management of a refugee camp and these will be referred to in subsequent paragraphs. These factors will usually be out of the engineer's control and, unfortunately, some of the most basic and critical decisions may have been taken, in one way or another, before you arrive on the scene. It is unlikely that you will achieve the best solution, compromise and expediency are inevitable, and urgency makes better the enemy of the good.

2.3 Site selection and layout and the provision of shelter have a major bearing on all other means of assistance (i.e. distribution of food and water, sanitation, a health programme and the psychological recovery of shocked victims). It must, therefore, be planned as an essential part of the overall relief strategy, so wide ranging consultation and coordination are called for. The engineer must involve himself, insistently if necessary, in the strategic planning at the earliest possible moment. Some relief organisations still look on engineering support as an adjunct to the main relief effort, and they need to be convinced that it is, in fact, the very essence of relief. The engineer must not only concern himself with the planning of the 'initial relief phase' but must also look to planning and transition to the 'consolidation phase'.

2.4 The following factors shoul;d be considered in selecting the site for a refugee camp:

a) **The social, cultural and religious background** of the refugees will influence their preference of a location, and tribal or religious groupings must be catered for in planning the layout of the camp and the provision of communal facilities. It is essential therefore that you seek the views of the refugees and the local people whose lives will be affected by the camp. The input from local engineers and officials is very important, but the REDR engineer is often the arbiter and decision maker. He must be clear and firm in his decisions after consulting all local opinion and guard against acting on prejudiced and often conflicting opinions.

b) **The area,** and consequently the capacity of the camp will be dictated by topography, land tenure, and availability of water, but the area recommended by WHO is 30 square metres per person plus the necessary land for agriculture and livestock. An early decision is needed on the capacity of each camp area, and the development of each camp unit over an area. Individual camps in excess of 15,000 people appear to involve a quantum step forward in the provision of public services, although factors, particularly water supply, often dictate that larger camps be allowed to develop.

c) **Security and protection.** The political situation often poses a threat to the refugees, and the camp should be located as far as possible from any trouble spots, and within an area that can best be protected by security personnel or if the situation warrants, security fences. It should be situated well away from frontiers and tribal boundaries which are always sensitive areas.

d) **Accessibility.** The camp should be readily accessible from a major, all-weather communication link to ensure the supply of food, fuel and construction materials.

e) **Environmental.** The site should be free from major health hazards such as flies, mosquitos and bilharzia. Ensure that year round weather conditions are tolerable -gently sloping higher ground facing the prevaiing breeze is often to be preferred,

f) **Water supply.** The year round availability of potable water for the newcomers (e.g. refugees) will, more often than anything else dictate the capacity of the camp. Before confirming the longer term availability of the source it will be necessary to investigate its existing usage by local people (e.g. dry season source for nomadic people or supplementary crop irrigation). Normal water requirement is 15 litres per person per day, but a provision as low as 5 litres per head can be tolerated for short periods (i.e. weeks, not months). In semi-arid conditions it has sometimes been found necessary to reduce water demand below 10 litres per person per day for a limited period during the dry season, so as to conserve a key source. The hauling of water by tankers should not be considered an acceptable supply of water - it is expensive and unreliable.

g) **Topography and drainage.** Ensure the site is above the wet season water table, and has a slope (3% is desirable) to permit surface water to be drained. The camp should preferably not be situated at high elevations above the water source so as to avoid expensive and complex pumping or water transporting systems. Surface water and foul seepage should not discharge into the water source.

h) **Soil condition.** Soil should be adequate to bear shelters and access traffic. Ideally the soil should be suitable for pit latrines or soakaways. The land should carry natural vegetation as a protection against erosion and the presence of trees for shade is very desirable. Land capable of cultivation will also have advantages for rehabilitation.

i) **Fuel sources.** In semi-arid zones it will normally be necessary for the people to seek timber for fuel over a wide area near to the camps.

2.5 Site planning and layout will be affected by:

a) **The initial relief effort** will result in people distributing themselves around the food distribution point, taking account of family, ethnic and community preference. It will be a hard pattern to break - nor should it be, simply to achieve a symmetrical pattern or a preconceived notion of good layout.

b) **Physical factors,** such as topography, water and food distribution, access and sanitation should be the main influences on modifications to the established pattern of settlement. Vehicle and foot access ways must be provided and protected against intrusion, water points should normally be provided no more than 100 metres from any family, and latrine units (one for every 20 people) should be no more than 50 metres from anyone. In semi-arid zones, it has sometimes been necessary during the early stages of the initial relief phase to ration the water supply during the dry season by closing water points less than 100 metres from the family home. Also defecation fields well away from the water source have been used where latrines are not practical or are not initially socially acceptable. Fire breaks about 50 metres wide should be provided every 300 metres, but these can also serve as recreation areas and small holdings.

c) If the **Relief Operation** is likely to be over a long period you must ensure that adequate land is reserved for central administration, community and health services; schools, churches etc. This is often underestimated but as a general guide it could be as much as 30% of the whole camp area.

d) **Physical layout.** Subject to all previous influences and constraints, the basic aim should be to organise the site into small, semi-autonomous community units or villages, each containing the decentralized community services such as bathing and washing areas, health and feeding centres, school and religious facilities, and all within easy reach of the central administrative facilities. The basic patterns of layout are demonstrated schematically in the accompanying sketches and suggest a number of varying options.

