4.4 VALVE AND HYDRANT OPERATION

Valve operation is a major problem to be overcome when introducing any form of active leak detection. This problem takes two forms; insufficient valves installed originally and failure of those that are available to operate effectively

Frequently this stems from low standards of design and construction for the initial main laying and the perpetuation of low standards in the repair works following mains fractures. Great care must be exercised to prevent the entry of stones or, during repairs, to remove stones and debris from inside pipelines. All too often mains laying or repairs are carried out with no attempt at protection of open ends and no subsequent high rate flushing out of the system through washouts (nor disinfection sometimes). When stones and grit are not removed, they inevitably become trapped in the valve seating and prevent effective closure.

Another problem arises from lack of care and discipline in the operation of valves. When valves are shut off for repairs, closing one valve on each side of the repair will normally suffice. But if they will not close effectively, then more remote valves must be closed until the flow can be shut off. The problem then is to remember, when the repair is finished, to open all the valves that have been shut off.

Unless rigid discipline is exercised many valves in a system are left closed, with the result that flows and pressures are reduced, supplies fail, and the quality of the water in "dead" lengths of main deteriorates.

A further difficulty arises when, as a result of road resurfacing, valve covers are broken or valves are covered over and lost. Frequently there are no valve marker posts to assist in relocation. Similar problems occur with buried-hydrants.

(1) District Inspectors

These problems usually occur when the responsibility for valve and hydrant operation and maintenance is not clear. Such operations should be undertaken by a limited number of experienced and responsible employees, who may be graded as senior or "district" inspectors.

Experienced, older employees should be trained as senior inspectors and given the sole responsibility for operating and maintaining valves and hydrants. No repair gangs should have valve keys among their tools. A senior inspector's main responsibility should be to personally ensure that valves are operated correctly, with labour assistance as necessary.

They should also ensure that valves are maintained in proper working order, complete with marker posts, and are repaired or replaced when found to be leaking or in any way defective. An inspector should ensure that valves are not damaged or lost when road works are in progress. Finally, inspectors must protect the mains generally against damage by operations of other utility

workers or during road reconstruction.

These inspectors are likely to be more than fully occupied. Yet at certain periods they may have time to undertake leak detection in the area they are controlling.

Before active leak detection can proceed very far, considerable effort will probably be required to find, map, mark, and change all defective valves, beginning with those required to isolate zones and districts effectively. This may prove to be a mammoth task, but the effort required will be amply justified by the improved operation and control of the system.

In some systems the number of valves may not be sufficient to exercise proper control. It may also be found that there are insufficient washout valves or hydrants to permit flushing of the system, either on a regular basis or following shutdowns for the repair of leaks.

In fact, one of the serious problems for leak inspections in some systems is the absence of any direct contact points. Valves are buried; hydrants are sparse; and there are no stop taps on consumers' services except those adjacent to meters situated on private premises not accessible at night. The first essential step in such cases is to restore, and if possible expand, the installation of valves and hydrants.

4.5 METER READING

While the maintenance of meters, including changing, repairing, and testing, normally falls within the duties of the distribution manager, the reading of the meters, together with billing and collection of charges, is usually the job of the financial manager. A common procedure is for the authority's area to be divided into meter districts; each meter reader covers a block of properties within that district.

Quite often meters are read and accounts sent out at bimonthly or quarterly intervals. The actual reading dates are spread over the whole quarter, but the period between readings is about 90 days. For this reason, a comparison between production and consumption figures over a short period is not valid unless special correlated readings are made for that purpose.

Although the reading of domestic meters is reasonable at bimonthly or quarterly intervals, this may not be the case for the larger industrial meters. Investigations will show whether it is not more cost effective to read the larger meters every month. This not only would permit improved collection, but would also ensure that any defective large meters are replaced with minimum delay. The larger the meter, the more frequently it should be read.

Meter failures frequently result from excessive grit and rust particles in the water. This usually occurs because mains are not being flushed systematically. Flushing is most effective from washouts discharging to drains, ditches, or culverts, but flushing from hydrants is necessary

where washouts do not exist. (Hydrants are essential on all dead ends of mains and should be spaced about every 100 metres.)

Irregularities in meter reading procedures can be rapidly detected if computerised accounting is introduced and programmed to throw up such anomalies. Failing that, frequent spot checks by management may be necessary.

The reading, billing, and collection procedures, including costs, should be reviewed by management, with technical assistance as necessary, and designed to improve data retrieval, as well as to highlight leakage on consumers' premises, and reduce irregularities, under-registration, and illegalities.

(1) Boundaries of Districts

The disparity between boundaries of meter districts and distribution districts often causes problems. Because of this difference, no accurate comparison of district production and demand can be made. This problem may be overcome by a one-off survey that allows the distribution district number to be entered on each meter account so that, with computerised billings, meter consumption for each distribution district can be readily totalled.

Where billing is not computerised, correlation of boundaries becomes a much more difficult task that could entail physical changes in the boundaries of meter districts and even of meter readers "blocks."

Moreover, if changes in distribution zones are required in order to reduce leakage by reducing pressure on consumers' services, a change in the meter reading district boundary may become necessary. Such changes may not be easy to achieve.

4.6 PUBLIC RELATIONS

The build-up of a waste conscious outlook both within the authority and in the wider community has to cover a period of many, many years. Thus the major part of the long-term effort to control UFW must be based on improved public relations in the media and, more particularly, in the schools. The appointment of a public relations officer by the authority is a first step.

Every opportunity must be taken to demonstrate the losses that occur from wasteful use and the resulting cost that has to be met by the consumers.

In most industrialised countries, byelaws to cover such practice are normally in operation but elsewhere, even where such bylaws exist they are normally ignored. Special attention is required to introduce such legislation where not existing and above all, to ensure compliance. The difficulties are considerable, but the first essential is to appoint plumbing inspectors to approve all new plumbing installations. In the long term, education to encourage public co-operation may be

more valuable than legal enforcement.

(1) Community Participation Programme

The term Community Participation Programme (CPP) refers to planned information, motivation and education activities which are specifically designed to

- encourage consumers to co-operate with the water supply utility,
- make sure that they obtain full benefit from their participation;
- help to ensure that the utility's activities and more specifically UFW team activities make an overall positive contribution to Community welfare.
- measurements (consumers can be requested to close their stop cock during one night), etc.

CPP are very useful in ensuring the success of UFW Control Programmes, particularly during field consumer surveys, improvement of consumer management, night flow measurements etc.. Above all, CPP aims at changing the behaviour of the people using the water.

Means of communication between the utility and the Community include:

i) through water utility routine work (maintenance works, meter reading, billing)
ii) mass media (TV. newspaper. radio)
iii) mailing
iv) conferences in schools. universities. or other public offices

i) Utility Routine Work

Meter readers, bill collectors and, to some extent; field workers, are frequently in contact with consumers. The image of the utility is largely conveyed by them and therefore it is important that these workers are motivated and well informed about the activities of the organisation; even if these activities are not directly linked to their daily duties

ii) Mass Media

This is probably the most efficient way to transmit general messages to the Community. They can include advertising, information on works going on, water cuts, public awareness campaigns etc.

In the case of a leak detection programme it can be useful to use mass media to warn and inform people in the area about the work going on and that it might disturb the supply in that area for a given period.

iii) Mailing

This mean is a good complement to mass media. In the case of the Leak Detection Programme, leaflets can be sent to all the consumers located in the district concerned. This would facilitate the task of the UFW team and limit the consumer complaints.

iv) Conferences

Conferences or lectures can be given in schools and universities to inform about the utility's activities, and to make students aware about the value of water.

(2) Improved Construction and Repair Works

One sector that may need special attention for public relations is the building industry. Considerable efforts are needed to educate builders and plumbers about the value of improved practice covering both the equipment and its installation.

If leakage problems are to be reduced in the long term, renewed attention must be directed to improving standards of design and construction of both new works and repairs. All contracted works must be inspected to ensure that they are, and will remain, leak-free.

It is also important to establish respect for byelaws by appointing plumbing inspectors to improve standards of consumers' internal plumbing, or by such other means as appear practicable. These inspectors task will be to encourage and assist rather than to heavy-handedly enforce.

4.7 BYELAWS & TECHNICAL STANDARDS

4.7.1 Context

Efforts directed at of UFW reduction fall into two distinct categories, the network and the consumer's installation. The network, including all facilities from production through to minor distribution mains pipes, is under the control of the utility but consumers' pipework is not. In many countries the greater part of the physical losses are or the service pipes even in well-regulated administrations.

To prevent the losses and wastage on consumers installations risking being uncontrollable regulations and standards (Byelaws) are implemented covering:

- materials & fittings to be used (quality of materials)
- Methods of installation practice (quality of installation)

These are then the subject of enforcement by the utility.

4.7.2 Policy

The first step, associated with an effective UFW control plan must be the preparation or up dating of byelaws and standards that are adapted to the local situation at present. Once implemented the byelaws should be periodically improvements in capacity and new technical and materials.

The byelaws once prepared need to be implemented. Mechanisms of legislation and its introduction are beyond the scope or expertise of this report. However the following points should be borne in mind:

- People need time to get used to new standards
- Simple enforceable standard are best
- The requirements should be reasonable and equitable for all customers.
- The division of responsibilities between the consumer and the utility must be clear and equitable.

There is no benefit having a set of byelaws it they cannot or are not enforced. It is therefore a prerequisite the political will is behind this policy to introduce it see it through and make it work.

In the preparation of byelaws and implementation mechanisms other policy matters such as metering is required so that there is consistency.

4.7.3 Division of Responsibility

To make byelaws workable and equitable the practice with almost all utilities is that the transfer is that the transfer of responsibility occurs at the customers property boundary (or close to it). In this way the consumer looks after the part on his property over which he has control and access and the utility manages all pipework on the public and municipal areas where they have better control and access for works than a private individual.

This practice if not already the case is strongly recommended. A stop valve with valve box should be installed at or near the transfer point. Then the water supply utility has the task of repairing the service pipe in the public area as well as ensuring that there are sufficient secondary (or tertiary) mains to keep service pipes short and direct.

4.7.4 Enforcement & Education

There is little merit in having a set of byelaws and regulations if they are not "properly" and reasonably enforced. However, for customer installations, policing and enforcement can never be absolute, so "proper" enforcement must include a good measure of public education and customer awareness of what is expected and assistance in how to achieve it.

Trained plumbing or byelaws inspectors are a common method of combining these functions of education and policing. Among other duties, no connection to the network should be permitted until an inspector has checked and approved the installation material and method, particularly of the service pipe. Further, it is recommended that the actual connection should be made by water utility staff (or a person contracted to the utility; NOT contracted to the customer). Otherwise, it is treated as an illegal connection.

