taps have proven effective in this context and their installation in tapstands should be encouraged (See 10.6). The use of prefabricated distribution standposts may be considered during emergency situations, especially if other system components, such as pumping sets, storage or filtration tanks, etc., are also being brought in as prefabricated packages or kits; these should, however, be of sturdy construction and should allow the use of water saving taps. No single standpost location is likely to meet all ideal requirements; selecting the most appropriate ones will always be a process of compromise. Standposts should be located in places where distances to water users are minimal; as a guideline, 200 metre distances are advisable for most refugee camps, while in less congested situations, such as in rural refugee settlements, a minimum distance of 500 metres may be acceptable. The need to drain away all waste water should also be given consideration; the costs for this drainage system may be substantially reduced by locating other service components, such as laundry or bath/shower facilities, in the vicinity of the standpost or by using some of this waste water (free of soap or detergents, please!) in fruit or vegetable garden irrigation. Water pressure at standposts should not be too high, never higher than 4 bars (40 metres); very low pressures should also be avoided (absolute minimum: 0.70 bars or 7 metres). While it would be desirable that a single tap would not be used by more than 20 beneficiaries on average, this figure could be as high as 100, depending on the characteristics of each particular refugee situation; to provide an appropriate coverage, multiple tap standposts may be constructed; common designs allow for the installation of 5 to 10 taps in each post.

10. The need to include appropriate *washing/laundry facilities* as a standard infrastructure component of a refugee camp is often overlooked. Washing cooking dishes and clothes is a basic need and, as such, should be appropriately covered by the camp infrastructure. If not, more wasteful, and perhaps less sanitary alternatives, will be developed by the refugees themselves. It is not possible to give general rules or guidelines for the design or construction of appropriate laundry or bathing facilities, as they should respond to the individual needs, as well as to cultural and religious practices of the refugee users. Therefore, their design should be entrusted to qualified engineers who should take into account cultural habits, sanitation requirements as well as the need to minimize water wastage.

11. In some circumstances, there will be a need to provide appropriate watering points for cattle (See 10.1) or for the filling of animal driven carts or water tankers (See 3.5). Adequate designs for these facilities are available in the literature. Their location (normally outside camp boundaries) should, as a rule, be away from refugee water supply standposts. These facilities should always be provided with appropriate access and efficient drainage facilities.

Considerations for Pipeline Designs

12. Water moving through a piping system is subject to *friction* with the inner surface of the pipes and therefore continuously loses pressure in the direction of flow; this loss is proportional to the length of pipes, to the roughness of their interior and to the square of the velocity. These friction losses may be calculated by using formulas; different graphs may also be used for this purpose (See Figure 35). This means that in a pipeline system with flow under dynamic equilibrium, pressure drops in the direction of flow in accordance to what is known as the *hydraulic gradient*, which also represents the energy levels at each point along the pipeline.

13. The amount of energy remaining in the pipeline system by the time the desired flow has reached the distribution points is what is called *residual head,* and may be either positive or negative. While positive heads indicate the presence of energy in excess and that there is enough energy to move an even greater flow through the pipeline, negative heads would indicate that, within the pipeline, there is not enough energy to move the desired quantity of water. If a pipeline with a positive residual head is allowed to discharge into the atmosphere, the flow will increase until the residual head is reduced to zero; this flow, which for the given conditions of each pipeline is always maximum, is called the *natural flow* of the system. In a gravity fed pipeline, the natural flow should always be smaller than the safe yield of the water source (See 6.20 and 6.38), otherwise, the pipe would drain faster than it can be filled and the result will be that the pipe will not flow fully and any standpost located in this section would not function normally.

14. As already mentioned, high *velocity* flows within a pipeline increase friction losses. At the same

time, with high velocities, suspended particles can also cause excessive erosion of the pipes; if the velocity is too low, these suspended particles may settle and collect at low points within the pipeline, which may even clog if provisions have not been made for sedimentation (See 8.14-16) of the water or for the provision of appropriate wash-out points for the pipeline (See 9.6).

15. *Air blocks* are bubbles of air that remain trapped, particularly at high points of a pipeline; their size may be such that they could interfere with the normal flow of water through this section. They may become very important (and problematic) in the case of pipelines which are subject to periodical drainage and refilling and provisions should be made to install air valves (See 9.6) at all high points of the pipeline.

16. The bases for the design of any pipeline is the graphic plotting of the topographic survey along the pipeline's route in the form of an "altimetric profile" showing the variation in soil elevations from the source to storage, treatment and distribution points. This survey should have been previously carried out as part of the basic studies to assess the beneficiaries' needs and to produce the conceptual design and budgets required for project approval and funding (See 5.1; 12.8). The hydraulic design comes next; the possibility of using gravity as the only driving force for the water to flow is assessed (See 10.12) and, if insufficient, the calculations for pumping requirements are made; all system components (including treatment facilities, storage, pumping and gravity mains, distribution lines and taps for which it may be possible to use standard models) are also designed (hydraulic and structural designs) and the final checking for hydraulic soundness and efficiency is done, bearing in mind the ultimate goal of providing a cost effective and reliable supply of safe drinking water to the refugees. The final drawings, showing all technical details of the system, are then finished and will accompany the topographical profile (showing also the pipeline's hydraulic gradients) and the planimetric map showing the exact location of all system components. Once this is done, the documents are ready for "blue-printing". Detailed estimates of materials, labour and money required for the construction are then calculated.

