"Documento original en mal estado"

Sponsored by the Department for International Development (DFID)

EMERGENCY WATER SOURCES

GUIDELINES FOR SELECTION AND TREATMENT

Sarah House and Bob Reed

Water, Engineering and Development Centre (WEDC)
Loughborough University UK

1

INTRODUCTION AND INSTRUCTIONS FOR USE

About these guidelines

These guidelines have been designed to help those involved in the assessment of emergency water sources to collect relevant information in a systematic way, to use this information to select a source or sources and to determine the appropriate level of treatment required to make the water suitable for drinking.

The guidelines, however, are not limited to the selection and treatment of water sources. The information collected will also be useful for:

- the design and costing of the water supply system;
- the ordering of material and equipment;
- the organization of human resources; and
- the implementation of the project.

A thorough assessment at an early stage will save valuable time later on.

Specifically, the guidelines will:

- act as an *aide-mémoire* to assessors;
- help to fill any knowledge gaps; and
- assist in the training of future assessors to undertake this occasional task, allowing them to learn from past experiences.

The selection tools and guidelines are not a replacement for experience. They should be used with engineering judgement and intuition gained from experience of emergency responses. They are not intended to make the assessor a specialist in all the skill areas but to support a basic understanding. Reference has been made where specialist help may be required (e.g. from a hydrogeologist or to interpret industrial pollution laboratory results). The assessor will need to study these documents and preferably have training in their use prior to using them in the field. A training pack has been developed to support this document and may be obtained from the authors.

What is an 'emergency'?

Perceptions of what constitutes an 'emergency' varies between personnel and between organizations. Organizations that concentrate on the initial stages of an emergency understandably consider their problems to be paramount whereas those that support affected populations for many years after the initial event consider the problems of the longer term to be equally important. These guidelines have been developed to cater for the requirements of both parties and those holding intermediate views.

Using definitions given in Davis and Lambert (1995 p1) 'disasters' can be either natural or induced by humans. They can be slow or sudden onset and they 'result in a serious disruption of society, cause widespread human suffering and physical loss or damage, and stretch the community's normal coping mechanisms to breaking point'. *The term 'emergency' is used to describe the crisis that arises when a community has great difficulty in coping with a disaster. External assistance is needed, sometimes lasting for many months, perhaps years.*

Assessors may have to work in a wide variety of scenarios, which include:

- responses required immediately after the event or some years after,
- natural or man-made disasters (e.g. flooding, war or chemical disasters),
- sudden onset or slow-onset disasters (e.g. earthquake or drought),
- operational local and national authorities or none,
- plentiful supply of surface water or an area dependant on groundwater and rainwater,
- high security risks (especially in conflict areas) or no security problem,
- serious logistical and resource problems or easy access to resources, and
- affected populations are displaced or there is limited displacement.

Each of these scenarios will require a different response and will have different constraints. The guidelines will therefore have to be adapted accordingly.

The term 'affected population' has been used to describe refugees, internally displaced persons, returnees who may be accommodated in temporary camps, and populations whose lives have been modified by the emergency but who have not been displaced. However, the documents also refer to 'local populations' which infers that the local and affected populations are different. This differentiation aims to ensure that local communities are not forgotten when there is a displacement into an area. The terms will require adaptation to suit a non-displacement situation where the affected populations and the local populations are one and the same.

Socio-political, legal, cultural and security issues

Often in emergency situations, the factors which dictate what can be undertaken to provide basic services are linked to socio-political, legal, cultural or security issues. The guidelines therefore emphasize these issues. A case study section has been included to describe some of the complex scenarios under which assessors have worked and some responses which were used.

Approach

Water source selection in an emergency situation needs a phased or upgrading approach. However it is important to recognize that there are constraints to future upgrading, such as

- a lack of commitment from the implementing organizations, local and affected populations
- a lack of finances (funds are often more widely available in the acute stages of an emergency than later on) and
- political restrictions

Therefore decisions made in the initial phases of the emergency are likely to affect longer term options

These guidelines use the terms 'survival supply' (the immediate response to an emergency) and 'longer term supply' (subsequent responses including improvements to survival supply and for the longer term). The survival supply requires quick assessment and decision making and the longer term supply requires a more thorough assessment and a more holistic approach. Below are two alternative descriptions of the stages of an 'emergency' and the corresponding terminology used in these guidelines. Every emergency is different and the generalizations noted here will not fit every situation. Specific situations, for example conflicts, may require a significantly longer period at the survival level of supply, and in other emergencies survival responses may have to be re-introduced at a later date.

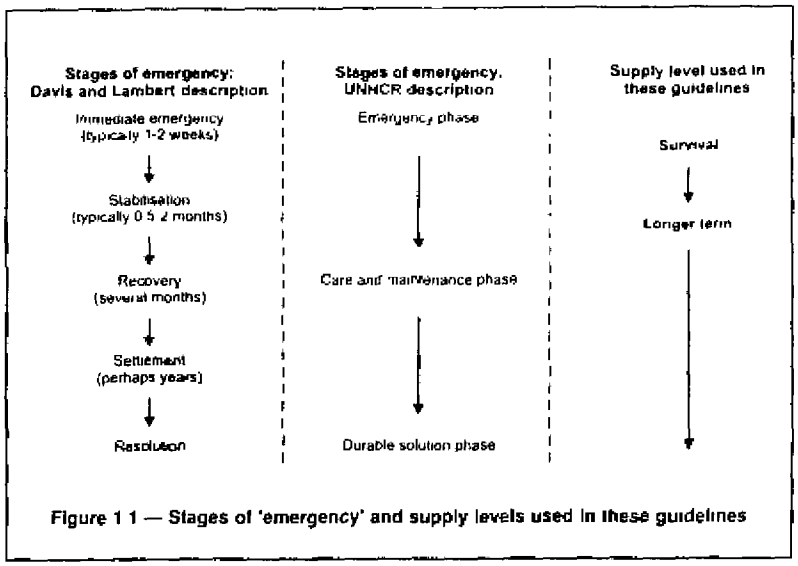


Figure 1.1 — Stages of 'emergency' and supply levels used in these guidelines

Time targets for assessments

Estimated time to undertake the assessment procedure (including general orientation) starting from arrival in-country or in-field is:

- survival supply: 1 – 3 working days
- longer term supply: 3 – 7 working days

These time periods will not be possible for every scenario but are general targets.

Instructions for use

Section 2 identifies procedures and provides tools for the selection of water sources for survival supply (usually most appropriate in the initial stages of an emergency). Section 3 identifies procedures and provides tools for the selection of a water source for longer term supply (anything other than survival supply). Within these sections are procedural flowcharts, selection tools, checklists for information gathering and survey sheets.

Section 4 contains supporting information on specific issues or assessment procedures.

Section 5 contains a glossary, useful addresses, details of field equipment and a bibliography.

It is suggested that the assessor should read through and become familiar with the contents of Sections 2 and 3 and only use Sections 4 and 5 when there is a specific query. Not all assessors will want to use the total contents of Sections 2 and 3. However, specific items, for example the checklists, may be useful even to experienced assessors, and reading through these sections may still be a good revision exercise.

To use Sections 2 and 3 follow these five steps:

1. Study the flowchart which highlights the steps that need to be taken to assess water sources. It identifies how the procedure described in that section fits into the overall programme for installing an emergency water supply.

2. Study the selection tools to understand what must be considered when selecting a treatment process and water source.

3. Work through the checklists collecting as much information as possible which is appropriate to the particular scenario. Record the information on the survey sheets or in another accessible form.

4. When as much information as possible has been collected, return to the selection tools and use them as required. If some of the necessary information is not available at the time then assumptions will have to be made.

5. If additional information later becomes available, the selection should be re-assessed to see if it needs to be modified.

Acknowledgements

Thanks go to all individuals and organizations who have been involved in the study or have given permission to reproduce extracts from existing documents. It is hoped that the wide range of organizations and individuals who have contributed to the work will ensure that it is likewise useful to a wide user group and in a range of emergency situations.

All contributions are gratefully acknowledged. It should be noted, however, that the opinions in this document are solely those of the authors.

The following individuals have contributed in detail to the research either in their role as peer reviewers, or by testing the work in the field, or by providing information for specific sections of the work.

Annick Barros	*IFRC (Bukavu, Zaire)*
Barend Leuwenberg	*MSF-H (Head Office)*
Bob Elson	*WEDC, Loughborough University (UK)*
Bobby Lambert	*REDR (Head Office – peer reviewer)*
Brendan Doyle	*UNICEF (Head Office – peer reviewer)*
Daniel Mora-Castro	*UNHCR (Head Office – peer reviewer)*
Denis Herdebroek	*MSF-H (Head Office – peer reviewer)*
Dixon Chanda	*MSF H (Head Office)*
Gary Campbell	*Independant Consultant representing UNHCR (Addis Ababa, Ethiopia)*
Koos Messelink and Bonane Cikota Rugendabanga	*MSF-H (Uvira, Zaire)*
Lila Pieters and Kalubi Misombo	*UNICEF (Bukavu, Zaire)*
Paul Larcher	*CEU, Loughborough University (UK)*
Riccardo Conti	*ICRC (Head Office – peer reviewer)*
Richard Luff	*OXFAM (Head Office – peer reviewer)*
Stuart Dale, Nina Ladner and Geoff Russell	*Public Health Laboratories, Loughborough University (UK)*
Tom de Veer	*De Veer Consultancy (The Netherlands)*
Uli Jaspers	*IFRC (Head Office – peer reviewer)*
Vincent Chordi and Anteneneh Tesfaye	*UNHCR (Regional Liason Office, Addis Ababa, Ethiopia)*
Yves Chartier and Gilles Isard	*MSF-F (Head Office – peer reviewer)*

The following individuals have also contributed to the study by being involved in interviews or discussions on sub-sections of the work or providing information in the field or from head office.