The enforcement of byelaws cannot be absolute; there is no way in which every single infringement can be detected and corrected.

Undertakers must therefore exercise judgement as to the amount of effort (and therefore of cost

which has to be met by the consumer) which should be reasonably expended. The criteria are clear in the terms for which byelaws are made; the prevention of waste, undue consumption, misuse or contamination. Byelaws cannot prevent leakage from occurring, as pipes and fittings fail through a variety of reasons. They may, however, help to minimise waste through failure by requiring reasonable and generally acceptable standards to be adopted.

4.7.5 Standards for Materials and Fittings

Materials and fittings allowed for in the standards should be of good quality and design to avoid undue risk of failure and wastage of water, but without being too onerous or expensive for the typical customer in the prevailing local context.

Within the house (or building), problems will be fairly quickly obvious and access for repair relatively easy. By contrast, the service pipe from the secondary main to the customer meter or entry to the house will be:

- inaccessible
- buried underground normally and so not show leaks or problems easily
- expected to last many years
- difficult to repair

For this reason, the emphasis of quality and specification of materials and associated cost burden should be concentrated on the service pipe.

4.7.6 Standards for Installation Practice

The same criteria and emphasis applies to installation practice as to materials.

The simplest method of ensuring good quality of installation for the service pipe especially is to prepare typical designs for a limited number of installation methods, suited to the range of local conditions.

Any installer not complying with one of these standard methods would not be able to connect to the water system unless prior approval had been given for the proposed installation method.

Use of a standard installation method still requires inspection and approval by an inspector before a connection is made to the network, in order to ensure that it is of a high enough quality.

4.8 OPERATION AND MAINTENANCE IN RELATION TO CONTROL OF UFW

4.8.1 Distribution Networks

Over time and without continued attention to operation and maintenance, distribution networks are likely to have deteriorated, but in the absence of testing facilities, it is impossible to know the extent and location of the problems.

Ignorance is bliss - until major failures occur. Reinforcement and rehabilitation of a network to improve pressures and flows is a matter of blind guesswork. Thus the greater part of an authority's capital investment is not based on a logical design process and. is not being utilised in an effective manner.

Improvements may be possible, but costs cannot be accurately estimated. Valves that have been left closed produce "no flow" sections in which excessive internal corrosion occurs. Failure to flush grit from the network can produce conditions where consumers' meters may fail only a month after installation.

Very old networks may also be too small to provide adequate supplies.

Although failures in transmission mains are normally self-evident, regular inspection is desirable throughout their whole length to minimise failures. Total leakage tests of other mains is rarely possible except for special investigations.

Maintenance includes inspection, full operation, testing of closure, and repairs of leaking glands, etc. on all valves. All air valves, PRV's, and hydrants should also be inspected, tested, and repaired.

The problems involved in organising the operation and maintenance of networks are a fundamental aspect of distribution network operation, and it is essential that the responsibility for valves and hydrants be clearly assigned to carefully selected individuals such as district inspectors.

All valves must have marker posts and must be numbered and recorded on distribution plans. All failures and repairs must be recorded in a form that readily reveals operating conditions in each street.

When special pilot areas are established, preliminary flushing out of all pipelines and testing and replacement of all valves in the pilot area are required.

4.8.2 Repair of Pipework and Leaks

Following the detection of leaks by leak detection teams, it is important to ensure that the leaks are repaired immediately and that the work is done and re-tested carefully in order to minimise the risk of further leakage occurring near the same place.

It is also very important to ensure that any stones, grit, or extraneous matter that may have entered the network as a result of the leakage or the subsequent repair are removed both manually and by swabbing and flushing out before testing and sterilising has been carried out. The cost of

excavation, refilling, and surface reinstatement forms such a major part of the overall operational cost that every effort must be made to ensure that all repairs are tested to a very high standard.

Records must be kept in a form suitable for rapid reference, giving details of the dates and costs of repairs in each street. These will indicate when wholesale mains and service replacements are required, especially where there are extensive corrosion problems.

The cost of repairs to individual small underground leaks being relatively high, every effort must be made to ensure high quality workmanship, flushing out, and testing before excavations are refilled.

Repair teams should be set up to deal with the additional workload probable following in the wake of a leak detection team. These teams should be numerous enough to cope with the workload.

If the network has deteriorated from lack of maintenance investment, it is probable that the existing repair teams will be under-resourced. The new (or revamped) repair teams need to be properly equipped with tools, transport and other equipment to ensure that they can perform effective and efficient repairs, such that leaks will not recur.

Equally, investment will be required to ensure that good quality materials are available in sufficient quantity for repair work.

4.8.3 Treatment Plants & Pumping Stations

Good operation and maintenance is also required for treatment plants and pump stations, to prevent them having an adverse effect on the UFW. This includes the regular testing of all plant and equipment, so that proper control of the system can be maintained.

Adequate equipment & instrumentation should be provided at the design stage for effective monitoring and control. The importance of these items should be recognised and efforts made to keep them in good operating condition. Cleanliness is very important to this.

Operator training is a prerequisite of successful operation and maintenance. If problems of grit in the meters, valves not shutting off, etc., are to be minimised, it is essential that proper attention be paid to all maintenance works, particularly on main and service repairs, to ensure thorough flushing out after completion of repairs. Additional hydrants and washouts must be installed if required for this purpose.

4.9 New Works In Relation To UFW Control

4.9.1 Design

The design of new works in a water supply utility may not previously have made sufficient provision for active leak detection. Frequently, no means are provided for measuring accurately the quantity of water produced. When new works are designed, everything must be done to ensure that:

- production meters are provided;
- pumps can be tested regularly;
- service reservoirs can be isolated for testing, cleaning, and repairs;
- reservoir inflow and outflow rates, as well as water levels, can be indicated conveniently;
- sufficient valves are fitted for shutting off new pipelines for repair purposes;
- tappings are provided in mains for inserting instrumentation to measure flows;
- washouts and hydrants are provided for charging and flushing out pipelines and sections of the network;
- valve and hydrant marker posts are fixed; district meters are provided on bypasses to record the pattern of distribution flows; pilot waste water districts can be readily set up for training and research on consumption, if not for active waste detection;
- accessible stop taps are provided on all consumer's services within the street boundary, complete with access chambers and cover plates to
- enable soundings to be made without entering private premises.

Preliminary design must, at a minimum, include or make provision for:

1. Simple tests on all pumps and production meters by isolation and volume measurements on clear water tanks or reservoirs and/or by discharge to waste through test meters. Installation of adequate instrumentation is essential
2. Production meters at headworks to be supplemented by meters for delivery to, and discharge from, service reservoirs;
3. Ample district meters or, at least the chambers and bypasses for later installation. For distribution extensions, smaller metered districts to be considered and allowances made in the layout. Adequate valves and hydrants to be provided for control, isolation, and flushing; as well as tappings for insertion probe flow meters.
4. Where waste water districts are justified, include chambers and bypasses, planning one meter to serve two or three districts.

Selection of material and equipment should be appropriate to local conditions, particularly allowing for interchanging with existing equipment; minimising stocks of spare parts; and simplifying operation, maintenance, and repair.

Suitability for purpose should take precedence over investment cost. Simple operation is preferable to the most modern sophisticated plant, especially when labour is plentiful.

Training of labour in construction standards is essential for obtaining satisfactory new works.

4.9.2 Water supply Design, Priorities and Principles

The following general priorities and principles for water supply system design are proposed as a working basis for preliminary assessment if the water supply utility has no established criteria.

(1) Priorities

1. The water system shall be designed to establish a continuous water service in all areas
2. Areas with an intermittent or low pressure water service at present should be provided with a continuous water service at a reasonable pressure before the water distribution system is extended to serve new areas.
3. Extension of service areas which have been planned and which can afford to pay for the service should have priority over areas which have been developed informally and which consist of mainly lower quality housing
4. Areas convenient to existing service areas should have priority over areas remote from the existing service area
5. Areas where the population density is high and the quality of housing is low should be served by standpipes until areas which can pay for water service have been supplied
6. Areas which are distant from the present water service area and which have adequate communal and private water supplies should have a low priority
7. Target pressures in the primary network: Minimum of 15 to 20 m (20 to 30 psi)

This approach will enable effort to be concentrated so that UFW control efforts will yield optimum results by also being concentrated to reduce losses.

4.9.3 Construction

In order to avoid or slow down the rate of leaks developing on distribution pipework and service pipes, good quality materials should be specified, but equally the attention to the conditions of installation will be an important element. Some of the factors to be considered are summarised in this section.

Before laying, all pipes must be cleaned; they must be laid on a proper bed (preferably sand) with a minimum cover of 1.0 meter. Roads with heavy traffic may require deeper cover and/or higher specification of pipe

If the pipes are made of ductile iron, and in corrosive conditions, polyethylene sheaths give valuable protection. If they are made of non-metallic material, the laying of a tracer cable along the top will be of value later, in case records of the line are lost.

Jointing requires special cleanliness and care. Manufacturers' instructions should be followed for centring and lubrication of joints, and so forth. An end stopper must always be fixed to the end of the open pipeline to prevent entry of stones, debris or, in the case of large mains, faecal and other waste matter.

Tapping of mains, particularly under-pressure tapping, requires special attention to manufacturers' instructions. Metallic fittings should be protected with waterproofing paste or plastic tape to enhance their resistance to corrosion. Service pipelines should be installed at a minimum 0.7m depth and bent or laid so as to avoid strain at the junction with the pipeline. Special protection should be provided when joining, dissimilar metals.

After the laying of. pipes, the pipelines must be tested, normally to twice the working pressure. First they should be swabbed with plastic swabs as often as appears necessary to remove all debris that has inadvertently entered the line. Before testing, the sides and ends must be supported and at bends, concrete blocks should be provided. Testing should be carried out while the pipe joints are still exposed to view.

Supervision of construction, particularly of local contracts, can present a special problem. In some cases local tenders are so low that proper construction necessitate a loss for the contractor. If the inspection is done locally, standards will decline. It is possible to see top grade pipes being laid so badly that the factor of safety against failure is less than 1.0 by the time the contract has been completed.

Local supervision of local contracts can also make it difficult to ensure that all variations from the original contract plans are recorded accurately and that proper record drawings are prepared showing the works as constructed.

It may be essential, in some cases, to insist on supervision by competent consultants to ensure adherence to contract conditions.

All construction must be required to comply with approved specifications. The same rigid specifications used for major contracts are required for small local contracts; the supervision and inspection of local contracts should be made the responsibility of a qualified consultant. For pipe-laying contracts, particular attention should be paid to the provision of temporary stopends in order to prevent stones and grit from entering pipes during construction.