17. As mentioned before, the task of designing any water supply system should be entrusted to a qualified and well-experienced engineer. It will be the responsibility of this engineer to provide a complete record of his investigations, surveys, calculations and designs; this data will prove useful in the project approval and funding exercise, in the negotiations for project implementation (identification of implementing partners, tender procedures, contractual negotiations) and for supervision, operation and maintenance purposes (See 12.8-17). Such data should contain, at least, the following:

i) Pipelines: All relevant data on the different sections of the pipeline (pumping mains, gravity mains, branches, tap connections, etc.) (See 10.4), including pipe material, lengths and diameters. A planimetric map, at an appropriate scale, of the layout of each section of the pipeline, giving clear indication of the length and diameters of each pipeline component, the position of related structures (intakes, valve boxes, reservoirs, etc.).

ii) Surface water catchments, boreholes or wells: Description of the catchment, well or borehole as a water yielding structure (See 6.37; 6.54); results of test pumping and productivity assessments (See 6.38; 6.55); water quality characteristics (See 3.13).

iii) Intake sections: Sketches (using convenient scales) of the location of sources and the future structures to tap them; design drawings of these structures; calculations of construction needs (volumes of excavation, construction materials, etc.) and labour.

iv) Treatment facilities: details and scaled sketches of pre-treatment and treatment structures required (sedimentation, filtration, chlorination, etc.), including specific details of all piping and valves, construction requirements in terms of material, labour, special tools, etc. (See 8.8).

v) Break pressure (See 10.8) and reservoir tanks (See 9.2): Careful drawings of the designs are required, depicting all necessary construction details on the structure, pipe and valve arrangements; construction requirements in terms of material, labour, tools, etc.

vi) Distribution points: Drawings of each water outlet (individual connections to service,

administration or staff accommodation buildings, public distribution standposts, animal troughs, etc.); construction requirements in terms of materials, labour, tools, etc. (See 10.9-11).

vii) Other system components: Drawings and other relevant details (location, construction characteristics, piping and valve arrangements, etc.) of special components such as valve boxes, river crossings, etc.

viii) Total estimates: Two lists, one for locally procured material and another one requiring purchase and transportation into the country or project area. Unit prices and total costs should accompany these lists. All tool requirements should also be presented, as well as other logistical details on transport of material and related costs (See 12.17).

Pipeline Construction

18. Beneficiaries, not taking into account strangers, heavy animals or vehicles, may cause considerable damage to exposed pumping equipment, pipes or fittings with frustrating results. These problems should be prevented by taking practical and tailor-made steps for each project. In this context, efforts should be undertaken to make beneficiaries understand the difficulties of repairing damaged systems and the negative impact that such repairs have on their own welfare; their cooperation in protecting the system should, therefore, be fostered and encouraged.

19. The design and construction of a water supply system should be guided by the need to avoid these problems and to provide maximum protection to the whole system against adverse weather and other environmental conditions. If pipelines are not constructed properly the first time, remedial actions are difficult, time consuming and discouraging tasks, especially if they have to be undertaken as a result of carelessness or sloppy construction techniques or practices.

20. Pipes should normally be laid within trenches to protect them from damage from traffic or weather conditions. In the tropics, the proper depth of trenches should be at least 0.80 metres; deeper trenches are necessary to avoid freezing and other cold weather effects in higher latitude countries; local experience should therefore be taken into account in choosing the right depth of trenches, always bearing in mind the increased costs deeper trenches represent. Although there are no special requirements for the width of trenches, cost factors determine that this width should be kept to the minimum necessary (mainly determined by the width of the trenching equipment). The trench should be dug in sections equal to the length of the pipe to be buried in it each day and should be free of sharp rocks or bends that may interfere with the pipe; when the entire section is dug, it should be inspected before the pipe is laid.

21. Once the pipe is laid within the trench, and all connections inspected, backfilling may be carried out. The material to be used should be soft and granular; large stones should be avoided. An initial backfilling, to cover the pipes with a minimum of 20 cm. of soil, should be carried out as soon as possible after the pipe has been laid into the trench to provide protection to the pipe. Final backfilling may be carried out after the entire pipeline section has been tested.

22. Although the pipeline should, ideally, follow the route that was originally surveyed and used in the pipeline design and related calculations, it may be necessary during construction activities to introduce some detours or other changes to avoid impassable areas (rocky terrain, landslides, deep gullies) not identified by the original survey. In this case, these detours must be re-surveyed to determine how will they affect the overall hydraulic behaviour of the pipeline system and to calculate additional requirements (pipes, construction materials, other structures, etc.).

23. It is always worthwhile remembering that, within relatively short periods, visible traces of buried pipelines may disappear, making it difficult, and sometimes costly, to find a pipe trace. Permanent markers, at strategically located reference points should be used for future reference. Concrete pegs are the most commonly used markers. They should be located at all branch points, reducers, changes in pipeline direction and at regular intervals in open terrain or bush. A record of each marker, containing at

least information on pipeline materials, diameters and direction of pipes should be kept at hand.

24. Leaks or damages to the pipeline should be identified before the final backfilling of the trenches is undertaken. Test pressures should be the maximum pressures possible if the system is gravity fed, or at least 20% higher than the working pressure of pumping mains. The test should be carried out continuously for at least 15 minutes for each 100 metres of pipeline; the air at all high points must be released during the filling of the pipeline, before the testing.

11. Operation and Maintenance of Water Supply Systems

- The effectiveness of any water supply system depends, in the long run, on the correct operation of each of its components and on the efficiency of the arrangements to service, repair or replace used or damaged ones.
- Although refugee communities cannot assume responsibility for operation and maintenance activities in an emergency camp by themselves, efforts should be made to ensure their maximum involvement in these activities as early as possible, in order to instill a sense of ownership in the community and to facilitate their involvement in longer term care and maintenance assistance activities.
- Every camp should have a plan to cover the operation and preventive maintenance needs of all its infrastructure. The engineers in charge of camp design and construction should provide clear and practical guidelines for its elaboration.