Abdi Awil Hersai	*UNHCR (Jijiga, Ethiopia)*
Abebe Chekole	*Fundika Town Committee (Dimma, Ethiopia)*
Ahmed Hussein	*Water Resources Bureau (Jijiga, Ethiopia)*
Amaha Altaye	*UNHCR (Regional Liason Office, Addis Ababa, Ethiopia)*
Angelo de Bernardo	*MSF-H*
Aregawi Hagos	*OXFAM (Addis Ababa, Ethiopia)*

Application

In most emergencies there will be more than one potential water source. The options could include surface or groundwater near to the site, or tankered or bottled water brought from a distance. The guideline procedures will encourage the assessor to look at as many source options as possible, not just the most obvious ones. It may be, however, that there is only one viable option and in this case the procedures set out in these guidelines will still be useful. They will help the assessor to identify the requirements to develop the source and to highlight key considerations. Some assumptions will have to be made during the assessments, particularly in the initial stages of an emergency, but the number of assumptions should be limited by efficient and logical information gathering. Any assumptions that are made should be verified as soon as possible.

Guideline user group

The guidelines may be useful to a range of personnel involved in the selection of emergency water sources and treatment processes. These could include:

- national or local government personnel from the affected country;
- field staff from local or international organizations who may have limited previous experience in this task (field staff would have a basic technical understanding but this may not specifically be engineering or water related); and
- senior staff who have significant experience in the assessment process in a range of different scenarios.

Assessors will usually work within a team comprised of either all nationals or a mixture of national and international personnel. The effective use of team members for information gathering can save time. The areas which require investigation are multi-disciplinary and cross over several fields e.g. health, social and technical. Use should be made of personnel from these disciplines where they are available.

Although assessments may be undertaken by national or international personnel, reference has been made in information gathering to the 'host country' and the 'donor country' to differentiate when this is the case. The terms will therefore have to be adapted to suit a situation where the host country and the donor country are one and the same.

Relationship between source selection with other activities

Water source and site selection are interdependent. Which is considered first will depend on the situation, particularly the political constraints. Ideally the site should be chosen on the basis of the suitability of the water source but in many cases the water source will have to be chosen in relation to a particular site.

This work focuses on the selection of water sources in relation to a particular site but obviously the same procedures can be followed for several sites The urgency of the decision will be a restricting factor to the thoroughness of the assessment

Source selection for drinking water is also affected by, and related to, sanitation, hygiene practice, drainage, irrigation and similar activities The guidelines point to the need to consider supplementary or ancillary activities where necessary

In many cases the person evaluating the source and treatment requirements will be also producing the whole water supply project proposal Attempts have been made in the guidelines to acknowledge this and to point out to additional information which may be required for this activity

Completeness of surveys

It is accepted that every emergency situation will be different and the skill level and experience of the assessor will also vary Hence, the guidelines are subdivided into sections which can be used or omitted as appropriate Not all of the survey information will be collected on each occasion but by highlighting its relevance the assessor can at least consider its appropriateness to his / her situation Using information from a range of sources allows confirmation or otherwise of initial findings or assumptions

The assessment steps as highlighted by the flowcharts S1 and L1 show only one of the many possible routes to assessment. The procedures have been represented in this way to try and make the assessor think of how logical and methodical his/her information gathering and decision-making are and as a guide to possible improvement The procedures will have to be used with common sense and adapted to suit specific situations

Record keeping

Good records should be kept of all gathered information and they should be stored in such a way that others can access them Information gathering takes time and hence the assessor (or those following the assessor) should not have to repeat work because of inefficient record keeping The survey sheets included in this document are designed to help with efficient record-keeping They may be enlarged from A5 to A4 and further blank sheets attached where space for completion is inadequate

Photographs and sketches

Photographs and sketches of water sources and supplies are very useful for decision-making especially for anyone referring to the survey who was not involved in the initial assessment

Time targets for assessments

Estimated time to undertake the assessment procedure (including general orientation) starting from arrival in-country or in-field is:

- survival supply: 1 – 3 working days
- longer term supply: 3 – 7 working days

These time periods will not be possible for every scenario but are general targets.

Instructions for use

Section 2 identifies procedures and provides tools for the selection of water sources for survival supply (usually most appropriate in the initial stages of an emergency). Section 3 identifies procedures and provides tools for the selection of a water source for longer term supply (anything other than survival supply). Within these sections are procedural flowcharts, selection tools, checklists for information gathering and survey sheets.

Section 4 contains supporting information on specific issues or assessment procedures.

Section 5 contains a glossary, useful addresses, details of field equipment and a bibliography.

It is suggested that the assessor should read through and become familiar with the contents of Sections 2 and 3 and only use Sections 4 and 5 when there is a specific query. Not all assessors will want to use the total contents of Sections 2 and 3. However, specific items, for example the checklists, may be useful even to experienced assessors, and reading through these sections may still be a good revision exercise.

To use Sections 2 and 3 follow these five steps:

1. Study the flowchart which highlights the steps that need to be taken to assess water sources. It identifies how the procedure described in that section fits into the overall programme for installing an emergency water supply.
2. Study the selection tools to understand what must be considered when selecting a treatment process and water source.
3. Work through the checklists collecting as much information as possible which is appropriate to the particular scenario. Record the information on the survey sheets or in another accessible form.
4. When as much information as possible has been collected, return to the selection tools and use them as required. If some of the necessary information is not available at the time then assumptions will have to be made.
5. If additional information later becomes available, the selection should be re-assessed to see if it needs to be modified.

Acknowledgements

Thanks go to all individuals and organizations who have been involved in the study or have given permission to reproduce extracts from existing documents. It is hoped that the wide range of organizations and individuals who have contributed to the work will ensure that it is likewise useful to a wide user group and in a range of emergency situations.

All contributions are gratefully acknowledged. It should be noted, however, that the opinions in this document are solely those of the authors.

The following individuals have contributed in detail to the research either in their role as peer reviewers, or by testing the work in the field, or by providing information for specific sections of the work.

Annick Barros	*IFRC (Bukavu, Zaire)*
Barend Leuwenberg	*MSF-H (Head Office)*
Bob Elson	*WEDC, Loughborough University (UK)*
Bobby Lamben	*REDR (Head Office – peer reviewer)*
Brendan Doyle	*UNICEF (Head Office – peer reviewer)*
Daniel Mora-Castro	*UNHCR (Head Office – peer reviewer)*
Denis Heidebroek	*MSF-H (Head Office – peer reviewer)*
Dixon Chanda	*MSF H (Head Office)*
Gary Campbell	*Independant Consultant representing UNHCR (Addis Ababa, Ethiopia)*
Koos Messelink and Bonane Cikola Rugendabanga	*MSF H (Uvira, Zaire)*
Lila Pieters and Kalubi Misombo	*UNICEF (Bukavu, Zaire)*
Paul Larcher	*CEU, Loughborough University (UK)*
Riccardo Conti	*ICRC (Head Office – peer reviewer)*
Richard Luff	*OXFAM (Head Office - peer reviewer)*
Stuart Dale, Nina Ladner and Geoff Russell	*Public Health Laboratories, Loughborough University (UK)*
Tom de Veer	*De Veer Consultancy (The Netherlands)*
Uli Jaspers	*IFRC (Head Office – peer reviewer)*
Vincent Chardi and Antenneh Tesfaye	*UNHCR (Regional Liason Office, Addis Ababa, Ethiopia)*
Yves Chartier and Gilles Isard	*MSF-F (Head Office – peer reviewer)*

The following individuals have also contributed to the study by being involved in interviews or discussions on sub-sections of the work or providing information in the field or from head office.

Abdi Awil Hersai	*UNHCR (Jijiga, Ethiopia)*
Abebe Chekole	*Fundika Town Committee (Dimma, Ethiopia)*
Ahmed Hussein	*Water Resources Bureau (Jijiga, Ethiopia)*
Amaha Alaye	*UNHCR (Regional Liason Office, Addis Ababa, Ethiopia)*
Angelo de Bernardo	*MSF-H*
Aregawi Hagos	*OXFAM (Addis Ababa, Ethiopia)*

Amos Szkudlarek	*MSF-H*
Bedlu Wagari	*MSF-F*
Brian Skinner	*WEDC, Loughborough University (UK)*
Chris Buckley	*University of Natal (South Africa)*
Chris Preston	*OXFAM (UK)*
David Byakweli	*CARE (Chimanga near Bukavu, Zaire)*
David Lashley	*David Lashley and Partners Inc. (Barbados)*
David Parrums	*UNHCR (Uvira, Zaire)*
Dr Berhanu Dibaba	*Administration of Refugee and Returnee Affairs (Addis Ababa, Ethiopia)*
Dr Elias Mitsale Mo	*Administration of Refugee and Returnee Affairs (Tefen Ber, Ethiopia)*
Dr F Bassani	*World Health Organization (Switzerland)*
Dr R Galal-Gorchev	*World Health Organization (Switzerland)*
Dr John Tabayi	*UNHCR (Regional Liason Office, Addis Ababa, Ethiopia)*
Dr Sandy Cairncross	*London School of Hygiene and Tropical Medicine (UK)*
Dr S Ben Yahmed	*World Health Organization (Switzerland)*
Dr Timothy Ama	*Administration of Refugee and Returnee Affairs (Dimma, Ethiopia)*
Erimias Gotton	*Administration of Refugee and Returnee Affairs (Dimma, Ethiopia)*
Eshetu Abate	OXFAM (Addis Ababa, Ethiopia)
Fouad Hikmat	*MSF-H*
Francis Mulemba	*MSF-F*
Ghidey Gieglabher	*Water Resources Bureau (Jijiga, Ethiopia)*
Gino Henry	*REDR (UK)*
Giselle Rouquie	*MSF-H (Uvira, Zaire) / MSF-F*
Habtamu Tekleab	*CARE (Tefen Ber, Ethiopia)*
Hailu Kebede	*ARRA (Dimma, Ethiopia)*
James W Burton	*UNDP / Emergencies Unit of Ethiopia (Addis Ababa, Ethiopia)*
Jean Luc Bruno	*MSF-B (Bujumbura, Burundi)*
Jim Howard	*Independent Consultant, Water and Environmental Engineer (UK)*
John Adams	*OXFAM (Head Office)*
John Fawell	*National Centre for Environmental Toxicology, WRc (UK)*
K S Nair	*CARE (Jijiga, Ethiopia)*
Kim Waterhouse	*REDR (UK)*
Kristof Bosleon	*MSF-B*
Lori D Berg	*Step by Step (USA)*
Major T. Duggleby	*British Army Water Development Team*
Manuel Jagour	*MSF-F (Bujumbura, Burundi)*
Margaret Ince	*WEDC, Loughborough University (UK)*
Mark D Bidder	*UNDP / Emergencies Unit of Ethiopia (Addis Ababa, Ethiopia)*
Mark Graham	*Umgeni Water (South Africa)*
Mesfin Lema	*UNICEF (Addis Ababa, Ethiopia)*
Michael Smith	*WEDC, Loughborough University (UK)*
Mohammed Rafi Aziz	*MSF-B*
Mohammed Said	*Water Resources Bureau (Jijiga, Ethiopia)*
Mohammed Zaheoil Islam	*MSF-H*
Moltot Haile	*Water Resources Bureau (Jijiga, Ethiopia)*
Mr Guy	*British Army Water Development Team*
Nick Wilson	*REDR (UK)*
Paul Andre Monette	*MSF-B*