2.6 Shelters must provide protection from the elements, a degree of privacy, space in which to live, cook and store belongings and engender emotional security. The first stage in this process is to provide a roof overhead for protection against sun and rain. This can be constructed of locally available materials such as grass, straw or leaf thatch or of imported canvas, plastic or sheeting. It is likely to be of communal nature at first, but as the immediate emergency passes, families will wish to set up individual shelters. At this stage it is important to ensure adequate spacing between shelters (not closer than 10 metres) and adequate land reserved for roads, paths, water points and latrines. Prefabricated housing or tents may be appropriate in some circumstances, but wherever possible, the most suitable shelter is to a local design and built with local materials. They should be weatherproof for all seasons, and plastic sheeting can augment traditional construction to achieve this. The shelters should be erected by the refugees themselves with some assistance in the form of building materials - cement, timber and iron sheets. Prefabricated or permanent structures are more appropriate for public buildings such as stores, medical centres and administration buildings. It is likely that at a later stage families will wish to provide individual washing and latrine facilities, and again the provision of pipes, taps and squatting slabs will assist them.

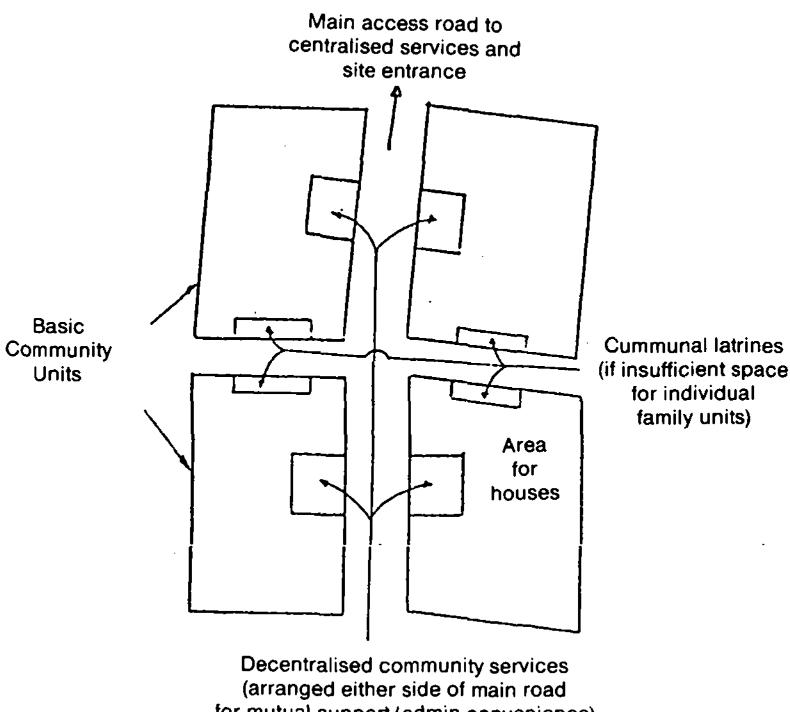


Figure No. 1. Example of limited area grid layout adapted to terrain

Further information in REDR library:

i) Engineer Field Manual Chapter 21 - REDR
ii) Refugee Camps and Camp Planning - F. Curry
iii) Disasters and the small dwelling - I. Davis
iv) Shelter after disasters - I. Davis
v) Plastic sheeting - use for emergency housing - I. Howard & R. Spice
vi) Relief Operations Guidebook - Intestect (1974)
vii) Planning Rural Settlements for Refugees - UNHCR (1979)
viii) Military Engineering Vol II - Field Engineering Pamphlet No. 1. Basic Field Engineering.