General

1. Once a water supply system is completed it should be operated and maintained to ensure the continuous and reliable supply of safe drinking water to its beneficiaries. Experience shows that refugee water supply systems are more difficult to keep running than to construct. The negative effects of inoperative systems on refugee health, the adverse impact on hygiene practices and sanitary conditions within the camp and the costs of regularly upgrading or repairing wrongly operated or badly maintained systems are reasons enough to make efforts to develop adequate operation and maintenance schemes already during the design and construction stages of project implementation (See 3.8; 5.2; 6.40; 6.56).

2. Whilst the primary responsibility for the continuous functioning of small water supply systems in rural areas and small towns lies with the community, emergency refugee water supply systems, due to their nature, should be kept operational throughout the emergency relief operations by those responsible for camp management (See 5.2), who may or may not be assisted by specialized government agencies (water authorities, municipalities, etc.) or other organizations working on behalf of UNHCR (voluntary or non-governmental agencies, service contractors, etc.) (See 12.7-iii). Once the emergency needs have been met, and if camp activities are to continue for an undefined period of time, refugee participation in simple operation and maintenance tasks should be gradually introduced, following an education and training campaign which should have started soon after the onset of the emergency (See 11.6; 12.20). At the same time, the possibility of handing over these responsibilities to specialized government agencies with a presence and similar responsibilities in the region where the camp is located will be explored and, if appropriate, pursued, always bearing in mind the intrinsic differences between a refugee camp and normal communities; these differences are created by the legal framework within which refugee assistance is carried out during emergency situations and a lack of sound economic bases for refugees to pursue any type of self-sufficiency at the camps (See 5.2).

3. When the construction of the system is finalized, a water supply operation and maintenance committee should start its work. This committee, as already pointed out, should be under the administrative and financial responsibility of camp managers and should be adequately supported by technical staff from the government or specialized agencies acting as UNHCR's implementing partners in protection or assistance efforts for camp beneficiaries. The committee should appoint a caretaker, preferably a person with technical background and experience in water supply operations, to coordinate and ensure the most effective operation and timely maintenance of the system at any time. The engineer

concerned with the design or construction of the system should always be responsible for instruction and training the caretaker before handing over the project to the camp authorities. The camp authorities will make sure that all administrative and financial matters related to these activities are appropriately covered and well understood by the committee and the caretaker in advance.

4. The main task of the water supply operation and maintenance committee should be to ensure that the caretaker (and his staff) operate the system in accordance with a preventive maintenance concept (See 11.9) and by using appropriate and cost-effective "curative" procedures whenever necessary. Preventive actions are those that may be carried out while the system and its components still function, in order to reduce breakdowns and ensure a good continuity and effectiveness of the service. Curative procedures are those actions necessary to upgrade or repair a system or its components to put them in working order again. While preventive actions are cost-saving in the long run, they require an effective use of available resources as well as good planning, organization and management skills from camp authorities and the committee.

5. The arrangements for the operation and maintenance of emergency refugee water supply systems should always be adapted to the needs of the refugees, to camp requirements, to the site's resources and environmental conditions and to the institutional framework of UNHCR's assistance programme (See 2.8; 12.20). The involvement of specialized government or non-government agencies in the operation and maintenance of camp infrastructure should be sought at the onset of the emergency relief efforts. Funds will have to be made available, on a periodical basis, to the responsible entity to pay for the staff and materials needed for the planned inspections and necessary repairs to system components; estimating these funds will require knowledge of the system and its requirements, on the number of personnel required to efficiently carry out all related functions, the level of competence and involvement of the refugee community in these tasks, and the salary scales to be adopted.

Training Needs

6. The agency responsible for the operation and maintenance of these water supply systems should develop a training programme on a continuous basis for staff and selected refugees who could eventually get involved in these activities, especially when the emergency phase is over, and when "care and maintenance" activities take their shape to cater for refugee needs until a durable solution is found for their plight (See 2.9; 3.8; 7.11; 12.20). This programme should include vocational (mechanics, plumbing, etc.), simple record keeping and other administrative training, depending on the technical approach and complexity of the system and on other institutional requirements of the agency and the "care and maintenance" programme being implemented. Technical staff at higher levels should also benefit from the training programme, which should include tailor-made training, covering administrative, accounting, finance and engineering aspects (See 11.20). These programme should also be carried out in such a way as to support and complement other on-going efforts in the fields of preventive health and hygiene education (See 8.24). In this context, a coordinated plan, including estimates of manpower, training staff, equipment, materials and operating costs should be pursued as a way to ensure the necessary funding and assistance from the international community and UNHCR's implementing partners (See 5.1).

Operation and Maintenance Plan

7. Activities related to the operation of emergency water supply systems depend on the type of system in use. The technical characteristics of the systems have been decided after considering all available resources and constraints. Their operation and maintenance requirements, as well as the approach to meet them, should also have been considered by the design engineer (See 2.10). It is his responsibility, therefore, to provide a clear and practical plan to operate and maintain all system components to camp authorities and relevant service personnel. This plan should be detailed and specific (it should refer to every single system component requiring operation or maintenance actions); it should also be realistic and have a time element in the form of work schedules, giving emphasis to preventive maintenance activities (See 3.16; 4.3; 6.40-45; 6.53; 6.56; 7.5; 7.11; 7.15; 8.19; 8.24; 8.26; 9.4-6; 10.6; 10.9; 11.9). This plan should already include a complete set of technical information required by the operation and maintenance staff to understand the system and its components as well as to

monitor their performance (See 2.6; 10.23); the ways and means of obtaining, storing, retrieving and analyzing additional technical data generated by operation or maintenance activities should also be included in the plan.