Proper standards of construction, including depth, trench pumping, alignment, bedding, jointing, refilling, testing, swabbing, disinfecting, flushing, and retesting of all pipelines are essential. Retesting at working pressure should follow the provision of services.

Service connections should be bent to give flexibility and prevent excessive strain on tappings. Ferrules (corporation cocks) and, where appropriate, saddles should be provided. Main stop-taps with surface boxes should be fitted outside and adjacent to consumer's boundaries to give adequate night access for leakage sounding. Alternatively, surface boxes must be provided over the ferrules. Complete records should be kept of all as-built work.

5 UFW CONTROL PLAN

5.1 BASIC PHILOSOPHY OF UFW CONTROL PLAN

This proposed plan for UFW control is not intended to be nor can it be prescriptive. Any plan of this nature with a horizon of 20 years must rather provide a framework and guidelines to the Water Supply Utility management, the detail of which can be defined, adapted and modified according to changing local conditions over time.

This point becomes even more germane in the current situation for Yangon and the circumstances in which this UFW plan is being prepared. Namely, that it forms part of an overarching Master plan to change and improve the whole Water Supply infrastructure and organisation to effect a sustainable, adequate service within the YCDC area of responsibility. Further, it has to be set in the context that active efforts at UFW control and management represent a new and unknown policy for YCDC.

Hence, the details of implementation to achieve the overall objectives for UFW control must be considered and co-ordinated with the other elements of the plan for the network and its operation.

The essential item to be constantly borne in mind is the final objective to be achieved in terms of UFW. The range of control principles and activities described in this plan, with the addition of any suitable, new techniques and technologies that may be developed in the future, are then to be adapted and applied as appropriate to work towards this goal.

5.1.1 Economic Level of Losses (ELL)

This ultimate aim of the UFW control plan is, by the year 2020 or before, to have reduced the level of losses to a point where the "economic level of losses" is reached and maintained. This is where the values of further reduction in the figure will be less than the cost of achieving that reduction. The ELL point itself varies in time and requires monitoring to ensure cost-effective allocation of resources to UFW control.

As the situation in Yangon water supply system is brought under control, the expectation is that the losses, which can be influenced, will become predominantly due to leakage. The non-physical losses will not disappear, but will be a relatively constant, low level factor, subject to monitoring and control.

To illustrate how ELL can change, the piped water in Yangon today has a notionally high value because demand exceeds supply and so UFW represents lost potential revenue as well as operating costs. When supply exceeds demand then the value of UFW is reduced to the operating costs only and less expenditure is justified to reduce it. This only considers operating costs for illustration, but capital expenditure must also be considered.

However, in Yangon at present, there is insufficient information available to even determine reliably the current global level of UFW, let alone any historical trends. Hence, it is not feasible to attempt any estimate of an initial ELL.

Nonetheless, in order to provide an initial reference point for the start of the programme, a preliminary target is proposed. This target must be modified and reset on a periodic basis, as more reliable and greater quantities of data become available and as conditions improve; particularly network rehabilitation, reinforcement & extension and water supply management.

5.1.2 Setting UFW Target & ELL

The recommended, preliminary target level at which UFW is to be maintained is 25% of Net Production (average day).

Not only will this require development and modification as the plan progresses, but it will become more detailed and possibly localised.

Elaborating on this point, Yangon water supply area is already large in terms of both geographical area and population and this will increase markedly over the next 20 years. Within these totals will be a fairly heterogeneous service area and so different levels of UFW may be economically justified for different parts of the system. For example, the value of and the cost of UFW reduction in dense, urban areas will be different than in sparsely populated rural areas.

Furthermore, as management and operation of the water supply utility improves and becomes more sophisticated, different components of UFW control will merit different concentrations of effort, according to their respective relative cost / benefit values.

Ultimately, the trend is expected to be towards the majority of active UFW control being directed towards the reduction of physical losses. This shift will be for two main reasons:

1. Non-physical losses are brought under control and require only routine or minimal action to maintain
2. Setting up of equipment and mechanisms for measuring and recording the relevant parameters for UFW will have been largely completed (although they may be added to)

5.1.3 Defining UFW Control Activities Long-term

As stated previously, it is not possible or advisable to define very detailed activities in the long-term. What can be defined is the principles and general range of subjects & activities to be followed in order to achieve the objectives. Success on attaining these objectives will require action on all of the guidelines, but the priority and emphasis will change with time

Once the programme is established, the guidelines should be monitored and reviewed

continuously and the plan modified to suit the prevailing circumstances. With the possible exception of some of the setting up of the programme, UFW control is largely a matter of continuing and/or periodically repeating the same functions in order to first reduce and then maintain at a given level the losses.

Most of the measures employed do not require sophisticated high-technology knowledge. Rather they require careful, conscientious management of relatively simple activities along with the collection of considerable quantities of data in order to enable:

- Effective control
- Directed & prioritised interventions (e.g. repairs analysis and high leakage areas selected for rehabilitation schemes)

So, in summary, the long term plan for UFW control is the repeated cycle:

- Collate data
- Analyse
- Review & Plan
- Prioritise / Modify
- Implement required measures
- Repeat

This will be continued many times to work towards achieving the target set (& reset).

5.1.4 Defining UFW Control Activities Short-term

For the more immediate future, the short-term plan can be defined more clearly.

No programme of UFW control can begin to effectively and sustainably reduce losses and implement control measure until the current situation is properly established. This is not the case in Yangon.

As a result, much of the emphasis for immediate action needs to be placed on determining the UFW level, comprising elements of:

- Procedures for collecting the required data
- Implementation of means for collecting the required data (e.g. installation of flow meters)
- Establishing the contributions of components of UFW to the total

As the programme commences & proceeds, the UFW figure will first be calculated as a global figure and then progressively determined with increasing accuracy and with more elements as more means are put in place. (e.g. progressing from production meters towards district metering)

At whatever level of accuracy and detail, an assessment will be made of the largest contributing elements and the bulk of the remedial effort concentrated on those.

The activities and constituents of the UFW control plan are described

The approach to UFW management is shown schematically for illustration in Figure G 5.1

5.2 UFW CONTROL PLAN FOR YANGON

5.2.1 Preliminary: Phase 1

The preliminary phase of the UFW is scheduled to last for one year. The priority of this phase will be directed primarily towards preparation and learning.

In order to be implemented effectively, it will be necessary to prepare a tactical plan with the details necessary for the first stage of this overall strategy in the context of the overall plan for Yangon water supply. Allied to this will be deciding on and making available the resources needed for the work

So this first year is mainly about:

- Setting up the required organisation and facilities
- Recruiting & assigning
- Training
- Planning
- Establishing procedures
- Providing the means for those procedures
- Practising and testing out the techniques and methods
- Gathering and analysing preliminary data for decision making and prioritisation

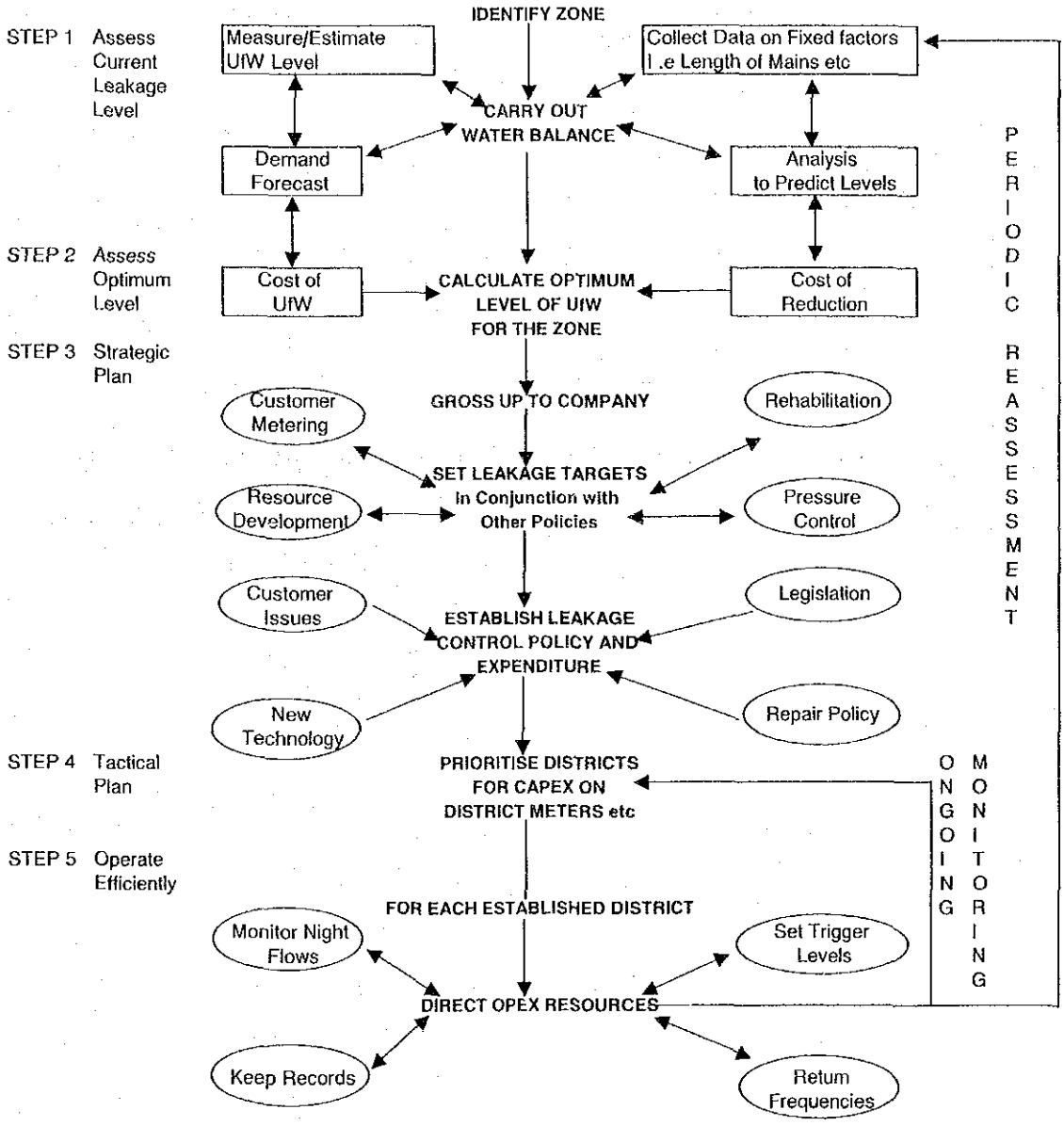
Ideally, within six months most of the setting up and planning will have been largely completed and the second part of the year will be directed towards practice, shakedown and transition to the main implementation phase 2.