Paul Keating	*REDR (UK)*
Paul Kremers	*MSF-H (Uvira, Zaire)*
Paul Steadman	*Environmental Engineering Group University of Newcastle upon Tyne (UK)*
Paul van Haperen	*MSF-H (Uvira Zaire)*
Peter Stern	*Author and Civil Engineer (UK)*
Pole Kore	*Dimma Refugee Representative Committee (Dimma, Ethiopia)*
Professor H H Dieter	*Umweltbundesamt Institute for Water, Soil and Air Hygiene (Germany)*
Richard Jabot	*MSF-F*
Sahid Ibrahim	*Water Resources Bureau (Jijiga, Ethiopia)*
Selemani Balongelwa	*MSF H (Uvira, Zaire)*
Shimeles Makonnen	*OXFAM (Addis Ababa Ethiopia)*
Sobhi M Abdel-Hai	*UNICEF (Addis Ababa Ethiopia)*
Tim Forster	*Merlin (UK)*
Timothy David Boucher	*MSF-B*
Tudor T Davies	*United States Environmental Protection Agency (USA)*
Waldu Muhray	*OXFAM (Head Office)*
Wies Van Bammel	*UNHCR (Regional Liaison Office, Addis Ababa, Ethiopia)*
Yirku Adere	*Administration of Refugee and Returnee Affairs (Addis Ababa, Ethiopia)*
Yohannes Gebremedhin	*Water Supply and Sewerage Department (Addis Ababa, Ethiopia)*

Permission was given to reproduce extracts from the following publications

- Brassington, R (1988) *Field Hydrogeology*, John Wiley & Sons UK

  Cairncross, S. & Feachem, R (1978) *Small water supplies*, Bulletin No 10, Ross Institute London

  Carror, R.F (1991) *Disposal of domestic effluents to the ground*, Overseas Building Note 195, Building Research Establishment

  Davis, J & Lambert, R (1995) *Engineering in Emergencies A practical guide for relief workers*, Intermediate Technology Publications, London

  de Lange, E (1994) *Manual for Simple Water Quality Analysis* IWT Foundation The Netherlands

- Foerster, J (1996) *Uvira Water Supply Project* Internal Report, ICRC /ARC, Melbourne, Australia.

  ICRC (1994) *Water and War Symposium on Water in Armed Conflicts* Montreux 21 – 23 November 1994, ICRC,

  Jordan, T D Jnr (1984) *A Handbook of Gravity Flow Water Systems*, Intermediate Technology Publications, London.

- Lashley, D (1997) *Vulnerability Assessment of the Drinking Water Supply Infrastrucutre of Montserrat*, Pan American Health Organization

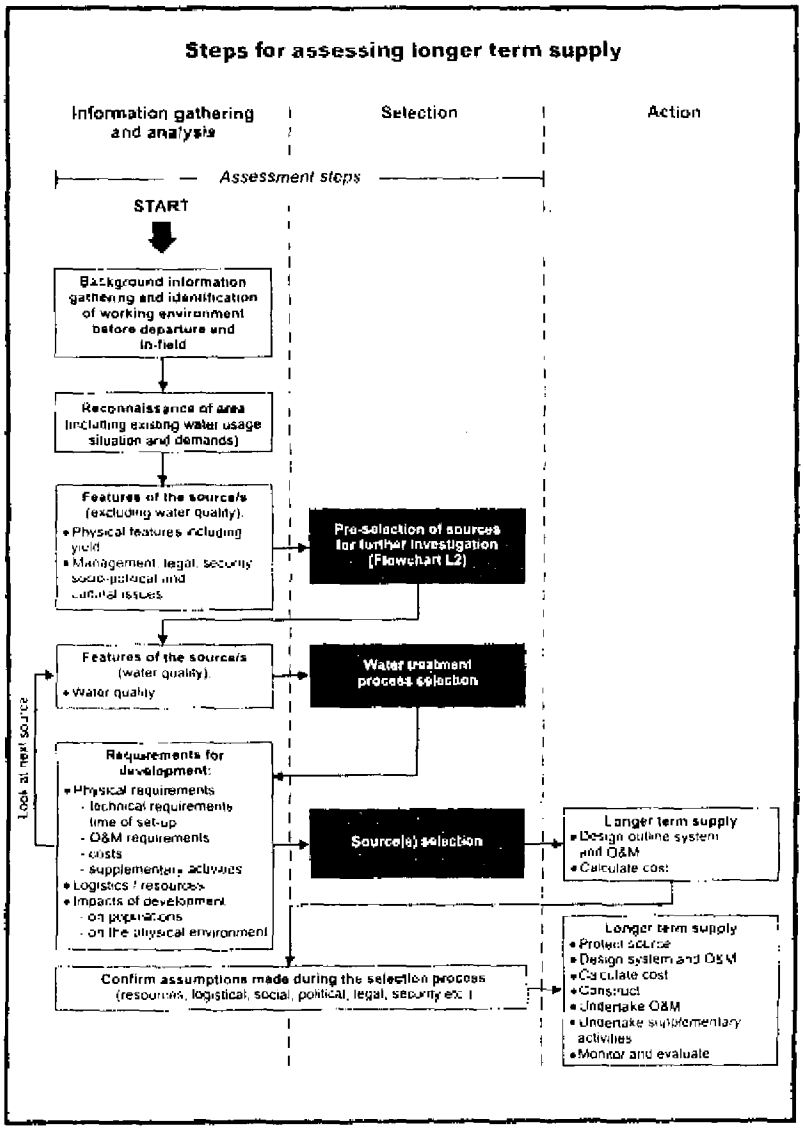
  MSF (1994) *Public Health Engineering in Emergency Situations*, MSF Paris, France

- Pacey, A. & Cullis, A. (1986) *Rainwater Harvesting The collection of rainfall and run-off in rural areas*, Intermediate Technology Publications, London

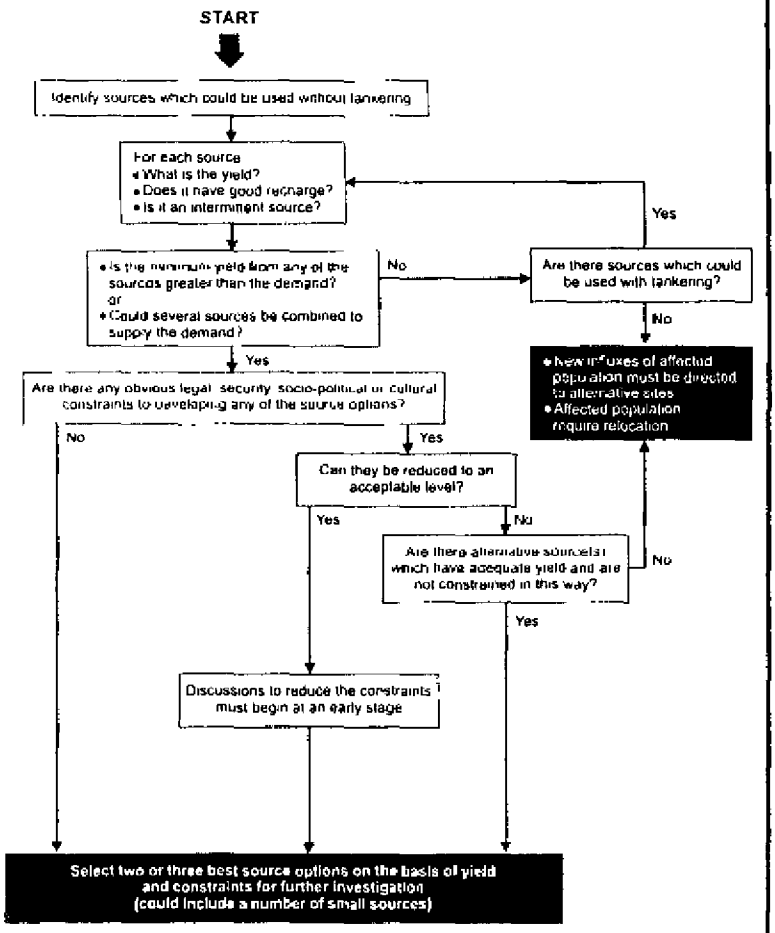
3

LONGER TERM SUPPLY

Survey sheets **79**


Steps for assessing longer term supply
Information gathering and analysis
Selection
Action
Assessment steps
START
Background information gathering and identification of working environment before departure and in-field
Reconnaissance of area (including existing water usage situation and demands)
Features of the source/s (excluding water quality):
• Physical features including yield
• Management, legal, security, socio-political and cultural issues
Pre-selection of sources for further investigation (Flowchart L2)
Features of the source/s (water quality):
• Water quality
Water treatment process selection
Look at next source
Requirements for development:
• Physical requirements
- technical requirements
time of set-up
- O&M requirements
- costs
- supplementary activities
• Logistics / resources
• Impacts of development
- on populations
- on the physical environment
Source(s) selection
Longer term supply
• Design outline system and O&M
• Calculate cost
Confirm assumptions made during the selection process (resources, logistical, social, political, legal, security etc.)
Longer term supply
• Protect source
• Design system and O&M
• Calculate cost
• Construct
• Undertake O&M
• Undertake supplementary activities
• Monitor and evaluate

Pre-selection of sources for further investigation



Water treatment process selection for longer term supply

Introduction

There is more benefit gained in terms of health and convenience from supplying large quantities of reasonable quality water than small quantities of very good quality water. However the aim should be to provide adequate quantities of good quality water.