Water Inventory Data

8. It is the responsibility of camp management (and more precisely of their engineering support), (See 11.2) to ensure that technical information is obtained and used to produce and periodically update a *water history file* for each system; experience has shown that this goal may only be attained if the operation and maintenance plans include a routine to ensure that all technical files are kept up-to-date (See 6.40). This water inventory will indicate, on an on-going basis, the operational possibilities, costs and constraints of the systems as well as the type of maintenance required and its possible timing and costs. For this purpose, check-lists may be useful, which should include all physical actions required as well as a complete breakdown of the type and quality of information needed to manage the system's operation and maintenance (See 2.6). The use of water by the beneficiary community should also be monitored and appropriate records maintained on this subject; the impact of a water supply system in an emergency refugee camp is related to social and cultural factors as much as to the technical characteristics of the systems and their components (See 2.8; 3.9; 5.2).

Preventive Maintenance

9. A preventive maintenance concept requires that enough technical attention be given to the functioning and performance of each single component of the refugee water supply system to allow the identification of future system faults (loss of efficiency, signs of wear, bacteriological contamination of the supplied water, leaks, etc.) before its breakdown occurs (See 11.4). It also requires a plan for visiting and inspecting every system component on a periodical basis. The results of these visits are to be recorded in the water history files for monitoring and future reference purposes (See 11.8) as well as all preventive maintenance actions then carried out (servicing engines and other mechanical devices, replacing worn parts, repairing leaks, etc.). The frequency of the visits and the type of actions to be taken at each site will be decided according to the system's technology and characteristics. Appropriate check-lists are also required to assist camp managers and caretakers in their tasks.

10. Camp managers, assisted by the water maintenance committee (See 11.3), will periodically read and analyze field reports to detect troubles before they occur, to take the actions required to solve them (e.g. usage leading to break downs, lowering of the water table, low levels of residual chlorine in the supplied water, unsanitary conditions at water points, etc.) and to obtain enough information for budgetary and other management requirements. Information and complaints from beneficiaries should be appropriately recorded and considered by the committee as part of their normal duties. For this purpose, a simple and practical system to receive these complaints or reports from the beneficiaries (refugees, service centres, administration, etc.) should be established, and each of these complaints should trigger the appropriate remedial actions by the committee, the caretaker and his staff.

Refugee Participation

11. Refugee communities do not live in "normal conditions" and therefore may not collaborate with camp authorities in maintaining the camp's infra structure and services as neighbouring host communities would do (See 5.2). The "temporary" nature of emergency refugee camps as well as the socio-economic and political situation of these refugees do not allow for a close and effective involvement of refugees in this type of activities (See 2.8). Efforts should, nevertheless, be made to identify and motivate members of the refugee community with the right technical expertise (or who are willing to be trained) to collaborate with camp authorities during the design and construction of the system and later in operation and maintenance activities (See 2.9; 3.8; 4.2; 5.1-iv; 6.33; 6.36-iii; 7.11; 11.22). This will facilitate their closer involvement in camp activities should the emergency camp evolve into a longer term "care and maintenance" camp.

12. When designing an approach for refugee participation in an operation and maintenance scheme for camp infrastructure which is likely to be useful, beyond the emergency, in longer term "care and maintenance", it should be borne in mind that the approach required should be adapted to the cultural

and social background of the beneficiaries as much as to the technical characteristics of the system itself. The role of women and children as beneficiaries and their possible contribution to operation and maintenance efforts should always be considered; they have been, and are, successfully playing an important role in these type of camp activities in many camps throughout the world (See 3.8). The size of the refugee camp should be considered very carefully when defining modalities and degrees of refugee participation in water supply operation and maintenance activities, as experience shows that whilst it is possible to adapt operation and maintenance schemes which have proven successful in rural non-refugee villages (particularly in developing countries) to *small* refugee camps (say, with populations of less than 3000-5000 beneficiaries), it is practically impossible to apply these approaches to larger refugee camps, whose water supply systems should be managed, operated and maintained in accordance with schemes more similar to those used in larger towns, which require a stronger central system and less participation from the beneficiaries.

"Village Level Operation and Maintenance"

13. An operation and maintenance approach that has proven useful and relatively successful in ensuring continuous and efficient water supply services in refugee camps located in rural environments of some developing countries is the so-called "Village Level Operation and Maintenance" concept (VLOM). Although its original conception was to address the operation and maintenance problems of handpump-based water supply systems, its main principles may be applicable to other types of systems such as those those serving small refugee camps (populations ranging between 3000 and 5000 refugees or less). As the bases for this approach should be established during the early stages of camp planning and construction (i.e. during the emergency phase) its applicability to each particular camp should be analyzed by camp authorities and technical staff at the start (See 2.9; 5.1; 12.3).

14. The VLOM approach was made possible by the agreement of handpump manufacturers tc develop pumps allowing maintenance efforts to be carried out by village caretakers with minimal skills and working tools, giving preference to the use of spare parts that could be manufactured at local level, and with special emphasis on the cost-effectiveness of these pumping systems and their operation and maintenance requirements. The system also contemplates a great deal of users' involvement in choosing when to service the pumps, the appointment of the caretakers and in meeting (at least partly) the financial requirements of the scheme (this last point is normally not applicable in refugee camps). The advantages (technical, financial and even social) of this concept are reasons enough to analyze its applicability to any refugee situation and to make efforts to adopt it in all camps showing the possibility of success. In this context, advise and support from donor agencies, local authorities, implementing partners and pump manufacturers should be sought.

Standard Designs and Equipment

15. Very often, several refugee camps may be located in one district, province or region within a "refugee-affected area" and the provision of services to them will very likely be the responsibility of the same government authorities and implementing partner agencies, with the support of the same UNHCR's field or branch office. The delivery of these services, their efficiency and cost effectiveness and the general impact on refugee welfare will greatly increase if standard designs and plant equipment are used in the construction of camp infrastructure, including the water system. Efforts and a great deal of planning are required at the early stages of camp development to achieve this goal. Camp authorities, with the technical support of the design engineer and other relevant technicians (See 11.2), will explore the uses and practices of local authorities and government agencies to define the best technological approach to use in the design of the system and its components (See 2.7). They will also look at the local and, if necessary, the international market to ascertain the immediate and future availability, and prices, of the equipment considered as most suitable to the project and the local environment. A decision to use the same equipment on a continuous base should then be made, bearing in mind the need to be as flexible as possible to adapt future needs to changing social, technological and financial circumstances. In this context, the use of emergency water supply prefabricated packages should be carefully planned in such a way that, they could either continue to provide a cost-effective service or be easily replaced for more permanent structures and equipment if the need to continue: longer term

assistance for the refugees arises (See 4.1; 4.7; 7.11; 8.19; 9.5;12.20).