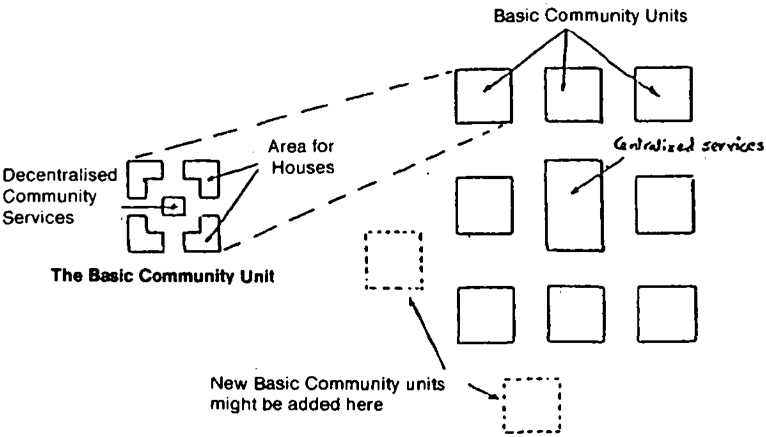


Figure No. 2 Example of a cluster or cross axis layout

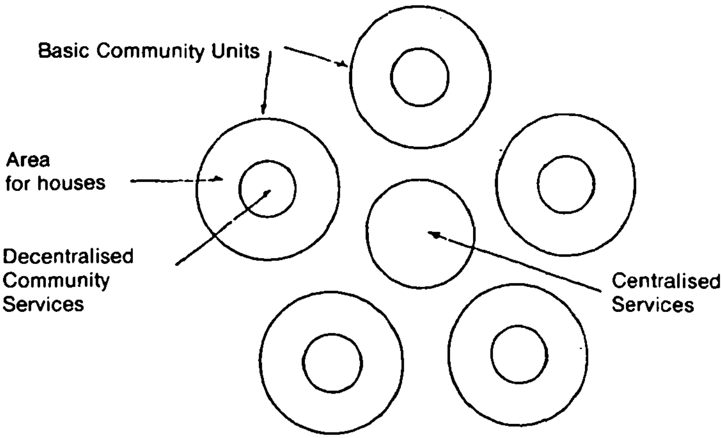


Figure No. 3 Example of a circular layout

CHAPTER 3
WATER SUPPLY

3.1 The need for an adequate supply of clean water is the single most important factor in determining the location and size of a refugee camp. The minimum quantity of water required to sustain life is 5 litres per person per day, but this will provide sufficient for drinking and cooking only. To create a healthy environment, for an extended period, water is also needed for personal hygiene and an overall supply of 15 litres per person per day, throughout the year should be the planning target. The water programme should ideally involve full participation of the refugee community, not be dependent on a continuing input of expatriates, and should not create a system that is markedly superior to the system available to the local non-refugee population.

3.2 When setting up or maintaining a refugee camp, the engineer's first action should be to identify the source, or sources of water, to estimate the year round yield, and to protect the sources from encroachment and pollution. This may involve the introduction and enforcement of sanitary discipline, the removal of causes of pollution, and the fencing of the intake area. The estimated yield will set a limit to the size of the camp and any pressure to expand the camp beyond its water capacity should be resisted - if necessary by finding alternative sources and establishing new camps. If all other options fail, and a reduced supply has to be accepted, it may be necessary to introduce a degree of water conservation and rationing. The supply of water by tanker should only be adopted as a last resort - it is better to take the refugees to the water, than the water to the refugees.

3.3 When planning a water supply you should seek the advice of hydrogeologists and hydrologists if such advice is locally available, but failing this (as is usual) you will need to act on the more expert opinions of local people - seek confirmation of all basic data from as many independent sources as possible. In cross checking you should be aware that local people may have a vested interest in being pessimistic as to a source reliability and volume since they may, if semi-nomadic, use such sources for a dry season supply or for supplementary irrigation. The system of extraction and distribution provided should be appropriate to the local technology - i.e. the simpler, the better, - do not abandon a simple, adequate scheme because the water falls short of UK standards of purity. The refugees themselves are likely to have been drinking suspect water all their lives and will have developed a partial immunity against some types of pollution. However in the longer term one should always provide storage, sand filtration and chlorination of surface water supplies, and should at the earliest opportunity provide the capacity to chlorinate water from springs, open wells and boreholes. In the earliest stages of an emergency it will generally be necessary to insist on boiling all drinking water. It is always necessary to set up a system of water testing to give warning of faecal contamination (e. coli) and excessive alkalinity.

3.4 In general there are three main sources of fresh water:

a) surface water from rivers, streams and lakes. This source is likley to give the greatest yield, but is most vulnerable to pollution or seasonal variation of flow; (beware of bilharzia).

b) below ground - from wells, boreholes or emerging springs - yield may be limited but more reliable, and more easily protected. A good spring is the best source of supply, and protected open wells with chlorination back-up usually adequate, but require high technology to operate and maintain. One should however fully investigate the requirements of the traditional users of springs and wells before developing them for refugee use;

c) Rainwater - a reasonably pure but volumetrically unreliable supply which generally requires large storage capacity to overcome the dry periods. It is unlikely to provide an adequate source for a large camp, nor even the sole supply to smaller facilities in an area which does not enjoy regular rainfall throughout the year.

Municipal supplies or occasionally desalination plants or nearby tanker ships are alternative options you may encounter. The possible shared use of existing municipal supplies with refugees should always be considered but is often impossible to arrange for local political reasons (e.g. payment of water charges in long term).

3.5 In the case of surface water the supply and purity of water may be enhanced by constructing low dams or by sinking shallow wells in river terraces with connection galleries into the saturated sands in the adjacent depressions. These saturated sands, often created from eroded material from basement rocks, can often be accumulated by the construction of sand dams built up in stages each flood season. With care a natural spring supply can be opened up and protected from collapse or blocking.

3.6 The following tables provide a useful guide to the likely yield from underground sources, and the types of wells or bores that may be appropriate. Considerable variation in yield may be found especially in drought susceptible regions, so yield testing is essential.