The main objective of water treatment for drinking water is to remove anything which is harmful to health such as pathogenic organisms, toxins, and carcinogens. Assuming high levels of toxic chemicals are not present in the water, pathogenic organisms are the most serious threat to health in the short term.

Disinfection (usually chlorination) is used to destroy the pathogenic organisms. In non emergency situations certain waters may not require disinfection (e.g. deep groundwater, mountain streams) as the faecal contamination may be low at the point of supply. However, because of the large numbers of possibly traumatized people in confined spaces, and the fact that contamination often occurs in individual containers after distribution, disinfection should be used whenever possible in emergencies as an added precaution.

The main constraint to eliminating pathogenic organisms is high turbidity, as turbidity prevents effective disinfection and hence can allow the passage of pathogenic organisms to the user. A range of solutions are available to remove turbidity, the most common ones being storage sedimentation, and assisted sedimentation (coagulation, flocculation, and sedimentation). It is possible that in the next few years there may also be an increase in the use of roughing filtration, as a range of institutions and organizations are working to develop such systems for use in emergency situations.

Other processes can be added depending on the water quality problems. Examples include the use of aeration, pH adjustment, and activated carbon.

In the initial stages of an emergency water must be supplied quickly, so an upgrading approach to treatment is necessary.

The availability of material resources and organizational preferences often dictate the solutions chosen for water supply. Variations include the following:

- Organizations may send in equipment before a thorough assessment has been undertaken so as to ensure a speedy implementation phase. **Several organizations have their own modular kits which simplify the process of equipment selection, installation, operation, and maintenance.** The modular items of kit include pumps, water tanks, and distribution systems including pipelines and tapstands.

- **Some organizations also have modular 'mobile' treatment units which are very expensive but useful in the immediate stages of an emergency, especially for industrially polluted waters or to supply specific units such as health centres.** See pp283-4 for details of a selection of modular kits and mobile treatment units.

Other organizations prefer to use **local materials, methods, and skills** wherever possible to benefit the local populations and to improve the effective operation and maintenance of systems over the longer term

How to use this section

Study the following:

- Figure 3.1, below
- Tables pp41-2, which highlight water quality problems versus treatment options and give guideline quality levels; and
- Figure 3.2 which links the water treatment processes in a water supply scheme, p43.

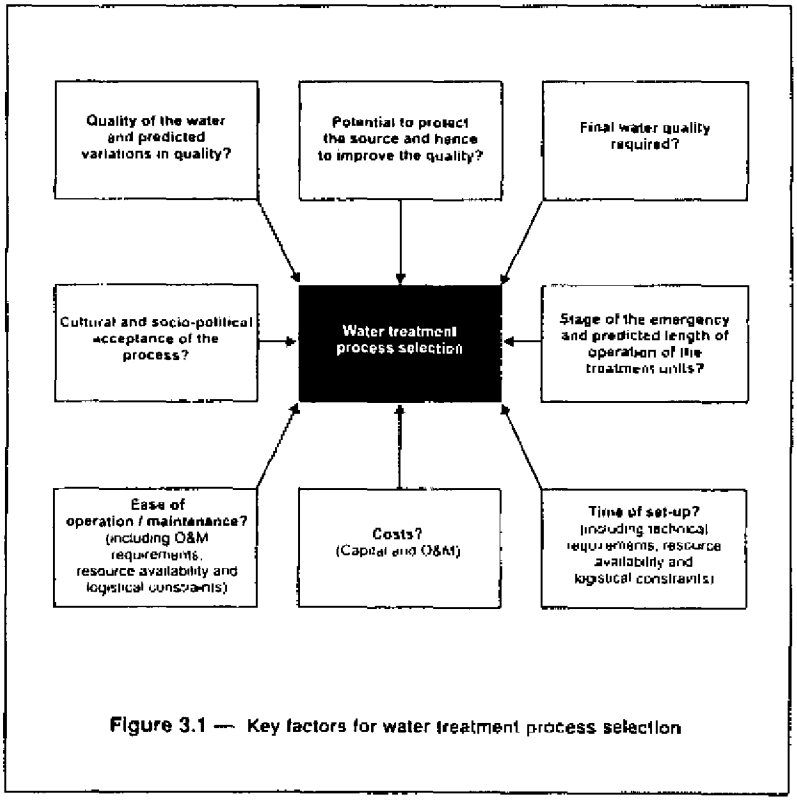


Figure 3.1 — Key factors for water treatment process selection

Complete the *Water treatment process selection tools* tables pp44-5, using the information noted on p40 and the following background information:

Water quality assessment routines, section pp148-53,
Water quality parameter summary tables, pp170-3
Features of water treatment processes, pp214-23 and
Mobile treatment units and modular kits section pp283-4

Instructions on how to use Tables pp44-5 are included within the tables

Common water quality problems versus treatment options

1A	1B	1C	1D	1F	1F
Parameter / issue	**Methods of assessment**	**Guide levels (max.)** (see tables pp170-3 for further information)			**Treatment process options or avoidance activities** (listed in general order of longer term preference for supply of populations in settlements rather than dispersed or for the short term)
		Survival	**Longer term** (min. recommended level)	**Longer term** (WHO)	
Floating solids	sanitary investigation, observation, local knowledge	no large solids	none visible	none visible	screen water at or near to the inlet
Turbidity	sanitary investigation, observation, local knowledge, biological survey, water quality analysis	20 NTU	10 NTU	5 NTU (1 NTU for disinfection)	infiltration
					storage and sedimentation
					roughing filtration
					assisted sedimentation
					use mobile treatment units including assisted sedimentation and / or rapid sand filtration (RSF)
Faecal pollution (E coli level or sanitary risk)	catchment mapping, sanitary investigation, observation, local knowledge, water quality analysis	<1000 *E coli*/100ml	<10 *E coli*/100ml	0 *E coli*/100ml	protect source, slow sand filtration (SSF) and disinfect with chlorine
		sanitary risk	sanitary risk	sanitary risk	protect the source and disinfect with chlorine
		medium - low	low	low	for very high levels of contamination (>1000 *E coli*/100ml) pre-chlorinate prior to, and in addition to, pre-treatment (but not if SSF used)
pH (needs modifying for assisted sedimentation, disinfection or corrosion purposes)	local knowledge, water quality analysis	See tables p[illegible]71 and p216 for specific treatment process requirements			adopt different technologies which work well within the natural pH range
					add lime to raise the pH or an acid to lower it (adjust the pH only if essential)
					modify quantities of treatment chemicals to compensate for an unsuitable pH

Notes

1 Colour, taste, conductivity, chlorine demand and permanganate value are all water quality tests which can indicate the presence of the parameters noted in tables pp41-2

2 The treatability tests (p173 and pp176-83) can help to identify the treatment process suitable for the particular water

3 **In all cases, if a source needs to be treated, look for alternative sources that require less or simpler treatment which may potentially be more suitable**

4 Treatment options noted in this table are those commonly used. Local alternatives may be more suitable and should be identified in the field

5 National water quality standards and WHO guideline values should always be aimed at all stages of an emergency. However, should this not be possible the above figures may be used as a last resort guide

Occasional water quality problems versus treatment options

2A Parameter / feature	2B Methods of assessment	2C Guide levels (max.) (see table pp170-3 for further information) Survival	2D Longer term (min. recommended level)	2E Longer term (WHO)	2F Treatment process options or avoidance activities (listed in general order of longer term preference for supply of populations in settlements rather than dispersed or for the short term)
Chloride	sanitary investigation / observation local knowledge water quality analysis	600mg/l	250mg/l	250mg/l	blend sources
					move camp
					use mobile treatment units with reverse osmosis
					distillation
Fluoride	local knowledge water quality analysis	3mg/l	1.5mg/l	1.5mg/l	blend sources
					move camp
					high dose assisted sedimentation with aluminium sulphate and lime (Nalgonda process)
					contact with activated alumina
					contact with bone char
					use mobile unit with reverse osmosis
Iron or manganese	sanitary investigation / observation local knowledge water quality analysis	Fe Mn	Fe 1.0mg/l Mn 0.5mg/l	Fe 0.3mg/l Mn 0.1mg/l	aerate water prior to main treatment processes including sedimentation or filtration
					pre-chlorinate prior to sedimentation or filtration (but not SSF)
Nitrate (or nitrite)	catchment mapping sanitary investigation / observation local knowledge biological survey water quality analysis	50mg/l as NO_3 3mg/l as NO_2	50mg/l as NO_3 1mg/l as NO_2	50mg/l as NO_3 3mg/l as NO_2	blend water from two sources
					move the camp
					use mobile treatment units with reverse osmosis
Sulphate	catchment mapping local knowledge water quality analysis	400mg/l	400mg/l	400mg/l	blend water from two sources
					use mobile treatment units with reverse osmosis
Algae	sanitary investigation / observation		No visible algae		protect source from the addition of nutrients
					roughing filtration with graded media
					pre-chlorinate prior to main treatment (but not SSF)
					reduce algae with copper-based algaecide
					use mobile treatment units with microstraining capacity
Industrial or agrochemical pollutants	catchment mapping sanitary investigation / observation local knowledge biological survey water quality analysis	Refer to the sector *Water quality analysis, Industrial pollution* and *Industries and activities and associated pollutants* pp181-92			protect source from inflow of pollutants
					move camp
					use mobile treatment units with activated carbon and / or reverse osmosis
Bilharzia	local knowledge		none present		stop people entering the water source; provide hygiene education
					storage > 24 hours
Guinea worm	local knowledge		none present		stop people entering the water source; provide hygiene education and filter the water before drinking