Logistics Support

16. To keep water flowing through a water system requires the importation to the camp of a large number of items. This task should also be carefully planned in the early stages of camp development. The needs are determined by the size and technological approach used in the system as much as by the camp's geographical situation and by the local social and economic circumstances. Arrangements should, therefore, be made to assess the procurement, transport and warehouse needs of each camp to ensure a timely and effective supply of fuel, spare parts, disinfectants and other materials required for the operation and maintenance of the water supply systems (See 8.21; 10.5).

17. In most cases procurement of assistance items for refugee camps is made outside the camp, by people not necessarily having a thorough knowledge of the technical details required for the obtention of the right type of equipment or materials for a given water supply system. Although the standardization of designs and equipment may prove useful to ensure a more effective procurement effort, a sound and complete description, with special emphasis on the provision of standard, easy to understand technical specifications, is the only way to ensure the timely availability of the operation and maintenance crews' requirements. It is most important to obtain an exhaustive record of the technical characteristics of each water system component from the design engineer; this record will be kept by the caretaker and adjusted periodically to reflect recent changes. On those occasions when there may be difficulties in obtaining the correct data, an experienced engineer should be consulted (See 11.2).

18. It is the joint responsibility of UNHCR, government counterparts, their implementing partners and camp managers to hold a large enough stock of fuel, spare parts and any other material necessary for the due functioning of the water supply system and its components and to provide workshop facilities for regular operation and maintenance activities. Enough attention should also be given to the conservation of perishable items, such as PVC pipes or disinfection chemicals, to slow down their decay (See 8.21; 10.5). To ensure an effective supply of these basic items, arrangements should be made for the utilization of the procurement, warehouse/storage, and control facilities (and their staff) covering charge of the provision and distribution of other assistance items to the refugees (construction materials, medical supplies, food items, etc.). When more than one refugee camp is under the responsibility of the same agencies, efforts should be made to centralize the system so as to ensure an even supply of the requirements to all camps (See 11.15). At camp level, warehouse facilities should be adapted to the technical characteristics of the water supply system and its components; details of these facilities should be given by the design engineer as part of the information to be submitted by him upon completion of his work (See 6.36-ii; 8.21).

Maintenance of Sources and Catchments

19. The need to protect all water sources from pollution has been previously discussed (See 2.2; 3.11; 4.3; 6.9; 6.19; 6.29). Appropriate actions should be planned, included in the operation and maintenance plan (See 11.7) and undertaken by the caretaker and his staff to periodically check that this protection is effective (prevention of farming in the catchment areas, cutting grass and overgrowth in the vicinities of structures, regular inspections at collection chambers of spring intakes, cleaning and greasing of locks, repairs to cracked slabs or leaks, etc.). As periodical coliform bacteria counts provide the best indicators on the evolution of bacteriological water quality, they should be performed on a regular basis (See 3.16); appropriate actions should be immediately taken to locate and eliminate any source of pollution thus detected. Catchment structures such as surface water intakes, dug wells, boreholes, haffirs, etc., require specific actions for the repair of erosion damages, for the cleaning of siltation or incrustation deposits or for periodical disinfection (See 6.11; 6.21; 6.40-45; 6.53; 6.56); these actions should be included in the preventive maintenance plan (See 11.7).

Maintenance of Water Treatment Facilities

20. Water treatment plants may perform many processes in accordance with the raw water quality and the design of the system; technological approaches to treatment are also many and very varied (See 8.8). It is most important to make sure that these facilities are well understood by the caretaker

and his crew to ensure the continuous potability of the supplied water. Cutting grass and overgrowth around the structures; greasing doors and locks, provision of preventive maintenance to valves (greasing, replacement of gaskets, etc.), periodical cleaning and disinfection of tanks, preventive maintenance, service and repairs to mechanical equipment (pumps, chlorine dosers, agitators, etc.) and water quality control (See 3.16; 8.24) are important activities related to the operation and maintenance of most treatment facilities. Slow sand filters, for instance (See 8.19), require water to be drained off first before 1 to 2 cm. of the sand surface is carefully scraped off, a process that could be repeated periodically until the sand filter layer approaches its minimum effective thickness (not less than 50 cm.); the intervals for cleaning depend on the quality of the raw water and the filter's throughput (generally between 3 to 8 weeks). Previously removed sand is carefully washed to eliminate all its contamination and dirt, additional "new" sand is added to complete the initial volumes and the filter is backfilled for another cycle once this minimum sand level has been reached.

Maintenance of Reservoirs

21. Maintenance of reservoirs is often overlooked or neglected; tanks need, however, periodical cleaning and repairs to keep their effectiveness and to avoid any possibility for them to become sources of pollution to the supplied water. Checks for damages in their structures and covers, detection of leaks, and related repairs may be carried out just after cleaning the tanks. Disinfection of the tanks should always be carried out after these operations and before they are put back into service. The surroundings of all tanks and reservoirs should be kept clear of grass and overgrowth.

Maintenance of Standposts and other Watering Points

22. Actions to take care of public distribution standposts and other watering points (e.g. cattle trough facilities) may, to a large extent be carried out by the refugee beneficiaries themselves. The importance of this collaboration should be stressed in hygiene education programmes (See 2.9; 11.2). Among the tasks that should be carried out by refugees are all those necessary to maintain the standposts clean and the drainage facilities (for waste water) operational (See 6.29; 10.9). All leaky taps should be replaced or repaired as soon as possible; the use of automatic closing, water saving taps may prove important in controlling water wastage and leaks (See 10.6). Valve chambers should also be inspected and cleaned on a periodical basis; repairs to them should be made without delay as soon as the faults are discovered.