A long preparatory phase is to be expected for YCDC, be cause there are no existing systems in operation even for basic data and all of this is new to the organisation.

5.2.2 First 5 Year Implementation Programme: Phase 2

Years 2 to 6 are concerned with the implementation of the programme, with those procedures and plans established and sorted out in year 1 at the core and getting them spread throughout the area, as far as practicable within the context of the general improvement of the water supply.

Fig: G 5.1
The Approach to UfW Control Management



Primarily:

- Active leakage control
- Zone and district metering
- Waste reduction
- Non-physical loss control

5.2.3 Long-term Implementation & Maintenance up to 2020

In the long term, as discussed above, the work will be to repeat and carry forward the activities of the previous phase to completion, which is when UFW control is a equal, integrated part of network operations.

In summary:

- Complete the expansion of the UFW control plan in the whole service area
- Maintain the efforts in those areas already set up
- Monitor
- Review
- Modify

5.3 UFW CONTROL PLAN SUMMARY OF ACTIVITIES FOR PHASE 1 & 2

The activities to be undertaken or initiated in Phase 1 & 2, during the first year and the subsequent five years are summarised below. The proposed activities fall into four principal categories, which are considered separately.

5.3.1 General Management & UFW Control Planning

(1) UFW Control Project Team

Phase 1

In the first stages of the overall UFW control strategy, a specialist, separate team is needed, charged with the responsibility for either undertaking or co-ordinating all the necessary analysis, works and planning. It is essential that it be given the authority and autonomy as well as the resources to enable it to be effective.

In phase 1, the job will be to get this UFW Unit set up and running properly.

This will include:

- Define the terms of reference
- Allocate the resources
- Mobilise
- Assemble/Recruit good staff
- Prepare properly equipped facilities
- Staff training and practice

- Implementation

Phase 2

Once it is fully established and functioning well, the tasks of the UFW unit will need to be reviewed and modified periodically through the duration of Phase 2.

The unit will be the focus for managing the implementation of the plan to be achieved. Clearly, its members will do some of the tasks themselves in the earlier stages, but the unit also has an important role in training and educating others as the work efforts increase and spread.

(2) Develop & Establish Reporting & Information Systems

Phase 1

Given the almost total absence of data collection and management information at present, it will be necessary to define, design, set up and expedite sustainable procedures for collecting all the information that is required for UFW control. Out based staff will have to be instructed and trained in their responsibilities for reporting to the UFW Unit, to ensure accurate and timely data.

The second part of this activity is the processing and presentation of the data once collected. This will also need to be defined and set up at an early stage. Temporary measures can be used in the very short term, but a departmental policy should be quickly established on information systems and data processing including storage.

From this policy will come specifications for supply and installation of :

- Geographical Information Systems (GIS) or Mapping / Drawing
- Management Information Systems (MIS)
- Customer Information Systems (MIS)

These should be computer-based, modular systems that can be expanded later and preferably capable of integration one with another; with widespread access to information and not shut off in an isolated centre.

Phase 2

Having set up data reporting in phase 1, phase 2 will be concerned with making sure that it is continues to be supplied and also to expand the scope and detail of the data collected, as it becomes more accepted & valued and staff become more proficient. (e.g. as bulk metering increases from production only to supply zones etc.)

If using sophisticated computer information systems, they may well not be completely developed in phase 1 if the job is to be done properly. This work should continue and be prioritised on the same basis as other activities such as leak detection and mapping. That is to deal first with the water supply areas where the service is good and results can be maximised.

What will begin to emerge in this five year period is the indication of trends, seasonal variations and other time-based criteria that depend on good historical data.

(3) Analyse & Review UFW Ratio

Phase 1

Key to the validity and priority ascribed to individual UFW control activities or service areas is knowledge of what the UFW figure is at any given time. Therefore, among the first action at the beginning of phase 1 is getting as much ready information as possible and calculating the UFW ratio.

Then periodically get updated data and recalculate the UFW at different points based either on time or changes in the situation such as:

- more accurate data for water produced once net production is measured properly
- after checks on large meters & large users.
- After introduction of revised consumption data from metering errors and un-metered consumption
- After pilot area data has been provided

If the situation has not changed, then the UFW figure should be recalculated on a 3 monthly period.

Phase 2

Keep reviewing the UFW figure.

With district metering, the calculation of UFW can be broken down into DMA's as well as a global figure and done more frequently (monthly).

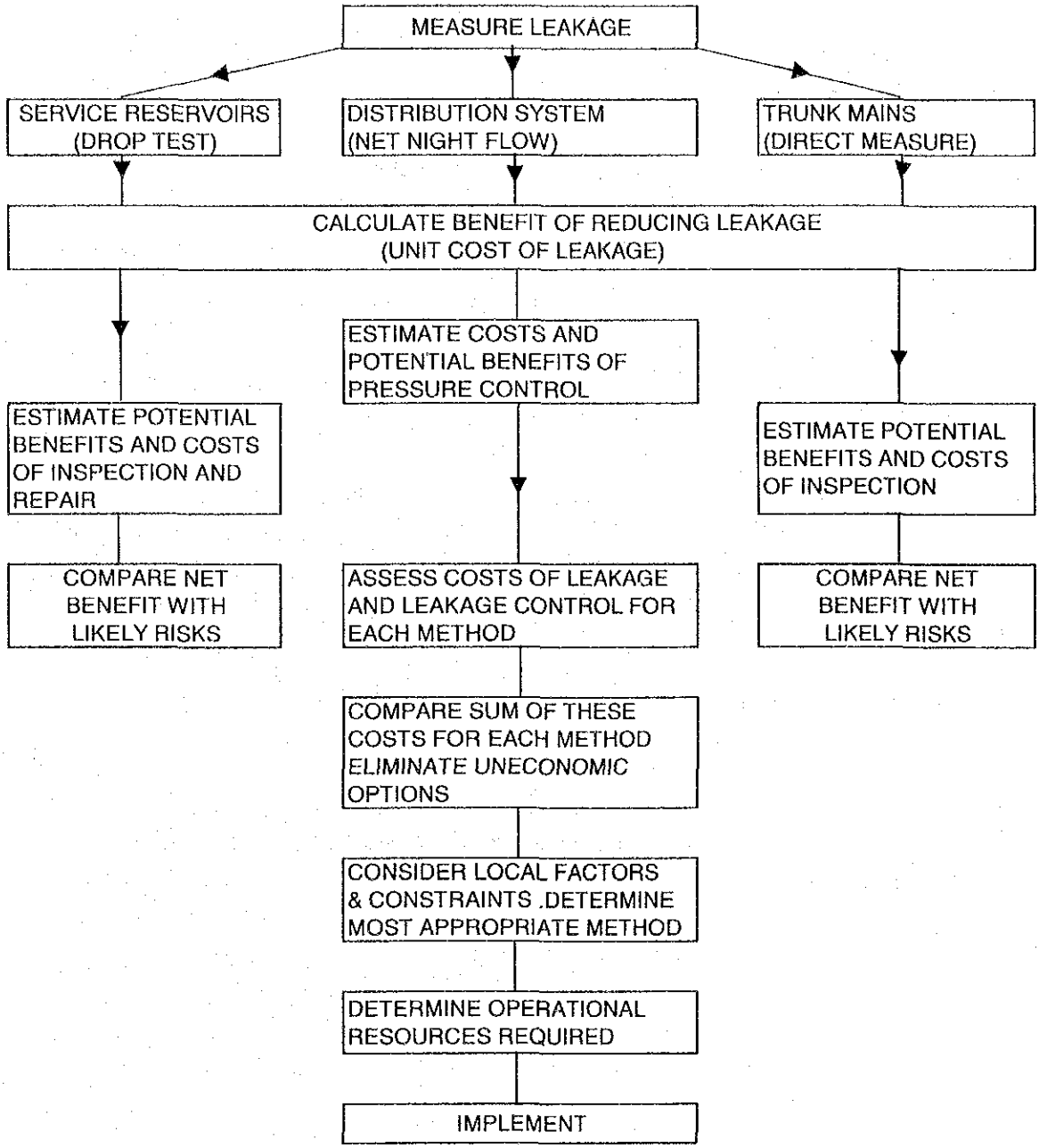
(4) Cost-benefit analysis for UFW activities

Use the figure(s) obtained for UFW to assess the potential for further reductions and the associated cost-benefits A flow chart of the process for physical losses is given in Figure G 5.2

Given that presently the level of UFW is truly excessive, an overall strategy must be devised, covering: maintenance, improvement in water supply, the basis of charges, and the justification for any change in the "status quo." This must inevitably entail a rapid appraisal of potential savings in terms of revenue and water. Set against this will be the potential cost of making such reductions.

This strategy will include arrangements for reviewing the cost-benefits of the UFW programme and the timing, and taking account of other parallel activities. Where appropriate, apportion costs to other departments.

Fig: G 5.2
Selection of Leakage Control Policy



Phase 2

Use the figure(s) obtained for UFW to assess the potential for further reductions, cost-benefits

5.3.2 Physical Loss Activities

(2) Trunk Mains Leakage Investigation

Phase 1

Immediately on setting up the UFW unit, check the trunk mains by

- Visual Inspection
- Measure flows along the line
- Repair any leaks located

Phase 2

- Repeat annually

(5) Service Reservoir Leakage Investigation

Phase 1

Immediately on setting up the UFW unit, check the trunk mains by

- Visual Inspection
- Measure leakage by drop testing
- *Locate and if possible repair any leaks located*

Phase 2

- Repeat every three or four years

(6) Network Leak Detection Programme

Phase 1

ALC Leak detection team

At an early stage, measures are to be taken to form a small but effective active leak detection team. They will need to be properly trained and equipped before they can start operating.

So more or less sequentially the following tasks will be completed in the first six months.

- Prepare requirements
- Specify & Supply Equipment
- Recruit
- Training
- Implement

In association with setting up the ALC team, the team leader and other members of the UFW unit will work together to identify one or more Pilot zones for intervention by ALC. The pilot areas should be common to as many of the various Physical and Non-physical loss tasks as possible.

To be effective, leak detection campaigns will be in areas with good pressure and continuous

supply.

The new ALC team will carry out leakage surveys on these pilot areas. This will include night-time investigations.

Phase 2

Over the period of phase 2 the ALC team should be reinforced to cover larger areas as appropriate and also some of the routine tasks distributed to area staff. The size of and timing for increase will be linked to the general progress on improvement of the water supply system.

Area staff should be involved from the beginning to ensure they feel part of the effort, at least to maintain and improve the present system of passive leakage control.

This plan is designed for completion over a five-year period. If is a resource constraint or any delays in the programme, it may take longer. The plan should be reviewed and updated annually.