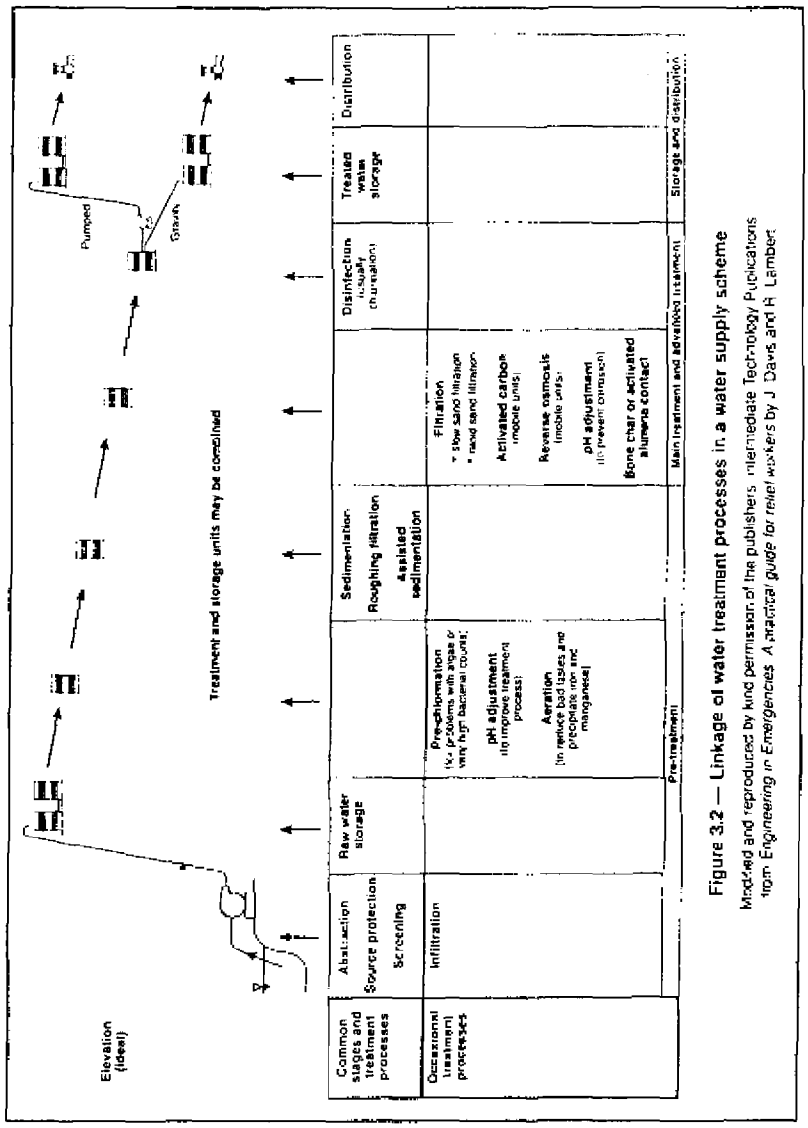


Figure 3.2 — Linkage of water treatment processes in a water supply scheme

Modified and reproduced by kind permission of the publishers, Intermediate Technology Publications from *Engineering in Emergencies. A practical guide for relief workers* by J Davis and R Lambert

Water treatment process selection tools for longer term supply

Complete the three tables below for each water source under investigation

Common water quality problems treatment process selection

	(3A) Selection step	(3B) Parameter feature	(3C) Details		
1	For each parameter or feature (column 3B) note the methods of assessment which have been used in column 3C (e.g. catchment mapping, local knowledge, etc.) Refer to table p41 for details		**Methods of assessment used**		
		Floating solids			
		Turbidity			
		E. coli or sanitary risk			
		pH			
2	Columns 1C to 1E (table p41) identify the maximum guide levels for each water quality parameter or feature versus the level of supply. Note the appropriate guide levels in column 3C		**Appropriate guide levels**		
3	In column 3C note the level or description of each parameter or feature and any variations expected in the parameter or feature in the future or seasonally. Compare present and expected future levels with the guide levels. Note which will require treatment		**Level or description of each feature**	**Variations expected**	**Which will require treatment?**
		Floating solids			
		Turbidity			
		E. coli or sanitary risk			
		pH			
4	Can the parameter or feature requiring treatment be improved by protecting the source? If so will the water still require treatment?		**Can it be improved by protection?**		**Will it still require treatment?**
5	Column 1F (table p41) identifies alternative treatment / avoidance options for each parameter / feature. Consider each option in turn in relation to: the stage of the emergency and predicted length of operation of the treatment units; its common usage in the area and hence the likelihood of existing appropriate skills and resources to run the system effectively; technical requirements; the availability of material, equipment and human resources; its time of set-up; its cost; its ease of operation and maintenance; its appropriateness to the group of concern (e.g. some groups will not drink water with medicines in it and hence will not allow chlorine to be used). Select the most appropriate treatment processes		**Treatment processes initially selected**		
6	To ensure that the treatment process will be effective check each individual process against: the information supplied on the features of treatment processes section (tables pp21 and 22); results of the treatability tests (pp76-83)		**Problems envisaged**		

Occasional water quality problems treatment process selection

	(4A) Selection step	(4B) Parameter : feature	(4C) Details		
7	Refer to (page p42 for stages 7 to 12 Repeat step 1 (Table p44 below) for [illegible] water quality problems		Methods of assessment used		
8	Repeat step 2 (table p44) for the occasional features parameters where a problem is expected		Appropriate guide levels		
9	Repeat step 3 (table p44) for the occasional features parameters where a problem is expected		Level or description of each feature	Variations expected	Which will require treatment?
10	Repeat step 4 (table p44) for the occasional features parameters where a problem is expected		Can it be improved by protection?	Will it still require treatment?	
11	Repeat step 5 (table p44) for the occasional features parameters where a problem is expected		Treatment processes initially selected		
12	Repeat step 6 (table p44) for the occasional features parameters where a problem is expected		Problems envisaged		

Linkage of treatment processes or avoidance activities

	(5A) Selection step	(5B) Details
13	List all of the treatment processes using [illegible] page p43 as a guide	Order of treatment
14	Check if any of the treatment processes can be removed from the chain. Some processes will be able to deal with several parameters/ features at the same time	Processes which can be removed:
15	Identify the final selection of treatment processes	Order of treatment

Key references:

Davis and Lambert, 1995, pp317-46
Howard, 1979
NSF, 1994, Section I, pp16-21, 38-45
Snoz and Okun, 1984
Tebbutt, 1992, pp167-91
Twort et al, 1994
UNHCR, 1992, pp80-93
WHO, 1971, 1989, 1993

Source selection for longer term supply

How to use this section

Source selection for longer term supply should only be undertaken after a thorough assessment of available information. See the checklists for suggested information to be collected and note your findings on the survey sheets provided or in another easily accessible form.

Key factors for source selection are highlighted in the schematic chart opposite.

Complete a source summary table [p48] for each source(s) option. From here the source(s) may be selected

by scanning the alternative summary tables and undertaking a selection based on experience

or

by using the source comparison tool and sample scoring chart to help analyse the variables

Whichever method is used, experience, common sense and engineering judgement will be required to make an appropriate selection

The source comparison tool does *not give an answer* it is only to be used to guide the thought process, highlighting the features which are critical and those which are not so important.