TABLE 1

	Geological formation	**Approximate yield in litres per minute**
1)	Sand, gravel and clay (intermixed and interbedded)	2,000 - 4,000
2)	Sand and gravel alone	1,000
3)	Sand and clay alone	2,000
4)	Fractured sandstone	2,000
5)	*Limestone*	40 - 200 (*may be more if near a cavern or stream*)
6)	Granite or hard rock	40
7)	Shale	less than 40

TABLE 2

Type of Well	Max depth (approx) metres	Techniques	Comments
Driven Tube	10-15	Simple - special pipe is driven into ground - time to construct - 1-2 days	Small bore - cannot be driven in heavy clay or rock. Needs special filter 'wellpoint' at tip.
Bored Tube	25	Simple - hand bored using auger and lined with tube - time to construct - 2-3 days	Larger than driven tube but requires tools.
Jetted Tube	80	More difficult - requires jetting pump and water tanker to loosen soil and driven tube.	Special equipment and good water supply nearby are needed.
Hand Dug	30-40	Deeper wells require skilled well-digger. May need to be lined with concrete or corrugated iron. Progress variable 4 men can sink 10 metres in 1-5 days in good conditions but very much less in harder rocks.	Has greater capacity than bore-holes because of greater storage characteristics and infiltration perimeter. Requires higher water table.
Bore Holes	over 100	Skilled team and equipment	Depth over 60 metres requires mechanical pump.

3.7 **Supplies.** A system of storage and distribution will, almost certainly, be required for any large camp (over 5,000). This will usually involve mechanical pumping from the source into concrete or steel storage tanks with gravity distribution to multi-tap water points. Peak demand problems may be overcome by installing 1,000 + litre steel or fibreglass tanks at each water point. Water wastage is a serious problem and a code of discipline must be enforced - self closing, vandalproof taps are essential and an on site plumber with spares and tools must be trained and provided to deal immediately with bursts or leaks. Water points should generally be no more than 100 metres away from any family, and the location of water points requires tact and full consultation. A standpipe provided for the use of an ethnic or communal group is more likely to be respected and cared for than for points geometrically or haphazardly placed. Care should be taken to drain wastage from the water points into a surface water drainage system well clear of the camp or into soakage pits. A maintenance team for the whole system will need to be recruited from the refugees and trained. In some camps in semi-arid zones, for reasons of water shortage at source and the potentially serious problem of dealing with waste water, distribution has been kept to a minimum within the camp area. Water has been pumped from shallow wells to nearby tanks and standpipes. At these camps washing facilities have been provided near the water points, but drinking water has as a result to be carried up to 500 metres into the camp areas.

3.8 Overnight storage of water from a surface source is likely to settle out most physical impurities and controlled dosage with chlorine to achieve a minimum residual presence may be the first stage in a treatment system. Longer term storage through the provision of dual storage tanks will improve water quality, and sand filtration followed by chlorination can be a most effective method of treatment. The following types of sand filter may be considered:

a) Packed drum filters. Use batteries of 200 litre (45 gal) old oil drums with a layer of sand overlaying a layer of gravel, from which the filtered water is piped. Inflow to each drum should be regulated to 50-60 litres per hour, which operating 24 hours per day will provide water for 80 refugees at 15 litres per person per day.

b) Horizontal sand filters. Comprise a raised trough or polythene lined trench to allow gravity flow through a graded sand/gravel media. Water is fed uniformly over the face at one end and collected at the other and discharged into a storage tank. Capacity is variable and a battery of units will be needed to treat the yield from a single well.

c) Slow sand filter. A layer of sand overlaying gravel is laid on a shallow concrete or steel tank over which untreated water is gently discharged (underwater to reduce scouring of sand). Treated water is collected in channels under the gravel and gravity piped into a storage tank. Rate of filtration should be about 30 litres per hour per square foot of filter media. The filter surface needs to be scraped and replenished at regular intervals.

d) River bed filters are manufactured devices which draw water directly from surface sources such as rivers or lakes. It comprises a screen in the shape of an inverted open box which is buried in the river and is filled with sand and gravel media. A suction pipe is attached to the top of the box and pumps water from the source through the media. Improved results are obtained if the intake itself is surrounded with media material.

3.9 OXFAM have developed a series of water supply packages with separate units for intake and pumping, storage, treatment and distribution. Each package is a complete section of the system and comprises all materials, tools and instructions for installation. A full set of manuals is available in the REDR library.

i) See Chapter 24 of Engineer's Field Manual

ii) Guide to Sanitation in Natural Disasters - Asser M

iii) Evaluation for Village Water Supply Planning - S. Cairncross

iv) Small Water Supplies - S. Cairncross

v) Water, Wastes and Health in Hot Climates - Wiley

vi) Safe Drinking Water - Oxfam Technical Guide

vii) Water Supply and Waste Disposal - World Bank

viii) Water Produce Manuals (Institution of Water Engineers and Scientists). Volume 3 Water Supply and Sanitation in Developing Countries 1983

ix) Small Communities Water Supplies. IRC International Reference Centre for Community Water Supply and Sanitation 1981

x) Hand Dug Wells and their Construction

xi) Royal Engineers Supplementary Pocketbook No. 6 - Water Supply

xii) A Handbook of Gravity Flow Water Systems - T.D. Jordan

CHAPTER 4
SANITATION

4.1 The need for an adequate sanitation system as a protection against airborne and intestinal diseases is well recognised. It comes only after water and shelter in order of priority. The difficult decision is the form of sanitation that is appropriate, but because of maintenance and operating problems it should be the simplest system that will meet the needs that are likely to arise.