Maintenance of Pumping Facilities

23. Little can be said on this subject apart from insisting that the manufacturer's instructions on operation and maintenance of mechanical equipment should be *closely* and *strictly* followed. The buildings should also be checked with some periodicity; valves should be maintained and leakages repaired (See 7.5; 7.8).

12. Management of Emergency Water Supply Systems

- The identification of appropriate water sources, the construction of the necessary structures to tap, treat, store, and distribute drinking water to the refugees and the activities related to the operation and maintenance of these facilities are only a small component of the assistance activities to be undertaken for emergency programmes. In view of their particular requirements, however, water sector activities require specific planning and implementing arrangements to attain the ultimate objective of providing enough safe water to the refugees and to their communal facilities in the most cost-effective way.

- Water projects, as many other refugee assistance efforts, require specific actions tc achieve their objectives. These actions should follow a previously defined order of actions to ensure the timely and effective coverage of refugee needs.

- These specific activities should be developed within the overall emergency programme and its cycle. Efforts should be made to identify the correct working paths to follow and their

timing, in such a way that full and up-to-date information is always available for programming purposes.

Needs Assessment

1. Emergency programmes should cover total needs of refugee camps form the start of the emergency. These programmes are designed on the basis of the assessment of total emergency assistance needs. As may be the case for other assistance sectors, it is very seldom that the basic data necessary for water supply project design and implementation, is available during the needs assessment exercise. Conceptual designs of the necessary structures and systems will have to be used for the initial planning of emergency response.

Conceptual Design

2. Conceptual designs will be useful for programme formulation, a basic step in ensuring a consistent approach towards meeting all refugee needs, including adequate funding, appropriate implementation arrangements and a clear time frame for emergency operations. Conceptual designs should be based on available technical data and should be flexible enough to allow for their adjustment to the physical realities of the project site, to the socio-cultural background of the beneficiary refugee population and to the institutional framework of the programme itself (including arrangements for possible longer term assistance to refugees, beyond the emergency programme's time frame) in accordance with the results of further investigations and surveys (See 12.8).

3. Any refugee water supply system is a combination of structures and other facilities to produce (collect, treat, store) and distribute potable water to a group of people living in camps (See 10.17). Its design should be based on a thorough knowledge of the available water resources and other relevant environmental conditions of the site; its construction and technological approach should ensure the compatibility of each system component with the others; both the type of service delivered and its operation and maintenance requirements should be appropriate to the socio-cultural background of the beneficiaries and to the operational characteristics of assistance activities in the camp. Several basic studies and surveys may be necessary for planning and final design purposes; the selection of adequate equipment should be carefully done after considering its technological characteristics, procurement possibilities, constraints (including those of spare parts) and operation and maintenance requirements.

Immediate Response

4. Short-term emergency measures will almost invariably be necessary to meet water needs of a refugee community while efforts are made to obtain the necessary data on the available water resources and the means to develop them into an efficient and cost-effective water supply system (See 4.1; 5.1; 6.4; 8.1; 8.3; 8.10; 11.2). There are flexible funding mechanisms to cover these initial requirements at the onset of emergency operations; they are made available through the *Emergency Letter of Instruction* (ELOI), which, while not intended to cover the whole emergency operation, should permit a rapid response to immediate needs.

Plan of Action

5. Once the most basic water needs of the refugee community have been met, and as a result of the needs assessment exercise, a plan of action will be needed to develop, in the minimum time possible, a water system capable of covering *all* camp needs on a longer term basis. This plan will include the description *(terms of reference)* of all investigations, studies or surveys necessary to obtain basic data for the design of the future system, construction and operation of the future system (See 4.1; 5.1). It will also include a complete description of any other action, already foreseen as necessary, which could be performed before the final design of the system is available (development of sources, borehole drilling, access roads, organization of refugee involvement, etc.). This plan of action should give a clear idea of the correct timing for each activity (and the plan's "critical path") as well as an *estimate*, as accurate as possible, of the required technical and financial inputs. This plan of action will be instrumental in formulating the water sector of the *emergency programme*, the instrument which should

ensure the full coverage of sector needs from the start of the emergency.

Emergency Project Submission

6. The correct formats and procedures to be adopted for project submission are clearly explained in other handbooks. A *technical project description* containing the objectives and actions to be undertaken to achieve them should be part of this documentation. While some of these actions could be carried out as a part of the same project, others, in view of their complexity or requirements, should be carried out independently. This is the case for some topographical surveys, highly specialized hydrogeological studies, borehole drilling programmes, etc. The implementation of these projects (or subprojects) should respect, as much as possible, the time schedules proposed in the plan of action (See 12.5).

7. A correct technical project description is an important tool for both, UNHCR and the executing agency (implementing partner) (See 5.1-iii). It should provide, in clear and concise terms, enough information to justify the need for the project, to assess its cost-effectiveness, to be the basis for the preparation of budgets, implementation and monitoring plans and to facilitate the fund raising exercise. An *executive summary*, covering all important aspects of the project should be presented first, for the convenience of interested individuals, particularly decision-makers who may not read the entire document. Location maps and other simple information should also be included in this summary, to enable clear presentation and quick understanding of all project characteristics. Project descriptions should also include a list of project objectives, a mention of all preparatory work required, and a detailed list of constraints, recommendations and actions to be taken; their main body should contain:

i) Introduction:

- Reasons for project proposal and its objectives;

- Background information on the water supply and sanitation sectors, including present water conditions; situation of existing infrastructures; socio-economic and cultural background of the beneficiary refugee population; self-help activities; and, if relevant, long-term development plans for the project site;