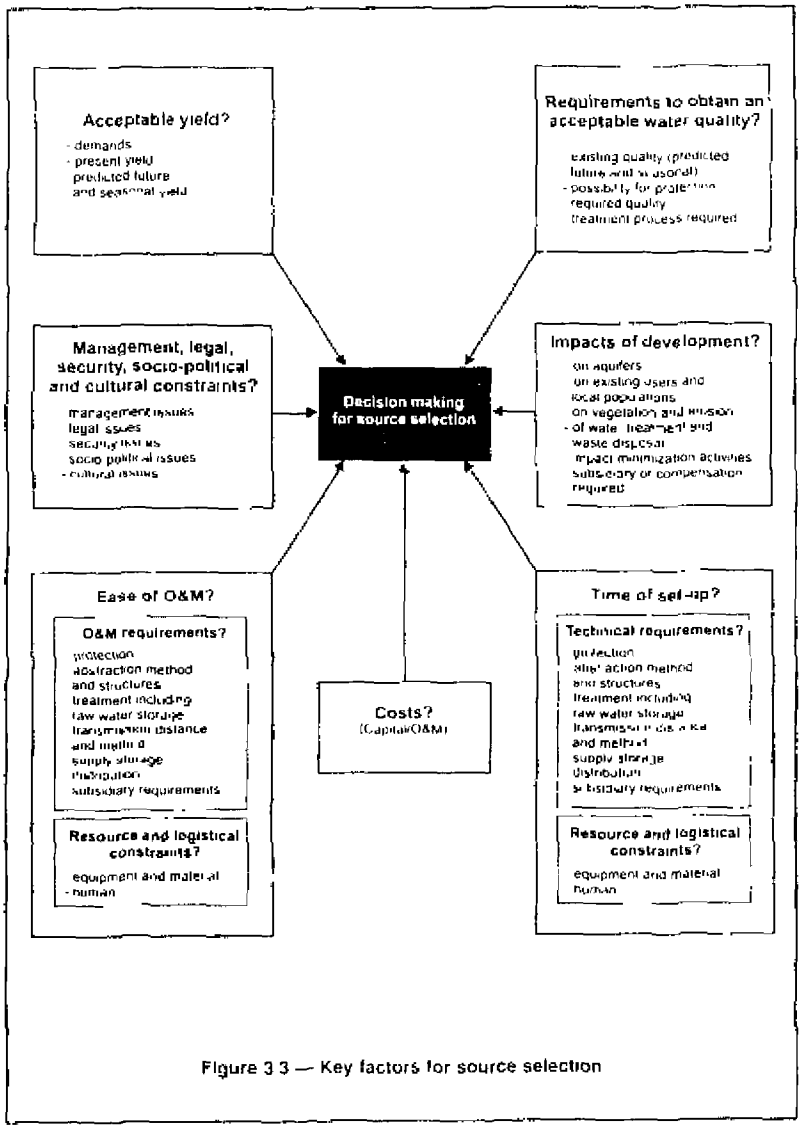


Figure 3 3 — Key factors for source selection

Source summary table

Affected population water demand

Source details	Source name - number and location
	Type of source
Acceptable yield?	Existing demand on the source (excluding the affected population)
	Present yield
	Predicted future and seasonal yield
Requirements to obtain an acceptable water quality?	Current water quality problems
	Predicted future and seasonal water quality problems
	Treatment processes required
Management, legal, security, socio-political or cultural constraints?	Management, legal, security, socio-political or cultural constraints
Technical and O&M requirements?	Protection
	Abstraction method and structures
	Treatment (including raw water storage)
	Transmission distance and method
	Supply storage
	Distribution
	Subsidiary requirements
Resource and logistical constraints?	Material and equipment resources
	Human resources
	Logistical
Time of set-up?	Time of set-up
Ease of O&M?	Ease of O&M
Impacts of development?	On aquifers, existing users and local populations, on vegetation and erosion and on water treatment and waste disposal
	Impact minimization activities, subsidiary activities or compensation required
Costs?	Capital
	O&M

Note: This summary table may require adaption for sources for dispersed populations. A separate form could be completed for typical examples of each type of source used in the area.

Source comparison tool for longer term supply

Introduction

The ranking and weighting method was chosen for source comparison as it allows several factors to be included in the comparison at the same time. It also allows for weightings to be put on the factors changing their relative importance with the stage of the emergency. For example, in the immediate emergency stage the time of set-up is critical but the level of O&M required is not so important. Over the longer term period the O&M requirements become more important and the time of set-up less so.

It should be understood, however, that it is difficult to apply objective weightings and their identification is purely arbitrary and based on best judgement. **They should be modified to suit the particular situation.** The original weightings have been set at 10 for a high level of importance and zero for unimportant. Sometimes a veto has to be applied (Davis et al. 1995). An example of this would be where the water source is located in an area controlled by a warring faction which is in conflict with the affected population. Under this situation access to the water cannot be guaranteed. Hopefully such problems will have been identified early in the information gathering process and the source option already discarded.

Source(s) with the highest total weighted scores are more favourable, but once the numerical determinations have been completed, a **visual analysis** should be undertaken on the results. **This is the most important step in the comparison** and should identify which were the critical factors for the source selection and whether additional activities could be implemented which would modify the results.

Survival supply weightings have not been provided in the scoring table. It required the following weightings could be used (from top to bottom: 9 2-9-5 2-2 1).

If two similar options are being considered, for example trucking from two different locations or abstraction from two different points on the same river, then comparison can be made using only the critical factors. For example the following may be considered:

- costs, security and impacts of development for the trucking programmes, or
- costs, security and requirements to obtain an acceptable quality water for the water source abstraction from two points on the same river.

This method may be more suitable for sources to supply camp populations rather than those in dispersed locations or mobile.

Instructions for use

1. Collect information on the alternative source(s) options and summarize this information in the **Source summary table p48**.
2. For the first source(s) option decide on **scores** for each of the key factors using the **sample scoring chart for source comparison p52** for guidance. A high score indicates that the factor is positive and a low one that it is negative.
3. Chose the **weightings indicated in the scoring chart p51 applicable to the level of supply** (in turn related to the stage of emergency to which the assessment applies).

4. Multiply the scores by the weightings in the table p51 to obtain the '**weighted score**'.
5. Repeat steps 2 to 4 for the other source options
6. Add all of the weighted scores for each source and insert the '**total weighted scores**' into the final row on the table p51.
7. Identify the sources in order of total weighted score

Analysis of results

1. Which source gives the highest score and which the lowest?
2. Compare the selected source(s) with the expected result by scanning the summary table. If they are different then investigate why.
3. Which key factors have been the deciding ones in making one option's total weighted score higher than the others?
4. Could the lower scores be raised by undertaking additional activities to modify the situation in the field?
5. Would this change the final order of preference of sources?
6. Look at the source(s) with the highest total weighted score. Are any of the key factor scores tenuous or dependant on unknowns? If these scores are replaced by ones representing the worst scenario, would the order of preference change between the sources?
7. Undertake a '**sensitivity analysis**' weightings and scores are modified slightly and the final positions compared (Reed, 1995). If there is no change in the overall positions then the results can be accepted with more confidence, but if there are variations, the results should be treated with care and further thought should be given to acceptable weightings and scores.
8. Is the order of preference sensible?
9. If so, chose the source with the highest weighted score. If not re-assess the scores and weightings for the particular scenario and repeat the process for comparison.

Key references (decision-making):

Davis and Lambert, 1995, pp563-7
Gosling and Edwards, 1995
Reed, 1995, pp13-8

Key references (water source selection):

Cairncross and Feachem, 1978, pp3-7
UNHCR, 1992, pp30-7

Source comparison tool for longer term supply

Key factors for source selection	*Weighting (supply for several months)*	*Weighting (supply for several years)*	*Source(s) 1*		*Source(s) 2*		*Source(s) 3*	
			Score for source	Weighted score	Score for source	Weighted score	Score for source	Weighted score
Acceptable yield?	7	6						
Requirements to obtain an acceptable waste quality?	5	5						
Time of set-up?	5	1						
Management, legal security or socio-political and cultural constraints?	4	4						
Impacts of development?	4	5						
Costs?	3	4						
Ease of O&M?	2	5						
Total weighted score for each source(s) option								

Refer to

- Key factors for source selection Figure 3.2 p43
- Sample scoring chart for source comparison p53

Sample scoring chart for source comparison

Key factors for source selection	Score			
	10	7	4	1
Acceptable yield?	> 50% of yield remaining after all abstraction	< 0% of yield remaining after all abstraction or Unknown yield but indications are that yield exceeds supply	Yield only meets the demand of the affected population and all residents during period of maximum yield	Insufficient yield to meet affected population and local demands even at period of maximum yield or Unknown yield but indications are that it would be lower than required
Requirements to obtain an acceptable water quality?	Only simple source protection and disinfection required	Protection, storage, assisted sedimentation, filtration and disinfection required	Protection, storage, assisted sedimentation, filtration and disinfection required plus additional treatment such as aeration or other	Very bad quality Heavy industrial / agrochemical pollution expected Very difficult to produce acceptable water quality using standard treatment processes
Time of set-up?	*Time of set-up < 1 week* Equipment and expertise already available on site	*Time of set-up 1-4 weeks* Some equipment and expertise already available on site Most additional resources can be obtained locally	*Time of set-up 1-2 months* Significant construction required Materials need to be imported or Borehole drilling required into known aquifer	*Time of set-up > 2 months* or Groundwater exploration required
Management, legal, security, social, political or cultural constraints?	No such constraints Local government, communities and landowners are very helpful and agreeable	Local government, communities and landowners are generally agreeable Some high level negotiations may be needed and local communities would need to be compensated	Some constraints to the development of the source Would require national level negotiations or Would require additional security at the source	Serious constraints to the development of the source Political interference Could lead to additional security problems Problems unlikely to be solved by negotiation
Impacts of development?	No obvious impacts on local users or the physical environment	Some negative impacts expected on the physical environment but not on local users	Groundwater to be used and pumping tests indicate a slow recovery of water levels and potentially effects on other sources or Some negative impacts expected on both local users and the physical environment	Groundwater source to be used from a known aquifer of limited capacity or Water sources already scarce for local communities or Negative impact expected on both the local users and the physical environment
***Costs?**	Low	Lower than average	Higher than average	High
Ease of O&M?	Would only require input from locally trained personnel and No fuel or power requirements	Would only require input from locally trained personnel and Fuel or power required	Would require occasional input from specialist personnel or High cost of consumables	Would require regular input from specialist personnel and high cost of consumables or Tankering operation

* Costs (both capital and O&M) are comparative between options. A project specific decision will be required as to the length of time considered for O&M costs. The same period must be used for all options.