4.2 In many cases the refugees will have come from rural communities in third world countries which have demanded no more than open bush or forest for latrine facilities. The need for a more sophisticated system is the refugee camp itself, which brings together a much larger population in a more dense environment. The larger and more dense the camp the greater the sanitation problem; consequently this is a case of small is beautiful, and the first line of defence is the camp layout itself. A satellite layout of small communities around a central nucleus is to be recommended (see chapter 2).

4.3 Investment in sanitation provides a diminishing rate of return - a larger proportion of the benefits will be gained by enforcing a regime that removes faecal contamination from water sources and contains it in an area that can be suitably located and controlled. In some semi-arid zones, camps have in the early stages of development been planned with designated defacation fields. These have been chosen such that the surface run-off from these areas does not run into the water source nor into the camp itself. Subsequent developments yield fewer benefits usually in inverse proportion to the resources devoted to them. In the interest of convenience, maintenance and visibility, the ultimate solution is for each family to have its own sanitary unit, be it a dry pit or water privy. In the meanwhile, communal units will be required if cultural practices etc allow. The decision on the types of unit and their location and distribution are fraught with problems. Sanitary units on a family basis should be encouraged at every opportunity.

4.4 It need hardly be said that you should seek the most reliable advice available, both expert and local, and the following considerations will need to be taken into account before planning the appropriate system:

a) Previous system of sanitation practices
b) Cultural practices and taboos
c) Segregation by sex and age
d) Preferred position - squat or seat
e) Need for privacy (varies between ethnic groups)
f) Method of anal cleansing
g) Need for special orientation or location to conform to ethnic or religious practices
h) Sanitation systems in use in vicinity of camp
i) social factors and community groupings

All of these considerations would help with location of units and achieve community responsibility for maintenance.

4.5 Generally it is better to provide a number of small units than few larger ones which are often inconvenient, cause nuisance and are abused. One unit for every 20 people is a target to aim for with a maximum walking distance of 50 metres, and with community maintenance responsibility. The unit should be located no less than 6 metres from any dwelling and further from any food preparation centre. It should be not less than 50 metres away from any well or water source, and should take advantage of any natural screening and be located downwind from the community.

4.6 The type of sanitation system adopted will depend on a number of factors such as:

a) The availability of an existing township system

b) The availability of adequate water

c) The geology of the ground - suitability for sinking pits or bores and stability.

d) The ground water table throughout the year i.e. is drainage from a pit a likely problem

e) Climate, assistance to bacterial action and need for shelter from elements

f) Materials and labour available locally

4.7 The following systems which may be considered are placed in order of simplicity and cost:

a) *Open trench - a shallow trench opened up and back filled as it is used.* Needs to be carefully located and requires sanitary control (latrine discipline and disinfectant spraying).

b) Shallow trench - 30cms wide by 90 - 150cms deep and covered with temporary squatting plate or seat. A length of 3.5 metres is needed for every 100 users, and will need to be back filled and relocated after weeks or months of use depending on natural drainage.

c) Deep trench latrine - 70 - 90cms wide and 1.8 to 2.5 metres deep - requires to be supported around top 50cms and a more permanent slab and shelter may be provided, 3.5 metres in length for every 100 users and will last several months or even indefinitely.

d) In large camps pits up to 2 metres wide and 7 metres deep may be required.

e) Family pit latrine. The pit should be 1 metre square, and 2 metres deep. (See sketch at Fig 1).

f) Bored hole latrine. (See sketch at Fig 2).

4.8 The following systems are dependent on an adequate water supply for flushing:

a) Pour flush (PF) latrine. (See fig 3). A water seal is essential and is flushed by hand using 1.3 litres of water each time. Particularly suitable where water is used for anal cleansing, toilet paper or substitutes cause problems.

b) Aquaprivies (or septic tank systems). See Fig 4. A constant level of water has to be maintained in the tank to permit anaerobic action to develop and to avoid smell nuisance. Tank needs to be water retaining and not less than 1 cubic metre capacity. Effective soakaway is essential. The septic tank can be buried outside the privy and connected via a water seal similar to that shown in Fig 3. A development of this system is the small bore sanitation system where surplus water from the septic tank is led to a waste stabilisation pond in a small diameter pipe.

c) OXFAM sanitation unit. A prepacked system with 20 squatting plates connected by pipe to two nylon reinforced rubber septic tanks. It is a complete system with all plumbing and tools and even the packing case is designed to provide screen walls. It has been proven in practice and 1 unit serves 1,000 people. It requires about 3,000 litres of non-saline water per day. It is comparatively expensive and is therefore only recommended for use where the water table or geology makes a pit system impractical.

4.9 Provision to deal with waste water, garbage and dust need to be considered. Sources of waste water need to be localised and drained either into open trench or soakage pits. Garbage should be disposed into strategically located bins or drums which should be collected daily and disposed of by fire and/or burial. The encouragement of shrubs and vegetation and the surfacing of roads should reduce dust nuisance.