- Location map, showing project site and overall layout of the proposed system (water source, water lifting methods, conduction pipelines, treatment facilities, distribution system, waste water disposal, etc.).

ii) Institutional background:

- Description of all governmental and non-governmental institutions or organizations having an impact on water supply, sanitation or public health in the camp or its vicinity, giving special emphasis to the proposed implementing partner. Information should be provided on their purpose and goals, operational responsibilities, managerial capability, staffing, location of headquarters and their regional and local facilities;

- Sector policies, including targets for service and standards, financial arrangements, institutional development, refugee community participation, administrative and technical support;

- Beneficiaries. Description of social, cultural and economic background of the beneficiaries (refugees and host communities, if applicable), criteria for selection of target groups, water demand estimates (including livestock, gardening or other purposes);

- Public Health aspects. Presence of water borne diseases and other existing health conditions, curative and preventive health practices, health education and hygiene training programmes, institutional arrangements, etc.;

- Water resources. Overview of available surface and groundwater resources; available geological, meteorological and hydrological data; its reliability and results of analyses in

terms of water balances and budgets, present and future water demand and patterns (in space and time); water quality and pollution problems;

- Existing water supply services (if any), type of service, coverage, standards, reliability, water quality, user charges, operating and maintenance status;

- Need for the project. This section should explain why existing water supply arrangements (if any) cannot cope with present or projected water demands, and the consequences the lack of better services will have on present and future refugee population. It should also give an outline of priorities and comments on the urgency of project implementation.

iii) The project:

- Technical description. Definition of the project and outline of its components, including maps, photos, drawings, sketches and bills of quantities, as appropriate. Description of additional project preparation work requirements (studies or surveys; further design work; related projects, such as opening of access roads, borehole drilling, etc.); necessary support activities, such as logistics, training of local operators, health education;

- Implementation arrangements. Identification of all institutions and voluntary organizations involved in project implementation, including the need for consultants or contractors (if applicable); description of their functions and responsibilities, coordination and monitoring mechanisms, needs for assistance or support (staff, training, financial, etc.); implementation schedule, complete with chronogram depicting the tasks of each group involved, critical paths and necessary administrative steps (provision of budget, preparation of tender documents, obtention of land and water rights, etc.);

- Operation and maintenance arrangements. Description of future arrangements for operation and maintenance of the water system facilities, including self-help (refugee participation) activities, technical assistance required, annual costs and any other requirement;

- Environmental impact. Description, in brief terms, of the various environmental impacts to be expected as a result of the project, including public health, sanitation and water resources themselves;

- Cost estimates: A summary of estimated project costs, taking into account a realistic provision for unexpected costs for each budget item. These costs are to be estimated on the proposed bills of quantities and on unit prices for each element; a breakdown of costs into foreign exchange and local currency components would always be desirable; a full explanation on how costs were estimated and a list of basic assumptions (particularly those for unit prices, contingencies, price increases, etc.) should be included. A breakdown of "in kind" and "in cash" costs should also be desirable;

- Financial plan. A final budget summary, in accordance with the FMIS formats (See 12.21) will be presented in this section and, if relevant, all possible sources of funding should be identified, both for project implementation and for the long-term operation and maintenance of the system to be constructed. A discussion on arrangements for future accounting and reporting should also be included.

iv) Technical annexes:

- Map of the camp/village/settlement, including all project related buildings and installations (existing or to be constructed);

- Assessment of water source productivity (pumping test analysis, flow measurements, hydrographs, etc.);

- Chemical and bacteriological assessment of water quality;
- Planimetric details and hydraulic profile of conduction and distribution lines;
- Technical details, specifications and plans ("blue prints") of all structures, system components and their interconnections;
- Terms of reference and technical specifications for additional technical inputs.

Project Preparation

8. In many cases, additional project preparation work will be required to study alternative sources (geophysical prospection or hydrogeological surveys, water quality analyses), to obtain basic data still required for the final design of the system (topographical surveys, assessment of source potential and safe yields) and to make the necessary adjustments to conceptual designs, in accordance with the results thus obtained (See 8.15-16). The nature of most of these actions allows for them to be carried out independently and requires rather specialized technical inputs. They could, therefore, be regarded as "subprojects" and as such should be planned and implemented in accordance with normal project implementation rules and practices. In some of these cases, the project description may take the form of *"terms of reference"* if the project is to be undertaken on a consultancy basis; in other cases, especially when construction or other types of physical work have to be undertaken in the field under contractual arrangements, the project description should take the form of *"technical specifications"*.

9. Terms of reference for a consultancy work should ideally include as much background and technical information on the project as possible (See 12.7) to provide a clear idea to potential consultants; a detailed description of objectives, project requirements and arrangements for the consultant to carry out his work as well as suggested (or required) methodologies should also be included; details on reporting and other project output requirements (blue prints, bills of quantities, budgets, tender documents, etc.) and a mention of the required technical expertise and experience will complete these terms of reference. Consultancy work may be carried out by individual specialized technicians or by consultancy companies offering a wide variety of technical expertise. The use of local expertise in this type of work should be encouraged (See 2.7).

10. The technical specifications given to a contractor for any work should be detailed enough to describe exactly the works required and the characteristics of resulting structures or other types of facilities (See 6.57). This is especially important because it is the only way to ensure the compatibility of the facilities thus built with the rest of the system. These specifications should refer to design documents (blue prints, sketches, etc.), bills of quantities and overall responsibilities for the contractor to carry out his work. Supervision and control mechanisms (including the description of tests or other verification work) as well as work acceptance or rejection procedures should also be contained in the technical specifications to allow the client (UNHCR or the implementing partner) to ensure the contractor's full compliance with contractual terms and, therefore, the quality of his work. Annex D gives an example of this type of document.