Identification of working environment

Information

- ❑ Field organizational structure of employing agency/organogram (chain of command, logistics, administration, technical, health education, medical personnel)
- ❑ Areas of responsibility for yourself and others
- ❑ Personnel from other organizations working in water or sanitation in the area (government, international and local)
- ❑ Operational structure for co-ordination between organizations, government — including role of UNHCR, organization and national and local government contacts, and employment agreements
- ❑ Decision-making structure re water source selection. Are you working for the lead organization? Which camps or populations are you responsible for supplying?
- ❑ Communication channels with affected and local populations and community structures (contacts), and role of UNHCR and governments in communication channels
- ❑ Organization's policy for supporting local populations
- ❑ Team members' access to local personnel (translators, surveying assistants, driver)
- ❑ Working facilities (office space, telephone / radio, fax, photocopying, storage space for equipment and workshops, power sources, security, vehicle)
- ❑ Methods of payment

Sources of information

- ❑ Employing organization staff
- ❑ Other organization staff (including UNHCR)
- ❑ National and local government

Reconnaissance of the area

(including existing water usage situation, logistics and resources)

Regional orientation

Information

- ❑ Physical features (high and low areas, vegetation, water sources)
- ❑ Location and type of water source (developed? not developed?)
- ❑ Human features (settlements, industry, agriculture, roads)
- ❑ Distances between users and water sources
- ❑ Distances and approximate heights between features
- ❑ Areas vulnerable to natural threats (cyclones, mudslides, earthquakes, etc.)
- ❑ Areas with high security risk (e.g. mined areas)
- ❑ Areas subjected to extreme weather conditions

Sources of information

- ❑ Observation
- ❑ Published and unpublished maps, aerial photographs, etc. as collected in background information gathering
- ❑ Simple surveying (GPS, Abney level, clinometer, altimeter)
- ❑ National and local government
- ❑ Local and affected populations
- ❑ Other field staff
- ❑ Natural threat monitoring stations
- ❑ *Catchment mapping: maps and symbols* pp154-60
- ❑ *Catchment mapping: surveying* pp161-8

Methods

- ❑ Mapping
- ❑ Panoramic photographic records

Settlement orientation

Information

- ❑ Boundaries, present sub-divisions (including ethnic or clan divisions), possible areas for expansion (include distances)
- ❑ Population density where settlements are dispersed or mobile
- ❑ Slope of ground (and existing drainage channels if any)
- ❑ Water sources (and areas susceptible to flooding and other physical threats)
- ❑ Areas with buildings / shelters, open spaces and communal areas
- ❑ Access roads
- ❑ Sanitation facilities including excreta disposal, refuse dumps / collection areas and graveyards
- ❑ Administration centres and feeding centres
- ❑ Chemical stores
- ❑ Lighting
- ❑ Security arrangements

Sources of information

- ❑ Observation from high ground (using binoculars) and by walking around the camp
- ❑ Aerial photographs
- ❑ Simple surveying (pacing, Abney level, clinometer, GPS)
- ❑ Other "field staff"
- ❑ Local government
- ❑ Local and affected population
- ❑ *Catchment mapping: maps and symbols* pp154-60
- ❑ *Catchment mapping: surveying* pp161-8

Methods

- ❑ Mapping
- ❑ Photographic records

Demographics, present water usage and water demands

Information

- ❑ Water user numbers — affected population
  - ○ *Individuals*
  - ○ *Livestock large and small (and average number per family)*
  - ○ *Other users / uses if specific supply is within remit e.g. health centres (in-patient, out-patient and cholera centres) feeding centres*
- ❑ Water user numbers — local population
  - ○ *As affected population (above) up and downstream*
  - ○ *Industries and agriculture*
- ❑ Present water source (type location level of service distance to collection point) Note The populations' own coping mechanisms should be identified and potentially built upon
- ❑ Current water consumption
- ❑ Does the affected population have adequate containers for water collection?
- ❑ Are the populations static or mobile?
- ❑ Diseases prevalent in the local and affected populations (e.g. cholera, dysentery typhoid malaria fluorosis, diarrhoea to those new to the area, skin diseases)

Sources of information

- ❑ UNHCR
- ❑ Employing organization staff members
- ❑ Other field staff
- ❑ Local government (water and sewerage social, statistical office)
- ❑ Local and affected population
- ❑ Observation
- ❑ Medical practitioners (traditional and non traditional)
- ❑ Checklist pp70-1

Methods

- ❑ Calculation of water demand for affected and local populations using employing organization's water demand figures or those given on p141

Availability of resources / logistics

Information

Logistics

- ❑ Condition of roads in the dry and rainy seasons (major access roads, minor access roads, internal settlement roads road crossings)
- ❑ Flooding and other physical threats (settlement areas access roads)
- ❑ Security (on access roads and within settlements) Which groups are causing the security problem? How common are guns in the area?
- ❑ Access to international freight (airstrips, ports, railways road links)
- ❑ Customs clearance (import taxes procedures, problems delays)
- ❑ Availability and reliability of freight transporters
- ❑ Journey time for freight

Note This survey information can be collected as the assessment procedure progresses or after the resources required for the specific engineering solution are known Depending on the agency procedure, the initial solution may be directed by the modular kit which has been brought to the field at the assessment stage

Sources of information

- ❑ Observation
- ❑ National or local government (water and sewerage, building)
- ❑ Local contractors
- ❑ Local suppliers
- ❑ Head office modular kit lists
- ❑ Other field staff
- ❑ Local and affected populations
- ❑ Customs authorities
- ❑ National threat monitoring systems
- ❑ *Mobile water treatment units and modular kits* Table p283.4

Availability of resources / logistics (continued)

Information (continued)

Resources

☐ **Material and equipment** (type, make, size, condition, capacity, power consumption, fuel requirement, cost, volume / number available, availability of drivers / operators)

- ○ *Pumps (electrical, diesel, petrol; hand pumps)*
- ○ *Generators (diesel, petrol)*
- ○ *Tanks (galvanized steel / iron, Oxfam tanks, pillow tanks)*
- ○ *Pipes (cast iron, galvanized steel / iron, asbestos cement, UPVC, MDPE, flexible hose)*
- ○ *Pipe fittings (valves, bends, air valves, couplings, etc.)*
- ○ *Mobile water treatment units*
- ○ *Construction materials and tools (cement, reinforcement steel and tying wire, gabion mesh, aggregate, sand, construction handtools, masonry hand tools, nails / screws, timber, cement mixer)*
- ○ *Drilling rigs (rotary, percussion)*
- ○ *Water tankers or trucks (tankers, flat bed truck with sides, flat-bed truck without sides, container truck)*
- ○ *Chemicals (chlorine, aluminium sulphate, ferric chloride ferrous sulphate, lime)*
- ○ *Fuel / power (diesel, petrol, electricity)*
- ○ *General usage transport (pick-ups, small lorries or vans)*

☐ **Human resources** (names, point of contact, employer, numbers)

- ○ *Tradespeople: plumbers, mechanics, electricians, carpenters*
- ○ *General construction personnel and supervisors*
- ○ *Water technicians / engineers*
- ○ *Health educators / community development workers*
- ○ *Logisticians*

☐ **Local construction techniques** (details):

- ○ *Well construction (hand dug well, tube well)*
- ○ *Spring tapping*
- ○ *Borehole drilling (are the drilling teams available with rigs?)*
- ○ *Pipe laying and jointing*

☐ **Water treatment processes used locally:**

- ○ *Infiltration*
- ○ *Sedimentation*
- ○ *Roughing filtration*
- ○ *Assisted sedimentation*
- ○ *Slow sand filtration*
- ○ *Rapid filtration*
- ○ *Disinfection*
- ○ *Activated carbon*

Features of the source (excluding water quality)

Physical features including yield

COLLECT FOR EACH SOURCE

Information

- ❑ Source name / number, type and location
- ❑ Ground and water level (note instrument used for measurement)
- ❑ Layout / dimensions
- ❑ Yield estimation (volumes / flows variation with season, recharge capacity)
- ❑ Discharges (in and out, where are they from and where do they go)
- ❑ Environmental features of the area surrounding the source (river bed materials, plant and tree cover activities such as farming or industries)
- ❑ Is the source affected by extreme weather conditions (e.g. below 0°C)?

Sources of information

- ❑ Observation
- ❑ Local and affected populations (including users and landowner)
- ❑ National or local government (may have pumping test records)
- ❑ Water diviners
- ❑ *Measurement of yield and water levels* pp143 7
- ❑ *Catchment mapping: maps and symbols* pp154 60
- ❑ *Catchment mapping: surveying* pp161 6
- ❑ Checklist pp64 5
- ❑ Checklist pp66 7

Methods

- ❑ Detailed sketch of source and abstraction point
- ❑ Flow measurement

Management, legal, security, socio-political and cultural issues

COLLECT FOR EACH SOURCE

Information

- ❑ Present demands (who, what for, how much, is there competition with animals)
- ❑ Are there intermittent users such as nomads
- ❑ Who owns the land and what is the procedure to obtain permission to abstract
- ❑ Responsible authority for control and maintenance
- ❑ Is a tariff being charged for using the source (paid to whom and how much)
- ❑ Accessibility at present for water collection (can elderly, children, or those with disabilities gain easy access to the source?)
- ❑ Security problems at the source (especially consider women and children and opposing groups in conflict situations)
- ❑ Are any areas mined?
- ❑ Socio-political constraints to using the source and cultural beliefs re water provision
- ❑ Consider national development objectives
- ❑ What are the affected populations and local populations' priorities for water provision
- ❑ Natural threats within the vicinity of the source (cyclones, earthquakes, mudslides, etc.)