Where metering and leakage problems are both evident, assume that the steps to be taken to correct both will proceed concurrently. The proposed "UFW Team" should be organised accordingly.

Periodically review arrangements for leak detection, and procedures for reporting and repairs. Consider all possible improvements using existing employees.

Repairs are a time-consuming and tedious task. Concentrate the leak detection and repairs in districts where tests suggest the greatest leakage losses occur. Do not expect that correlators or other modern equipment will normally solve the problem, though they may be invaluable for locating certain leaks. Monitor and evaluate for a trial one-to-two year period. Pinpoint possible areas where complete renewal of network may be the most economical solution.

(7) Leak Repair Programme

In association with the leak detection activities, repair work is essential to physical loss reduction. There is no benefit in identifying many leaks if they either go unrepaired for a long time or are ineffectively repaired and will leak again soon.

Therefore parallel effort is required to ensure timely intervention and good workmanship for repairs on leaks reported. The timetable will be tied in with that for ALC.

To achieve this requires attention to three aspects of repair activity:

Network Repair Team

- Set up repair team(s)

- Order & Supply Equipment
- Train team in good practice and correct use of materials & equipment
- Implement procedures to ensure teams can do their work effectively

Network Repair Materials

- Review repair supplies required
- Order & Supply repair supplies
- Set up stores system for repairs
- Implement procedures to ensure repair teams have the right material available when they need it

Repair Reporting

- Monitor repair team
- Record Leak repair data
- analyse leak repair data for action

Determine the extent of delays in repairing reported leaks and take action to reduce any backlog including, if necessary, temporary additional contract or other labour. Review existing equipment and assess needs.

The most important parameter in UFW control is the average time to repair a leak once it has been detected and the volume (or value) of water discharging from that leak. Intensify repair organisation as necessary to deal with extra leaks detected. This may be required only temporarily, until the backlog of leaks found diminishes back to a constant level.

Service Pipe Repair Programme

Service pipes are to receive as much or more attention as the network, because of the amount of leakage experienced. Whether this is achieved by the same or similar organisation to the network repairs is tied in to various policy issues and the general improvement plan.

For instance, YCDC can decide to repair service pipe leaks with its staff or to enforce customer repair requirements through waste inspectors. Also, review of the byelaws and regulations policy will hopefully modify the division of responsibility, so that both the customer and YCDC will each "own" part of the service pipe.

Once the policy issues are resolved, then an urgent plan of preparation and implementation for service pipe leak repairs should be initiated. This is probably the location of the majority of physical losses.

If within three months, policies have not been drafted, then a provisional programme for service pipe repairs is to be instigated. This is based on having a repair team set up on the same criteria as

for network repairs, to concentrate on repairing leaks on and improving the standard of installation service pipes outside the property boundary.

Experience shows that most leakage problems are due to innumerable small leaks on service connections. Even when domestic consumption is metered, these small leaks can often be found on the consumer's pipework.

Correcting this problem is usually the responsibility of the householder, upon whom notice should be served to take action within a certain number of days. If no action is taken, faults should be rectified at the householder's expense. However, in most countries the customer's pipework only starts at the property boundary, unlike Yangon where the situation is much more arduous for the consumer.

This issue may benefit from being combined with the programme for network rehabilitation and reinforcement. This is especially true where the secondary mains need to be reinforced in order to eliminate the excessively long service pipes.

(8) Pressure Management

Pressure management is not going to be an issue in phase 1 and unlikely to be relevant for a long time to come if at all, given the topography of the Yangon area. However, it is control that should be kept in mind and reviewed when pressures have improved.

Though not strictly a leakage matter, the only immediate context where pressure control might be considered would to fit pressure-sustaining valves to off-takes on transmission mains to protect the main pipeline.

5.3.3 Non-Physical Loss Activities

(1) Non-Domestic Consumers

At present, YCDC does not meter all non-domestic consumers. This should be rectified in as timely a manner as possible. As a first step, a combination of records and field survey will identify all non-domestic consumers and assess their water requirements. This includes not only commercial and industrial, but also governmental, municipal and "free supply" connections. The results of this investigation will be compiled into a database for non-domestic consumers, which should then be kept up-to-date.

For all those identified as not having meters, the latter are to be selected, ordered and installed. For those already fitted with meters, checks are required to ensure the correct size, proper operation and calibration of the units. Replacements to be made where necessary.

Procedures for regular reading, recording and monitoring of all non-domestic consumers will be set up and maintained. This information will be used for:

- Assessing changes in consumption patterns
- Providing data for UFW calculations so that the non-domestic component is properly known.

The UFW team will have responsibility for the investigation phase of this task, but it may later be handed off to another department for routine aspects (e.g. accounts or customer services department)

(2) Large Users (consumers)

Phase 1

From the existing list of non-domestic consumers, a category of "large users" is to be defined, possibly the top 100 to 200 customers in terms of water use. This group is to receive special attention, since a relatively few users will take an appreciable percentage of total consumption.

Spot checks followed as necessary by extensive tests of all large consumers' meters (including reference to historic data) should be undertaken immediately. A revised estimate should then be made of total water consumption.

Carry out an initial sample check for accuracy by connecting test meter or by replacement of meter or, where possible, by positive measurements on delivery to tanks. Results of initial tests will determine the extent of further checking justified to reassess losses due to under-registration at low flows.

Phase 2

Concentrate on large meters and institute a program of (a) more frequent reading according to size; (b) regular (at least annual) testing on-site or replacement; and (c) critical examination of records and follow-up. Consider monthly reading and quarterly testing of meters 3 inches in diameter and over.

In addition to site-testing, calibration every two or three years should be implemented in the longer term.

(3) Domestic Metering Policy

At present, the policy is for universal metering, but no plan for implementation. This policy should be reviewed to decide:

- Universal metering is still appropriate and so targets set to achieve it
- Continue with the status quo
- Adopt un-metered policy,

Un metered connections will save investment on meter purchase, installation and repair/replacement but will require a fully developed framework for ensuring effective and equitable tariff structures and assessment mechanisms. It will also remove the problems of meter

damage due to lack of network maintenance and water treatment.
Metered connections will reflect the true consumption per consumer, but will take a long time to reach 100% coverage and will be less than fully effective if the meters are not kept in good condition.

Consider standardisation appropriate to the operating conditions, of type and normal domestic diameter to minimise low-flow errors. Examine a mains flushing policy and water treatment procedures to improve water quality and reduce meter failures.

(4) Domestic Meter Testing

Meter test & repair Facilities

The following measure for meter testing and repair facilities are required:

- Study meter repair and testing shop procedure and capacity.
- Establish records of meter failures and necessary data retrieval procedure for reducing failures.
- Design any necessary expansion of meter testing, repair workshop.
- Specify and Install meter calibration equipment, selected to be suitable to ensure testing at very low flows as well as normal rates.

Meter Testing Programme

Once the meter test workshop is up and running, the following work should be done:

- Prepare sample survey for meter testing
- Check, test, calibrate sample meters
- Monitor & Evaluate sample
- Determine routine procedure
- Implement routine meter check programme in phase 2

Establish a program for regular (four-to-five year) meter changing and testing. Commence colour coding or similar identification method. The replacement period can be modified according to network conditions

(5) Un-metered Non-Domestic Use by category

Calculate the total figure for accounted-for water, which must include not only the water sold by meter but also water used for public purposes (government departments, military, and so forth). Until such time as all non-domestic use is metered it is necessary to undertake investigations to identify and estimate consumption by those consumers. This will reduce the component of unaccounted for water taken for legitimate use and so improve assessment of the problems.

(6) Assessment of un-metered domestic use by sampling of groups

In phase 1, set up and undertake a study of actual domestic consumption by sampling procedure in different social areas.

Use the results to:

- Obtain estimates of un-metered domestic consumption for the UFW calculation, in combination with population data for each category
- Compare the results with the metered consumption to assess the proportion of UFW attributable to under-registration of meters, non-metering,

5.3.4 Measuring & Prioritising Of UFW Activities

The major element of this activity is the installation and then monitoring of flow meters, covering progressively smaller supply areas. The first step is production metering, then supply zones up to the most developed level of district metering. The extent to which bulk metering proceeds will be a subject to be reviewed periodically and implemented, where it is shown to be cost-effective at that time.

The sequence to be followed for any bulk metering is:

- Review requirements
- Plan locations & select meters accordingly
- Specify and Supply
- Install
- Log & Record production

(1) Production Metering

The first action must be to check the production volumes. With no meters installed probe meters will be used provisionally. If possible, as a short term measure, the installation should be made permanent and readings taken at regular intervals thereafter.

Permanent production metering is essential for the system. An immediate action in phase 1 will be to ensure that meters are installed at principal production sites. The measures chosen may be stop-gap in cases where the general improvement plan includes new or refurbished production facilities that will include permanent metering in the design. For example, as just cited above, "permanently" installed probe meters could be applied for a limited period.

Since surface water production accounts for around 90% of the total at a few sites, this will be the priority. Second to that set of meters is consideration of meter installation at boreholes, especially those connected to the network. This activity may be modified in the light of any overall strategy to increase, maintain or reduce the use of groundwater abstraction.

Clearly, any new sources developed, whether surface water or ground water must include provision of metering. The same applies to any bulk transfer that may be initiated (e.g. sale of piped water to another water supply utility).

(2) Bulk Metering in Network

After or overlapping the provision of production metering, identify and install permanent flow meters at key points on the existing transmission and primary distribution network. These meters will measure flows of water from production and to the principal supply areas.

Install additional meters as necessary at pump stations, service reservoirs (inlets and outlets), and boosters. This programme should be well advanced in phase 1 and completed early in phase 2 for supply zones.

Begin regular monitoring of production and district flows. The application of data loggers should be considered.

This is the first essential step in a programme of:

- collecting time-dependent data
- improving network management
- initiating UFW control as a prelude to improved network efficiency

A typical example of a time-based record of production and consumption data for monitoring is shown in Figure G 5.3.

Once there are separate districts or zones, the next step is to check the measurement of flows to each district or zone in order to locate probable problem areas.

(3) District or zone metering in Network

Later in phase 2, once metering of the main supply areas is well-established and data collection and analysis is routine, consider dividing the system into smaller section, at least by township.

The harder the search for losses, the greater the benefit of smaller metered areas in order to localise problems; up to the point where it ceases to be cost-effective.

The process of meter selection, installation and data acquisition is the same as previously described for larger meters. Additional tasks will consist of identifying suitable areas and taking the necessary steps to ensure that each area is independent and isolated from the rest of the system except via the meter(s).

It will probably be necessary to install extra or replacement valves and modify pipework arrangements, especially in view of the inadequate level of correctly functioning valves in Yangon.

For full use of this additional data, it must be possible to compare it with consumption data for the same area.