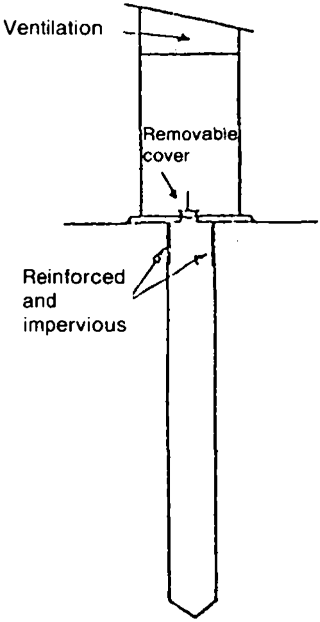


Figure No. 2 Bored Hole Latrine
(Example with squatting slab)

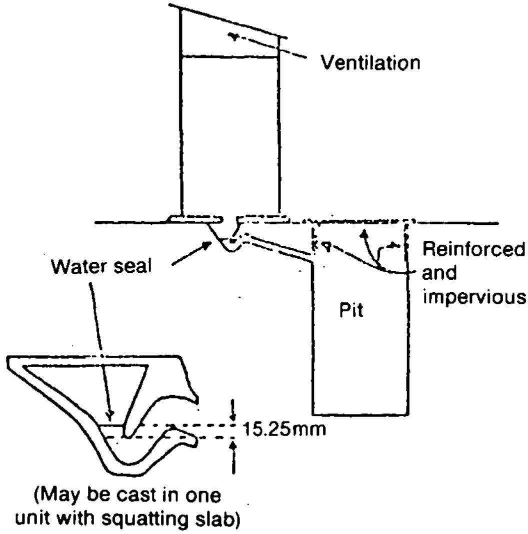


Figure No. 3 Pour-Flush (PF) Latrine
(Example with squatting slab)

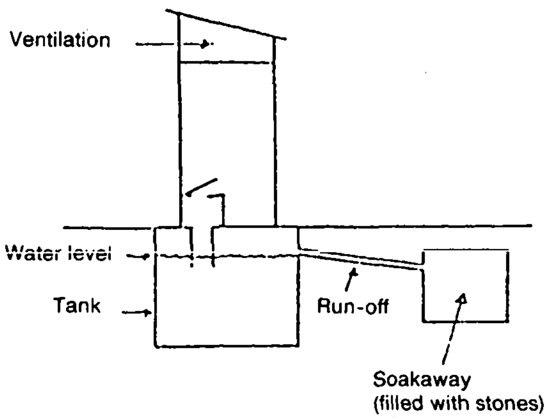


Figure No. 4 Aquaprivy (Example with seat)

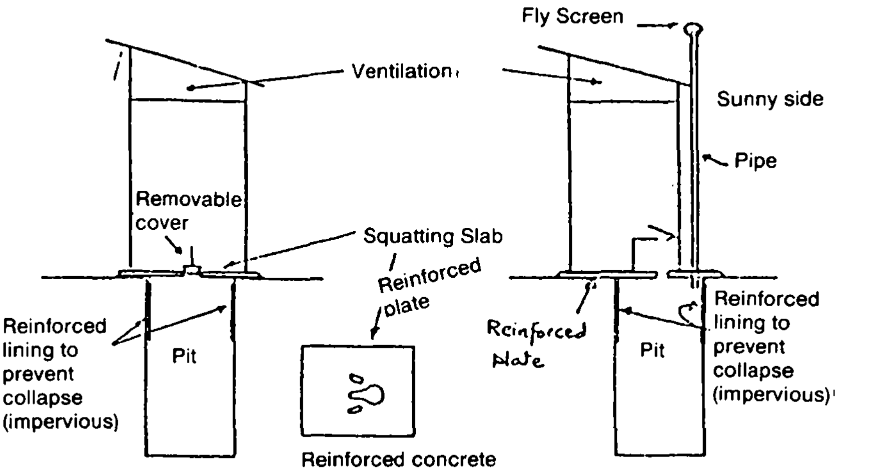


Figure No. 1. Basic Pit Latrine
(Example with squatting slab)

Ventilated improved Pit Latrine
(Example with seat)

4.10 Insect and rodent control should not be forgotten. Preventive action to destroy breeding areas is the first priority and if this fails, trapping, poisoning and spraying may be required. A food bounty for carcasses delivered can be effective.

Further information available in REDR library:

i) REDR Engineers' Field Manual - Chapter 25

ii) Small Excreta Disposal Systems - Ross Institute

iii) The OXFAM Sanitation Unit

iv) Rural Sanitation - Planning and Appraisal, - ITT

v) Water Treatment and Sanitation, Mann & Williamson

vi) Water Practice Manuals (Institution of Water Engineers and Scientists) Volume 3 Water Supply and Sanitation in Developing Countries 1983.

vii) Environmental Health Engineering in the Tropics - John Cairncross & Richard G. Feacham.

CHAPTER 5

FOOD SUPPLIES - STORAGE AND DISTRIBUTION

5.1 A relief operation involves the handling, storage, transporting and distribution of huge quantities of food, clothing, shelter, medical supplies and building materials, yet very often the organisation of this work is left almost to chance, sometimes with disastrous results.

5.2 It may be that the solution requires little more than the systematic application of common sense, to the necessary input of constraints and logistics, but it is an exercise that should be investigated and carried out in a logical manner.