Sources of information

- ❑ Observation
- ❑ Local and affected populations (including local users and landowner)
- ❑ National or local government (may have pumping test records)
- ❑ Natural threat monitoring stations
- ❑ *Management, legal, security, socio political and cultural issues and case studies* pp108-24
- ❑ *Guidance on undertaking assessments and report writing* pp103-4
- ❑ Checklist pp68-9
- ❑ Checklist pp70-1

Features of the source (water quality)

Water quality assessment

COLLECT FOR EACH SOURCE

Information

- ❑ The quality of the water at present
- ❑ Existing protection and potential for improved protection of the source
- ❑ Predicted variations in the water quality in the future and pollution risks

Parameters commonly causing problems:

- ❑ Floating solids
- ❑ Turbidity
- ❑ Faecal contamination (thermotolerant coliforms / *E coli* level)
- ❑ pH

Parameters occasionally causing problems:

- ❑ Algae
- ❑ Arsenic
- ❑ Chloride
- ❑ Fluoride
- ❑ Iron or manganese
- ❑ Nitrate (or nitrite)
- ❑ Sulphate
- ❑ Industrial or agrochemical pollutants

Sources of information

- ❑ Observation
- ❑ Field-testing equipment
- ❑ Local government
- ❑ Local and affected populations
- ❑ Health centres
- ❑ *Water quality assessment Assessment routines* pp148-53
- ❑ *Water quality analysis* pp169-203
- ❑ *Biological survey* pp204-213
- ❑ *Water quality analysis and surveying equipment* pp261-82

Methods

- ❑ Catchment mapping
- ❑ Local knowledge including medical information
- ❑ Sanitary investigation / observation
- ❑ Water quality analysis
  - ❍ *Core parameters (common problems)*
  - ❍ *Secondary parameters (occasional problems)*
  - ❍ *Treatability tests*
  - ❍ *Industrial pollution assessment*
- ❑ Biological survey

Requirements for development and impacts summary

Physical requirements

COLLECT FOR EACH SOURCE

Information

- ☐ **Technical requirements:**
  - ○ *Protection requirements*
  - ○ *Abstraction method*
  - ○ *Treatment requirements including storage*
  - ○ *Transmission distance and means of transmission*
  - ○ *Supply storage*
  - ○ *Distribution requirements*
  - ○ *Subsidiary requirements (e.g. road construction, threat mitigation activities)*
  - ○ *Consider standardization with existing systems in country as support to national development objectives*
- ☐ **O&M requirements (human and consumables).**
  - ○ *O&M human resources*
  - ○ *O&M consumables*
- ☐ **Resources / logistics**
  - ○ *Material and equipment requirements*
  - ○ *Human resource requirements*
  - ○ *Logistical requirements*
- ☐ **Costs:**
  - ○ *Costs for capital and O&M (materials, equipment, human resources, logistics)*
- ☐ **Time of set-up:**
  - ○ *Total time for system to be up and running (technical requirements versus resources / logistics and other constraints)*
- ☐ **Ease of O&M**
  - ○ *O&M requirements versus resources / logistics and other constraints*

Sources of information

- ☐ Past technical solutions
- ☐ Head office WATSAN division
- ☐ Agency modular kit and equipment lists
- ☐ Standard text books
- ☐ Local government and other organizations involved
- ☐ *Requirements for development* pp13-15
- ☐ *Mobile water treatment units and modular kits* Table pp283-4

Impacts of development

COLLECT FOR EACH SOURCE

Information

- ❑ **Effects of source development on the aquifer and remote sources**
  - ❯ *Location and capacity of aquifers*
  - ❯ *Which sources are fed from the same aquifers*
- ❑ **Effects of development on existing users of the source and local populations at the point of abstraction and downstream:**
  - ❯ *Determine yield of source at present, existing demands, new abstraction demand, remaining yield (dry season) and the effects on existing users*
  - ❯ *Possible compensation for local communities up and downstream for the loss of yield or inconvenience. Also compare local and affected populations supplies and consider upgrading local supplies to prevent friction*
  - ❯ *Consider migration of people and animals livestock to improved water sources (may be pronounced with nomadic populations)*
  - ❯ *Effects on community structures / management capacity of organizations and populations*
  - ❯ *What subsidiary / ancillary activities are required (training, road construction, sanitation, agricultural extension, hygiene promotion, etc.)?*
- ❑ **Effects on vegetation and erosion**
  - ❯ *Change in yield*
  - ❯ *Effects of abstraction on vegetation and erosion and potential actions to minimize effects*
  - ❯ *Effects of migration to improved water sources on vegetation and erosion*
- ❑ **Effects of water treatment and waste disposal.**
  - ❯ *Increase in waste water - - how will it affect levels of standing water*
  - ❯ *How will chemicals and fuel for water treatment be stored (location, security)?*
  - ❯ *How will waste chemicals be disposed of?*
  - ❯ *How will the sludge produced during treatment be disposed of?*

Sources of information

- ❑ Observation
- ❑ National or local government
- ❑ Local and affected populations
- ❑ *Impacts of development section* pp136 8
- ❑ *Management, legal, security, socio-political and cultural issues with case studies* pp108 24
- ❑ *Groundwater investigation* pp249 52
- ❑ Checklist p64-5
- ❑ Checklist pp70-1

Confirmation of assumptions made during the selection process

Resources, logistics, legal, security, socio-political, and cultural issues

COLLECT FOR THE SELECTED SOURCE

Information

- ☐ **Resources**
  - ❍ *Can the required resources be made available within a suitable time scale?*
  - ❍ *Are the costs within the available budget?*
- ☐ **Logistics**
  - ❍ *Will logistical constraints prevent the solution being implemented?*
- ☐ **Legal, security, socio-political, and cultural issues**
  - ❍ *Have there been any developments in these areas which could prevent implementation? (physical developments could be due to natural threats or human activities)*
  - ❍ *Have the selected options been discussed with the local and affected populations and accepted as culturally appropriate?*

Sources of information

- ☐ Site previous checklists

Groundwater investigation

The use of groundwater is limited in the initial stages of an emergency because

- ❑ It is difficult to locate
- ❑ It is difficult to assess the capacity of the aquifer in a short time period, and
- ❑ Access to equipment and an experienced drilling team is often limited

If groundwater is available, however, it is an excellent source of water often with limited requirements for treatment and if the conditions are right can supply large quantities of potable water. Development of new groundwater sources is limited in the initial stages of the emergency because of time restrictions. However a general overview of the groundwater situation in the area is an important addition to the initial assessment of emergency water sources. The information gathered can be used to identify whether further studies should be undertaken by a hydrogeologist and can be a useful start to his / her investigation.

Situations where groundwater could be used in the early stages

- ❑ Spring sources,
- ❑ Existing developed groundwater sources such as shallow wells and boreholes which have reliable yields and additional capacity;
- ❑ Sub-surface flow abstracted from sandy / gravel river beds of rivers which flow intermittently and can be rapidly and easily abstracted, and
- ❑ New boreholes in areas where drilling equipment is readily available and the aquifer is already located and known to be reliable

Information

Level 1 (possible to collect some of this information as part of the initial assessment of emergency water sources).

- ❑ Locations and details of all natural and man made features including topography (can indicate potential recharge routes, pollution sources and location of populations who could supply information on water sources)
- ❑ Details of existing water sources including types, water levels, seasonal variations, present yields and reliability (can indicate locations, depths and reliability of aquifers)
- ❑ Existing borehole logs and testing results (indicates geology and hence possible aquifer characteristics, such as yield, water quality, drawdown during pumping, seasonal fluctuations)
- ❑ Climatic data (indicates potential for recharge)
- ❑ Soil and rock types (indicates potential aquifer characteristics)
- ❑ Vegetation (indicates potential locations of springs and shallow groundwater)
- ❑ Investigation of river beds, erosion channels and nearby hills for rock outcrops (identification of the rocks and angle of outcrops provide further information in the assessment of aquifer capacity)
- ❑ Use of aerial photographs (highlights topographical, vegetational and geomorphological features which can be interpreted by an experienced hydrogeologist. Aerial photographs can also highlight drainage patterns and land use)

Level 2 (unlikely to be collected as part of an initial assessment, but may be recommended in the RAEWS conclusions):

- ❑ Use of remote sensing images (1:12,500 to 1:25,000) (highlights topographical, vegetational and geomorphological features which can be interpreted by an experienced hydrogeologist)
- ❑ Geomorphological analysis and hydroclimatic monitoring
- ❑ Geophysical surveying assessment (electrical resistivity, seismic refraction, electromagnetic profiling, VLF profiling)
- ❑ Exploratory drilling (hand drilling, machine drilling, geological logging, test pumping)

* Note: Difficult to do in the field but useful if possible

Sources of information

- ❑ Local well drilling team
- ❑ Observation
- ❑ Local populations
- ❑ National and local government (water resources, agriculture, geological survey and water supply departments)
- ❑ Other organizations working in the provision of water supply (consultants, NGOs, etc.)
- ❑ University departments of host country (geography, geology, environmental science, civil engineering, mining, surveying)
- ❑ Certain organizations such as the British Geological Survey can provide interpretations of information based on satellite imagery and their vast data information banks for a fee (See *Useful addresses* pp289-90)
- ❑ Other sources of information as indicated in the checklist p53
- ❑ Hand drilling — See reference Oxfam (1991)
- ❑ *Measurement of yield and water levels* pp143-7
- ❑ See *Background to groundwater and aquifers* pp230-5
- ❑ *Rock and soil identification* pp235-48
- ❑ *Groundwater investigation* pp249-52

Methods

- ❑ Catchment mapping
- ❑ Cross section drawing of topography and water levels using details from existing sources
- ❑ *Pumping tests on existing boreholes
- ❑ Interpretation of the information identified under Level 1 using table *Indicators of the presence of groundwaters* p252

Rainwater investigation

The use of rainwater in emergencies is limited because

- ❑ It requires significant time and capital to set up large schemes
- ❑ It may only be available for short periods of the year and
- ❑ It is unpredictable

However, rainfall can be a useful source of water as a supplement to individual household supplies if simple catchment structures can be constructed or for small centres such as clinics or health centres where other sources are limited. Consideration should only be given for mid to long term projects where there is time to investigate yields and develop appropriate catchment structures and storage systems or for the short term if the emergency begins in the early season.

Rainwater can be collected on corrugated sheeting or plastic roofs, on other artificial material, or on the ground surface if it is relatively impermeable.

Techniques for storage include

- ❑ Ponds (do not tend to have isolated abstraction point)
- ❑ *Bukas* (cement lined ponds)
- ❑ *Hafir* dam (artificial pond with isolated inlet and outlet structures)
- ❑ Sand or sub-surface dams
- ❑ Household tanks (ferrocement, bamboo reinforced cement, concrete, steel, etc.)

Different geographical areas may have differing names for rainwater harvesting or storage techniques.