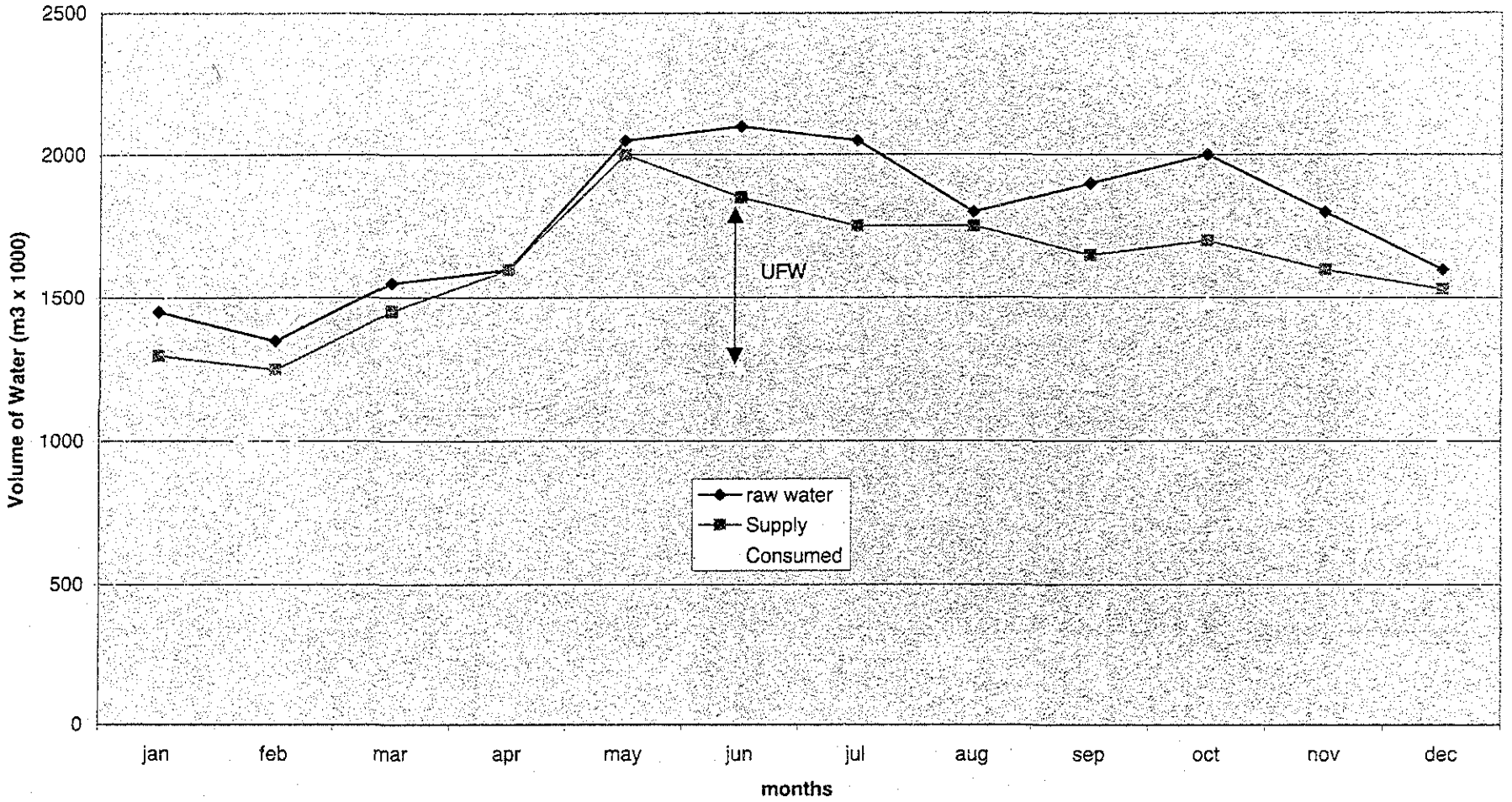


Figure G.5.3 Example of Chart Record of Production vs Consumption

(4) Pilot Area Metering Programme

Select one or more pilot areas and prepare a waste meter installation, which may be for a permanent or a removable meter. Also ensure that the area can be fully isolated by installing new valves and checking that those already installed can be effectively closed.

Undertake regular tests of 24-hour and night flows and, if possible, regular step tests. Initially test monthly for training purposes, later every six months when there are enough areas set up.

Once the techniques have been learnt and applied to the first pilot areas, then progressively expand the number of zones, in conjunction with the programme for the ALC team.

(5) Analysis of Minimum Night Flows

Data from routine meter readings will only provide total flows for the meter reading interval, which will include all consumption.

To gain information on probable levels of physical losses, night flow measurements and analyses should be undertaken periodically.

From whatever level of bulk metering is installed (taking account of night pumping for service reservoir filling), obtain total night flow data, either from loggers or special exercises for hourly meter readings from midnight to 6 a.m.

Take sample readings on all large consumers' meters to assess industrial and commercial night consumption for the whole system. Adjust the total night production flows to determine the net (domestic) night demand and express as a percentage of production. This figure should not exceed 25 percent (or alternatively 10 litres/property/hour).

Identify areas with high net night flows and investigate. Monitor results over time to look for trends and changes that require checking.

If using loggers, use the flow graphs and knowledge on legitimate night use to assess minimum night flows as well as net night flows.

This exercise should be repeated after a leak detection and repair campaign in the area to provide a baseline level of background leakage and legitimate night use.

Repeat for each area

(6) Prioritisation of Areas for ALC & Rehab.

Evaluate data from:

- Production and Consumption

- Zone or district metering
- Night flows
- Waste meter area testing
- Time-related changes or trends in data

to identify areas that seem probable for high levels of leakage.

The areas can then be ranked in order of priority for intervention by ALC teams & repair gangs or for network rehabilitation schemes.

5.3.5 Associated Activities

(1) Mapping of Network and Recording of Network Data

Essential to the long-term sustained success of good network management and UFW control (a constituent of network management ultimately) is accurate, up-to-date information, most especially about the pipe network and the customer base. In Yangon, neither one meets that criterion.

Therefore, among the very first issues to be addressed must be a plan to rectify this situation. Review and decide on a course of action to effect a complete and thorough survey of the whole water supply area.

The remapping has two parts, comprising these elements:

- **Data Capture & Presentation**
  - Mobilise
  - Prepare Offices
  - Establish Systems
  - Collate existing data
  - Train Data staff
  - Prepare Drawings & databases
  - Make available to staff to use

- **Field Survey Work**
  - Establish Methods
  - Review existing drawings
  - Train Survey Staff
  - Survey network

Remapping should include finding, exposing, marking, and numbering all valves. This work may best be done in conjunction with remapping of consumers' service connections. Consider having all the remapping completed by private contractor (covering also possibility of the contractor preparing the computer mapping.)

The project will take time, but must be allocated sufficient resources to be completed in a reasonable period. The field survey should be done within one year with data recorded on at least a temporary format. The final entering of all the survey results on the final information systems may take longer, depending on the system selected.

The costs and possibly division of workload should be attributed not only to UFW control, but also network operations and new works planning, since all will need this information.

(2) Establishment and Updating of Customer database (Service Connections)

As for the pipe network, re-survey the water supply area in respect of properties, connections, meters and customers.

Prepare and maintain an updated customer database, sorting out any anomalies uncovered. Allow for the growth of this database and ensure additional connections can be properly recorded and monitored.

Separate and manage the two functions of:

- **Data Capture & Presentation**
- **Field Consumer Audit Survey**

Consider the sharing of this project with the department responsible for customers.

(3) Wasted Water

Review problems of wasted water, both public and private, and determine action to be taken by improved education and public relations as well as by strict application of bylaws. Review existing bylaws and make changes as needed. Where bylaws do not exist, prepare legislation for approval by the government

Byelaws & Technical Standards

- Study & review existing situation
- Formulate revised regulations
- Negotiate with government to enact
- Develop enforcement progressively

To fit in with the proposed requirements of the new byelaws and standards, YCDC will need to take into account a number of other associated tasks, including:

- Installation of valves and valve boxes at or near the property boundary
- Repair or replacement of the service pipes up to the transfer point
- Design and implementation of reinforcement of the secondary mains; to progressively

eliminate excessively long service pipes and replace them with short, direct services

(4) Meter reading & collection

At the outset of this plan, the reading, billing, and collection procedures, including costs, should be reviewed by management, with technical assistance as necessary, and designed to improve data retrieval, as well as to highlight leakage on consumers' premises and reduce irregularities, under-registration, and illegalities.

Study general meter reading procedure and results. Undertake spot tests by management for sample study of reliability of meters and .meter readings. Undertake sample survey of illegal connections in selected areas. Take steps to eliminate irregularities and anomalies by co-ordination with other departments concerned.

Examine all possible means of correlating meter consumption statistics with distribution district boundaries, including any necessary boundary changes.

5.4 UFW CONTROL PLAN LONG-TERM: PHASE 3

During the first five years, phase 1 and 2, a number of results will have ensued:

- Established, experienced staff in the UFW control team
- reliable teams for active leakage control and repair
- programme of activities directed to UFW reduction and loss control
- Installation of production and bulk metering equipment
- data recording and collection systems set up and operating
- data results giving historical data, trends, seasonal variations etc.
- a much clearer picture of the situation with respect to:
    - UFW losses and the division between leakage and non-physical losses
    - The status of programmes such as rehabilitation and expansion of the system
- Procedures for valve maintenance and mains flushing should also have been developed.

Phase 3, the remainder of the master plan period duration, will not represent a major change of approach or activity, but rather a continuation and adaptation of those being followed in the previous phase. As noted previously, UFW control is the repetition of tasks to achieve and maintain reduced levels of losses.

Guidelines for further action can only be suggested in general terms, which will be decided and detailed at the end of the first phases. In essence, the procedure will be to continue with the activities of the first period, modified and adapted according to review of the costs, benefits and priorities of UFW control.

Five years is an appropriate period for long term projections of UFW control activities. It is proposed that during this extended long term period, this should be the interval for undertaking a

detailed review of the situation and preparing a framework strategic plan for the coming period. This 5 year plan will then be detailed, reviewed and modified periodically (e.g. annually) to achieve the overall objectives set Thus, the strategic review at the beginning of phase 3 will be repeated every five years.

The review should be done in co-ordination with other planning and programme departments, as applicable, to ensure that the plan is integrated with their activities, such as network rehabilitation and expansion, development of new water supply resources etc.

Some particular items to review include:

(1) Organisational Aspects

Review the organisation that has been set up for UFW control in the light of achievements. Either confirm or make needed organisational changes, as long as changes will not restrict further efforts toward controlling UFW.