5.3 First it is necessary to identify the first points of entry into the country and the modes of transport to that point, i.e. sea or airport or road crossing at the border. Next the modes of transport available between that point and the disaster area, i.e. road, rail or river, and the capacity of that mode to carry traffic. This would require the quantification of rail, barge or boat capacity or the strength of road pavements and bridges.

5.4 It is then necessary to make an estimate of the quantities of food and materials to be transported daily to the disaster area and the frequency and quantities of deliveries to the primary point of entry. Finally an inventory should be made of all the various transport vehicles available for the project, or an order made for the acquisition of such vehicles.

5.5 From this information it should be possible to plan a system with storage facilities at the points of trans-shipment from bulk transporter to local distribution vehicles. The principle should be that bulk stores should use the heaviest transport mode available as far as the infrastructure permits before being broken down into smaller loads.

5.6 In assessing the number of vehicles/barges/trains etc required, it is necessary to increase the estimate by at least 25% to allow for maintenance and breakdown and where large fleets of vehicles are to be engaged in a country with inadequate commercial repair facilities it will be necessary to set up a repair and servicing depot. Fuel stocks and refuelling arrangements should not be overlooked.

5.7 Stores should be no more elaborate than necessary for their protection against theft and the elements. An enclosure surrounded by barbed wire with goods stored on pallets and covered with plastic sheeting will serve in most cases.

CHAPTER 6
ROADS AND BRIDGES

6.1 The engineer's first task in approaching a transport problem is to carry out a survey of the road system as it exists, and to estimate the current traffic usage. Much documentary information in the form of maps and road inventory reports may be available from the local road authority, and, where an effective highway organisation exists the engineer's role will be to cooperate with them to identify suitable routes to carry relief traffic and to introduce a programme of strengthening and enhanced maintenance to deal with the extra traffic that the relief operation will generate.

6.2 Often, no such organisation exists and the relief engineer will need to carry out his own survey to categorise roads by type and to locate sources of road building materials. Low cost roads can be categorised as follows:

a) Dirt Roads - usually little more than a cleared track with minimum drainage and no selected surfacing material. The roads are capable of carrying no more than 15 to 20 light lorries per day, and become impassable in the wet season.

b) Roads surfaced with locally selected materials such as laterites, gravels or crushed rock and with an efficient drainage system. With good maintenance such a road can carry up to 150 medium lorries daily.

c) As above but with a bituminous surface dressing - can carry up to 500 medium lorries per day.

d) Roads with an increased depth of base with at least 15cms of crushed rock or gravel or stabilised soil, and 5cms of bituminous macadam. Can carry up to 2,000 vehicles per day, including heavy lorries.

6.3 Bridges should be assessed for strength but only in terms of the lorries likely to be available for use. Where the road is lightly trafficked, lorries can be controlled to slow them down and to ensure that not more than one vehicle is on the bridge at any one time. It is not unusual for details of the bridge design or construction to be unavailable, or for the structure to be of unconventional design - i.e. felled tree trunks or infilled sheet piling. In such cases enquiries into the current users will provide the best guide to strength capacity.

6.4 Where the roads require to be constructed or improved, two aspects are particularly important in low cost roads. First in width and alignment, single track roads with adequate verge width can successfully carry up to 500 vehicles per day with a regime of unloaded vehicles giving way to loaded ones. High speed alignment is not necessary and speed limits can be imposed where necessary. Route location is of obvious importance in achieving the best standards possible, and an examination of all maps, aerial photographs, and geological and weather information is a prerequisite to a good ground reconnaissance. The route should keep to higher ground and follow ridges in the interest of good drainage. Existing paths and tracks often follow the best alignment and local advice regarding flooding, wet weather swamps, location of springs and stream or river crossings is invaluable. The following table suggests alignment parameters:

		Min	Desirable
One Way Road	Paved width	3.5m	4.0m
	Overall width	5.0m	7.0m
Two Way Road	Pavement width	4.5m	7.5m
	Overall width	7.5m	10.5m

Normal Gradients	Light vehicles		**16%**	**4%**
	Heavy vehicles		**7%**	**4%**
Extreme Gradients (short lengths only)		Light vehicles	**25%**	-
		Heavy vehicles	**10%**	-
Crossfall			**3%**	**5%**
Horizontal Curves			**35m**	**100m**
Corners			-	**10m**
Vertical Sight Distance			**100m**	**150m**
Right of Way - cleared width			**20m**	**30m**

6.5 The second important aspect is drainage which is essential to enhance the strength of the sub-grade and base. An efficent system of side drains with frequent turnouts to reduce scour requires to be discharged into a natural run off or into a back drain and thence to an outfall. The provision of adequate camber and crossfall is the first stage of the drainage system and bituminous surface dressing does no more than protect the surface from the intrusion of rain water and maintains a necessary moisture content to prevent dusting in prolonged dry spells. Soiling and grassing of verges also protects them from erosion and dusting.