11. Once all necessary basic data and other project requirements have been obtained, the final design of the system may be undertaken (See 2.3; 10.16-17). Appropriate sketches and blue prints of every single component of the system should then be prepared in final form; accurate bills of quantities (a list of all materials, labour and other inputs required for the completion of the system or any of its parts) should be drawn up and final budget estimates calculated.

Tender Documents

12. The nature of the work required to build and commission a water supply system is such that very often this work may only be undertaken by contractors having specialized knowledge and equipment. Financial rules require that, in this case, potential contractors be invited to offer their services in accordance with a tender and bidding procedure. For this invitation, appropriate documents should be prepared by the executing agency (UNHCR or an implementing partner) to describe the procedures, the type of work to be carried out, the type of contractual arrangements that will regulate the

future works and the mutual relations between the client and the contractor during project implementation.

13. Tender documents, in general, should contain an *introduction* section, where the basic "rules" to be applicable to the future contract are explained (these rules, of course, should always be compatible with UNHCR's financial and programming rules); a list of the document's terms, expressions, abbreviations, etc., and their respective meanings will also be included, as well as the definition of the working language(s) and type of units to be used (usually metric units should be used; however, the final choice depends on the country and its normal practice; in this case, conversion factors should be defined). Currency units should also be defined. The next part of the document should be the *instructions to bidders* section, which should clearly explain:

i) General principles, including general specifications and instructions for bidding and for the handling and flow of documentation, as well as the price (if any) to be paid for these documents by bidders;

ii) Procedures for the amendment of published documents; it may be necessary to amend, cancel or make addenda to previously published documents; procedures for this purpose, and their time frame, should be adequately explained;

iii) Type of information to be given to potential bidders and UNHCR's (or the implementing partner's) responsibilities and limits on the type of information given. This is the place to make it well understood that although legal constraints may not be spelled out, they should be applicable in as much as national or regional laws are applicable to UNHCR, implementing partners or contractors. The procedures to be followed for the obtention/release of specific information, including time frames, should be explained. The value of "non-technical" or "unofficial" information given or received by UNHCR, the implementing partner or government counterparts should also be defined here;

iv) Legal requirements for bidding companies/individuals (i.e. contractors); technical or financial capacity, required expertise and experience, definition of the "rules of the game" for groups of individuals or companies who, as in a "joint venture", decide to participate as a single body;

v) Definition of restrictions and incompatibilities, to exclude persons/companies which, by legal restrictions, or any other reason, may not work as UNHCR's contractor; these restrictions may also be extended to all activities within the future contract (i.e. banks, consultancies, supervision, monitoring, etc.);

vi) Presentation of offers. It is necessary to define the number of copies required for each document, the formats, language, style, currency used, pricing criteria, cost breakdowns (e.g. local versus international procurement, international staff, local labour, etc.), payment arrangements. It will also be necessary to define the treatment to be given to incomplete, partial or late offers, to incorrect (e.g. arithmetically) offers, as well as the legally binding character of the offers. All additional documentation, to be handed jointly with the offers, is to be defined (legal certificates, guarantees, bonds, etc.) as well as the procedures required for the amendment of offers, addenda to them or their withdrawal;

vii) Assessment of offers. The opening of offers should be defined in terms of exercise (private/public), venue and date;

viii) Treatment of bidding documents. The legally binding character of the offers should be repeated here, and a definition of unacceptable documents or offers due to defects or legal constraints should also be given;

ix) Contractual arrangements. Definition of who is to award the contract, when and how; criteria used, always leaving open the possibility to reject all offers if found unacceptable;

procedures and criteria for appeals;

x) Documentation and guarantees for the contract. A definition of what documents, when and how they should be provided by the successful contractor; these documents should, at least, contain information on the contractor's legal and financial status and on the required performance guarantees, licenses or permits;

xi) Procedures to formalize contractual agreements. Definition of document formats, procedures for their approval at all levels (local, regional, national, UNHCR Headquarters, etc.), other documents necessary for the due completion of contractual documents (insurances, lists of prices, etc.); work programmes and time schedules, other management tools (bar charts, flow diagrams, etc.); direction, monitoring, inspection and acceptance (or rejection) criteria and procedures should also be defined.

A last section should contain the *general contractual norms*, including:

i) Legal obligations of the different parties involved, the legal character of all documents, the obligations of the contracting party or client (UNHCR or implementing partner) including all mandatory clauses for project implementation and contractual arrangements; information to be provided by the client, other requirements and responsibilities;

ii) The obligations of the contractor, including the provision of labour and his obligations towards them, services to UNHCR/implementing partner and their staff, provision of adequate materials and equipment, laboratory/sampling/testing facilities, storage facilities, etc;

iii) General principles and rules to be followed during project implementation should be spelled out and discussed in this section, including:

a) The need to follow plans, specifications, instructions and other decisions made in accordance with contractual terms, sound technical practices and "good faith";

b) Contractor's responsibilities during implementation, including those at working sites, obtention of permits and licenses as required;

c) The type of communications between the contractor and UNHCR or the implementing partner, specifying the inclusion of a "log book" which will be part of the official communication channels between parties and which should always remain at the work sites;

d) UNHCR's or the implementing partner's inspection authorities and responsibilities;

e) The importance of technical plans and specifications;

f) The procedures to solve discrepancies within plans, to amend them or to change them;

g) The need for temporary arrangements at the construction site, especially if these arrangements are likely to interrupt existing services or facilities (opening of existing roads or destruction of crops for pipe laying, etc.). Provisions should always be made here against the destruction of trees, wild life pollution, etc.;

h) The property of the material resulting from works and the responsibility for cleaning work sites from debris, pollutants, etc.;

i) The need to follow previously agreed time schedules and other work plans, while making provisions for required changes of any of these working plans within the limits of contractual arrangements;

iv) Procedures to make changes outside of contractual arrangements (supplementary