(2) Rechecking Data

Where the marginal cost of water indicates that further reduction is justified, proceed by steps, first repeating the original program of checking accuracy of production metering and accuracy of estimates of public un-metered water consumption. Examine potential savings offered by alternative methods of procedure.

(3) Pressure Reduction

Examine possible reductions in pressure including the use of PRV's if this has become relevant.

(4) Updating District & Waste Metering

Further extend the pilot schemes for waste meter districts by stages, beginning in those Sections where excessive leakage is expected.

Alternatively, or additionally, extend district metering by subdividing the original large districts and increase the frequency of monitoring districts

(5) Application of New techniques & Technologies

Review developments in techniques and equipment used in UFW control and consider their applicability to Yangon, cost-benefit assessment

(6) Renewal / Calibration of Metering & Other Equipment

The issue of the need for replacement, repair, recalibration of equipment, especially network flow meters should be reviewed periodically and not ignored.

(7) Updating & Improving Active Leakage Control

Re-examine possible improvements using additional training, equipment, labour, and incentives.

(8) Public Relations

Establish respect for bylaws by appointing plumbing inspectors to improve standards of consumers' internal plumbing or by such other means as appear practicable. This could include adult education, publicity, legal action, and community involvement. The private sector could be given incentives for providing low-cost and efficient plumbing services.

(9) New Works and Repairs

Pay particular attention to improving the standard of construction of new works and repairs to ensure that all work is properly inspected and may be expected to remain leak-free for years to come.

5.5 IMPLEMENTATION OF THE UFW CONTROL PLAN

Previously, the underlying philosophy and final objective for this UFW control plan have been discussed, along with a summary of the specific activities associated therewith. It is necessary to also consider the general approach by which those activities will be applied by YCDC to eventually cover the entire service area.

YCDC has responsibility for adequate quality of and access to water supply within the Yangon city limits, which covers a considerable area (729.7 km2). The population to be served within this area is both large and variably distributed; estimated at circa 3.8 million in 2000 (base year) and forecast to rise to over 7 million by the target year of 2020.

5.5.1 The "Ripple" Effect

UFW control, no more than any other aspect of the improvement of the water supply infrastructure and management, will not be implemented overnight, nor will it be a one-off effort. It will not happen all at once and, in any event, it would not be feasible to mobilise resources immediately on such a scale.

The approach requires to be one of progressive, incremental increase of control, coverage and capacity. The nearly 20 year planning horizon provides the opportunity to utilise the principle of a "ripple effect" and so limit the strain on resources and capability.

To those charged with the reduction of UFW, the task will appear daunting and present many obstacles to be overcome. In Yangon, there is no existing UFW control policy and programme, so implementation of this plan has to start from scratch. On the bright side, there are no entrenched, bad practices to be unlearnt and everyone starts with a clean sheet.

It is important to start somewhere and develop at an achievable pace. If this is a bit slow but

ultimately successful, then all is well. The risk is to try and do too much too fast and either discredit the process or come to a stop.

A list of activities and a provisional timescale for the initial phase is presented in this report, which will be dependent on the resources available and developing circumstances. It is more important to build up a sustainable UFW control policy than to be overly rigid about schedules.

The principle to be applied to these UFW control measures is to start on a small-scale, get established and then expand progressively. The detailed measures described previously are equally valid irrespective of the scale of their application. The only difference will be the coverage concerned.

The growth will be in two inter-related aspects:

- Resources & Organisation
- Area of Coverage

5.5.2 Organisation

The first stage is to create a specialist, central team to be trained in the necessary techniques and then to manage and perform the necessary works. Once trained, this group will develop procedures and practices to suit local conditions at YCDC and proceed to implement them on small "pilot" areas that they will select. Then more pilot areas will be investigated and so on.

As this core team becomes increasingly proficient and as they increase the number of areas covered, the number of people involved will increase in two ways:

- More and possibly larger teams for intervention on new areas (or repeats later on)
- Maintenance of areas already covered

Over time, the number of pilot areas that have been investigated will increase and combine into larger areas, complete townships and supply zones. These will require maintenance and monitoring , once the initial "blitz" is complete, as well as periodic re-investigation (either routine or prioritised). Similarly, as the metered areas are broken down into successively smaller units (production, supply area, township, DMA, waste area), more staff will be involved for information gathering.

Initially, the UFW team will be relatively small, not least because of limitations in the logistics and feasibility of providing the necessary training and skills to get started and setting up all the necessary procedures etc.. These early members should be selected not only for their capability, but also with the expectation that they will be acting to train others in the organisation and pass on the requisite skills.

During the course of the programme, the number and size of the teams will increase, as the water supply service improves and covers a larger area.

UFW control is an integral function of good network management and should eventually be regarded as a routine operation along with the rest. So ultimately the UFW control activities are to be merged into the network operations of the general organisation. (e.g. Active leak detection will end up as an integral part of area network operations)

5.5.3 Area & Coverage

As explained, for practical reasons the first UFW control team will be limited in size and will start operating in small, defined pilot areas. To be most effective, their activities will be directed to parts of the system where they can get maximum results.

For many of the requisite measures, this requires that the work is concentrated on areas that have, among other things, both 24 hour supply and also relatively good pressure.

In Yangon, at present, the parts of the supply area where these criteria are met is limited. Even some areas that supposedly comply with these criteria have low pressure that would not meet minimum service levels in many countries.

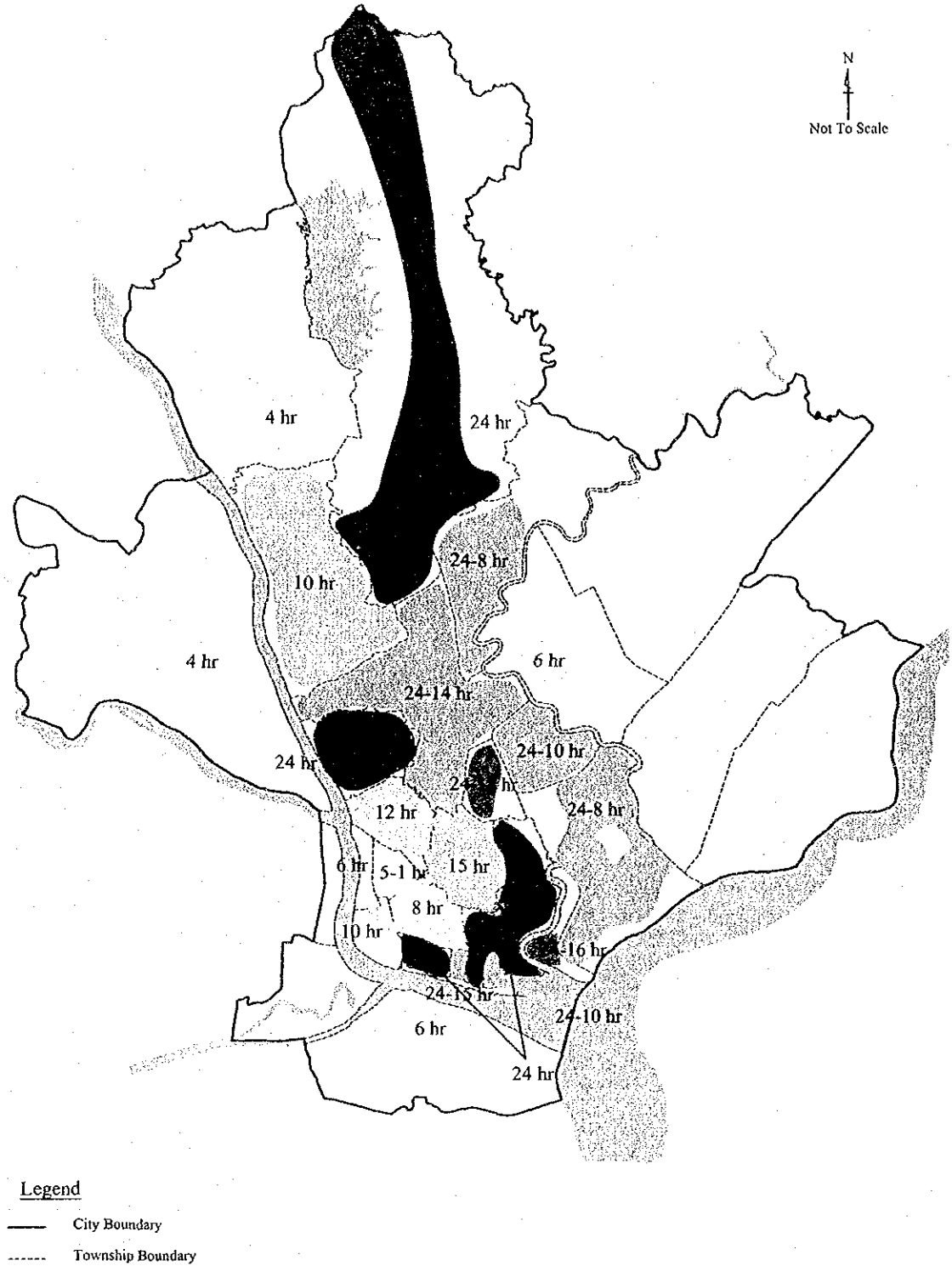
So, the UFW control will commence with pilot areas and repeat / expand to fully cover this pressurised area and put measures in place to maintain the control. By that time, it is supposed that the general plan of improvement of water supply will have increased the extent of the 'good' supply area and the UFW control effort will be able to move in behind. Though it will be a presumably less arduous task since the new works will have already included much of the necessary preparatory work and repaired many of the problems.

This underlying method for applying UFW control to Yangon water supply area on an expanding basis to be retained until coverage is 100% and it has become a routine, inclusive part of everyday YCDC operations.

A map showing the different service level areas is given in Figure G 5.4.

5.6 INTEGRATION & CO-ORDINATION

The general institutional requirements and planning for the whole organisational structure are presented in detail elsewhere in the report, prepared by specialists in the subject. So it is not proposed to dwell on the subject here, merely to set out a few reminders to be borne in mind when considering UFW activities.



JICA	THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR	FIG. G 5.4
	Map of Supply Duration	

5.6.1 Integration of UFW Control

The UFW control organisation, in whatever form it takes, has to sit comfortably within the general operational organisation and be compatible with it. It must not be an isolated and possibly ignored unit.

In the same vein, UFW control must change and adapt to suit the changing structure and needs of the organisation.

5.6.2 Co-ordination

It will be necessary to liase and co-ordinate continuously with other concerned departments in order to maximise the benefits. These include, but are not limited to:

(1) New Works and Network Rehabilitation

Co-ordination for items such as:

- Design criteria
- Rehabilitation priorities

(2) O&M Departments

Co-ordination for items such as:

- Repair teams
- Meter checking and testing

(3) District Inspectors

Select top-grade district inspectors to have the sole responsibility for all maintenance and operation of valves, including initial location and subsequent guarding of surface boxes.