6.6 The provision of cross drainage under roads can be achieved using French drains, precast pipe or in situ stone or concrete for culverts. Armco corrugated steel culverts may be used and large diameter multi units can carry the flow of streams and small rivers. Cheap river crossings, such as fords or Irish bridges, or raft ferries may be used until more permanent structures can be provided, and propping existing bridge spans to increase loading capacity are obvious options.

6.7 The identification and location of suitable surfacing material is very important, but, because of transport constraints it will be necessary to select the best available within reasonable haul distance rather than to set a minimum or desirable standard. The best materials clearly are well graded coarse sands and gravels or crushed rock, but natural soils, provided they are largely granular with no more than 30% of low plastic clay can be very good provided their moisture content can be maintained about the optimum. Likely sources of materials are wadi beds and ox-bows, but trial pits alongside the proposed roads may reveal suitable layers of materials at a depth of 1 to 2 metres.

6.8 The assessment of available plant and labour is essential. Satisfactory roads can be constructed with pick and shovel if adequate labour is available; and refugees themselves should be employed wherever possible, possibly on a food incentive basis. The most important piece of plant for both construction and maintenance is a grader or skimmer blade mounted on a lorry. A blade dozer and tipping lorries are more important than compaction plant - usually the traffic itself provides efficient compaction if it can be controlled to avoid wheel tracking. The use of bituminous emulsions permits surface dressing by hand although a light roller is needed to embed the chippings.

6.9 Maintenance plays a much more important role if low cost roads are to be heavily trafficked. Its aim should be to restore and ensure good drainage by maintaining camber and crossfall and clearing ditches and waterways. Restricting traffic after heavy rains may prevent serious damage. Replacing lost surfacing material is a constant task, but all this can be achieved by hand labour organised in gangs of 6 to 8 men responsible for a section of 10 - 12kms long. They need to be equipped with hand tools and barrows or a pram and their work should be planned on a monthly task basis.. A gang leader should carry out a daily inspection of his length to arrange for emergency repairs. In remote areas, road camps may have to be established and serviced. Where labour is scarce, a grader, loading shovel and tipper truck can maintain camber and surfacing, but some labour is essential to keep drainage clear. Where bituminous surfaced roads are to be maintained a mobile unit with a lorry, bitumen and chippings and 4 men can look after about 80 to 100kms of road.

Other literature available in the REDR library:

i) REDR Engineers Field Manual - Chapter 8

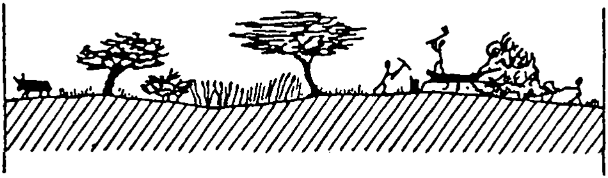
ii) Road Note 31. Bituminous surfaced roads in tropical and sub-tropical countries - TRRL

iii) Note on the Basics of Road Construction

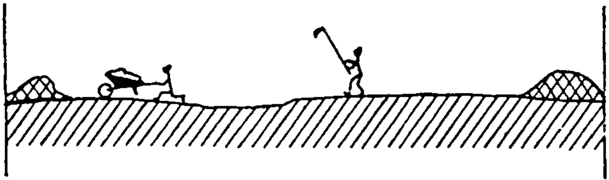
iv) Lesotho Technical Manual - Scott Wilson Kirkpatrick

v) Royal Engineers' Supplementary Pocket Book No. 5A - Roads.

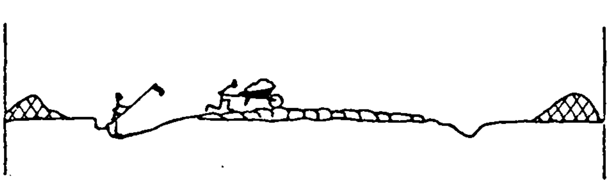
HOW TO MAKE A SIMPLE EARTH ROAD



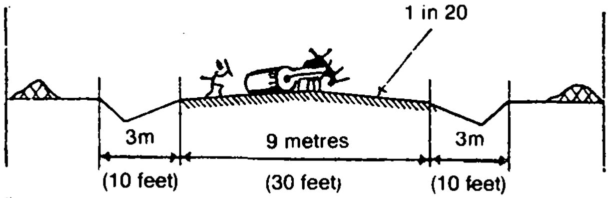
1
Clear trees, bushes and roots. Clear trees far enough to keep road in sunshine.



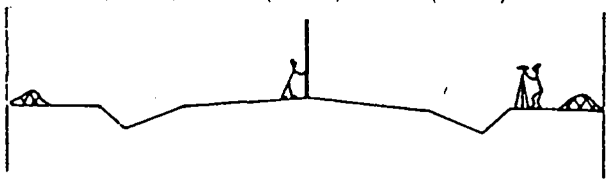
2
Strip off top soil for at least 8 metres from centre of road.



3
Dig wide ditches and dump sub-soil towards centre line to raise road level.



4
Complete the ditches and roll, compact the formation using minimum slopes and widths shown.



5
Check the slopes and levels on formation and along ditch to make sure that water can run away.

6
Lay the topsoil on the ditch slopes to encourage grass to grow again.

Now MAINTAIN IT

- keep drains clear
- fill in holes
- maintain slopes

Figure No. 1