(4) Senior Management & Government Organisations

Co-ordination for items such as:

- Byelaws and regulation
- Public Relations

5.6.3 Political Will

UFW control will require time, effort and resources to become effective and will not be established overnight. To achieve this objective will require continued support form both senior management and higher authorities. Without the resources and political will to properly implement the necessary measures, the cost-effective reduction of UFW will not be accomplished ever. This particularly applies to means used to minimise losses on the customer side of an equitable division of responsibilities.

5.6.4 Technical Assistance

Technical assistance will be required for the early stages of various aspects of this plan, detailed

elsewhere, as it will for other areas of the whole organisation. This should be co-ordinated by the senior management to make sure it is:

1. applied effectively
2. not stinted on

5.6.5 Control Room

For the benefit of many aspects of water supply operations, it is proposed that a central control room be set up, with all the normal functions of such a unit.

6 RESOURCES AND ORGANISATION

The strategic plan for implementation of UFW control has been described in the preceding sections. It is now germane to consider and outline the means and resources that will be wanted in order to begin to put the plan into effect.

There are five main aspects to be considered:
1. Organisation for UFW control
2. Personnel to staff the team
3. Training and skills acquisition for the staff
4. Technical assistance to the organisation
5. Material and equipment resources

6.1.1 Organisation - UFW Task Force Approach

(1) UFW Control Team

To grapple with the task faced and to implement the structures and measures needed to begin the process of reducing UFW to economic levels, a separate, dedicated section will be essential.

This section and its manager need to be vested with sufficient authority to deal with heads of department so that data is collected & supplied and agreed tasks are carried out in a timely and effective manner. It is also very important that the unit has the requisite autonomy to be able to make progress once the plan has been agreed.

The UFW control section must be set up immediately on starting the programme. It should be considered as a permanent unit, not a time limited, temporary one; though ultimately many or all of its functions may be subsumed within the operations of mainstream departments, such as distribution, finance, or customer services.

The applied methodologies should in most cases be introduced at pilot level and then applied progressively to other areas of the township or city, once the method has been tested and any problems resolved. However, due to the tremendous work it represents with 33 townships with an average of 2211Ha and 111,877 population and related significant investment, it is necessary also to retain a global overview to identify priority areas and to evaluate the cost-benefits before full implementation of the programme. The first level of prioritisation is, as already cited, those areas having continuous supply at reasonable pressure.

Phase 1

During the first twelve months of operation, the UFW control unit will be set up, trained, developed and become firmly established. By the end of this period two important steps will have been effected.

- A lot of UFW data will be available

- A core group of staff will be competent in and familiar with UFW control

Within this period, it is expected that the first half will be principally occupied with setting up, preparing and training and the latter half will be practice and trial implementation. This applies to the team not to preliminary data collection and analysis.

For phase 1 the team will be kept relatively small and exclusive, so that it remains manageable and all its members can be properly trained. This is a relatively long lead-in time, because YCDC is starting from zero and a sea change in approach is needed.

Phase 2

At the end of phase 1, a review will be carried out to determine the future direction of efforts and reinforcement of the team that is needed, along with the additional resources required. The role of the original core team will then be modified to include training and supervising additional staff brought in to cope with the expanded work programme.

(2) Repair Teams

A properly resourced repair section should also be set up and equipped at the same time as the UFW control section. Though probably part of the distribution department, the repair section will have close ties with the UFW team, mainly physical loss group, and work co-operatively.

The same principles apply to this repair section as to the UFW control team. That is to develop a small, strong competent core then review the full scale of the requirements to reduce UFW levels according to a timetable and finally provide the resources and staffing accordingly.

The size of these first stage teams should be limited to around 12 to 15 persons, though later many more staff will be involved in one way or another. The suggested composition of the UFW control team is given in the following section. The size limit for the repair teams does not include unskilled labour.

6.1.2 UFW control Staffing

(1) UFW Project Manager

In anticipation of ongoing need for UFW control, an immediate action program should be developed. To ensure that effective action is taken a well-qualified project manager responsible for UFW should be appointed. A one-year temporary assignment is a good way to begin.

This position of project manager should be seen as prestigious and challenging. The appointee must immediately be freed from all other responsibilities. He or she has to be responsible directly to senior management for the initial studies, but must have the requisite stature to work in collaboration with the assistant managers responsible for finance, operations, maintenance, water production, and distribution. The project manager should have the authority to agree upon and

implement action plans.

The project manager must be allocated sufficiently experienced staff to develop a separate UFW team and should be given suitable assistance to undertake special studies. Additionally, the task force manager may be assisted by one or more consultants or other technical assistance. This latter is recommended for phase 1 at least, but longer term technical assistance support would be advisable to fully realise the potential of this programme.

But, whatever the circumstances peculiar to an authority, experience shows that effective action can be expected only if the financial manager is fully involved and if UFW control is vested in someone not only dedicated to achievement of results but also with the necessary patience and persistence to pursue a steady methodical course over an extended period. It must be recognised that results, certainly for leak detection and repair, will not be achieved quickly and that much unrewarded effort may be necessary. This applies very much in the case of Yangon.

The employee will have to take charge of and to imbue his team with the same dedication and enthusiasm, because they may all need to work unsociable hours and face many disappointments. Above all they must not be diverted from their normal duties in UFW control, except in the event of a dire emergency.

(2) UFW TEAM

A typical UFW team organisation is shown in Figure G 6.1

Typical duties and functions of each of the members of the team is described below:

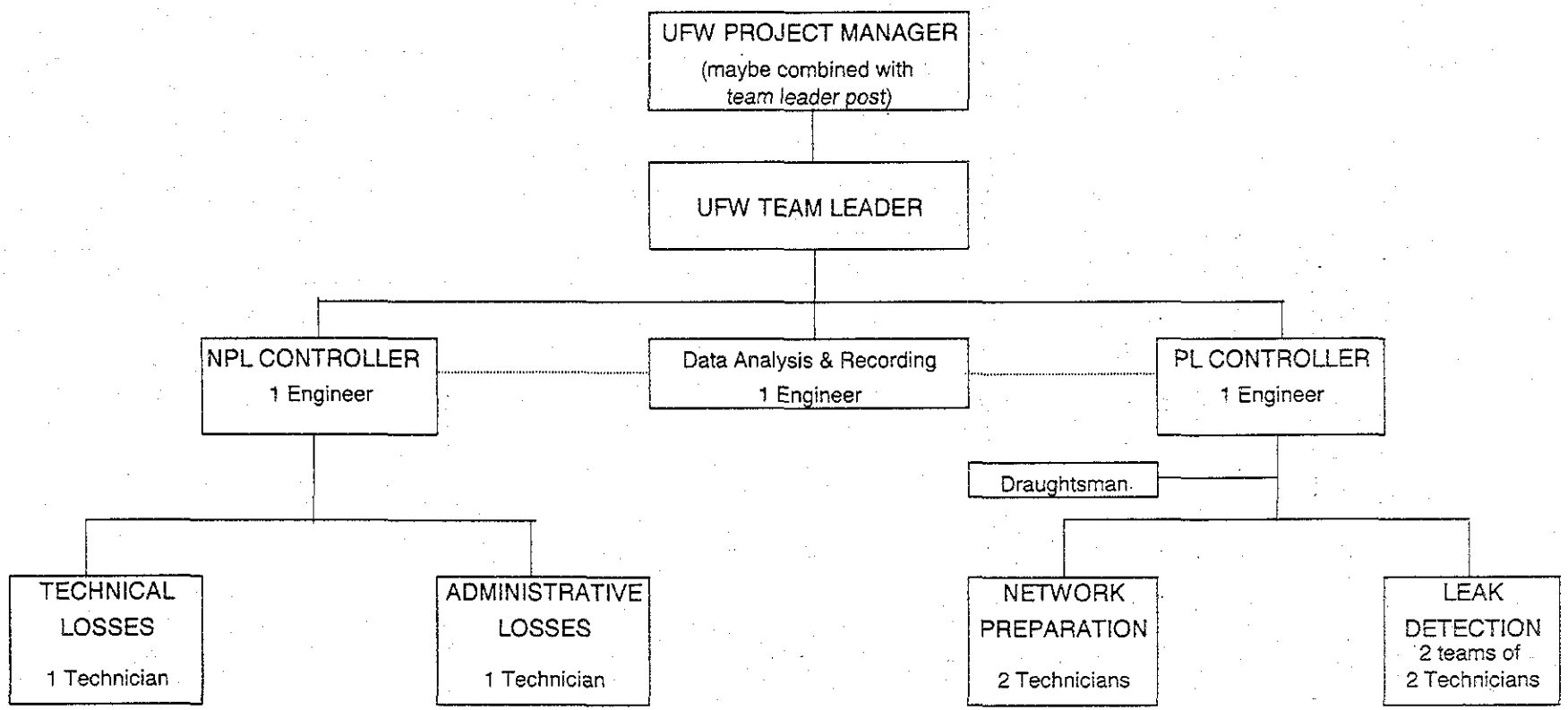
Team Leader : maybe combined function with the project manager

- controls and supervises the UFW team, for daily operations
- bears overall financial and technical responsibility for the operation of the unit
- define yearly programme of works and corresponding budgets, -reports to the Director of the water supply department (WSED),
- -ensures good co-operation of other services of the WSED and with external authorities

Data Control Engineer

- Co-ordinates with other engineers to:
- Set up and maintain procedures and formats for data collection, recording and presentation
- Work on application of information systems
- Analysis of UFW

Fig: G 6.1
UFW TEAM ORGANIZATION



Non-Physical Loss Team

NPL Controller: 1 Engineer

- manages the NPL team,
- reports to Team leader,
- defines detailed work schedules and supervises implementation of works
- computes and interprets results
- co-ordinates with other services and branches of the WSED.

Technical Controller : 1 Technician Specialised in Water Meters

-prepares and conducts meter calibration campaign

- prepares and conducts meter repair and replacement programmes
- determines technical anomalies and conducts relating works.

Administrative Controller: 1 Technician

- prepares and conducts consumer surveys
- detect and follow settlement of illegal consumers and other administrative anomalies
- settles consumer queries.

Physical Loss Team

PL Controller : 1 Engineer

- manages the PL team.
- reports to Team leader,
- design districts and waste districts,
- defines detailed work schedules and supervises implementation of works
- computes and interprets results
- co-ordinates with other services and branches of the WSED.

Draughtsman

- co-operates with both PL and NPL teams daily,
- collects and update network drawings,
- prepares drawings for network preparation and step testing,
- prepares valve report and survey sheets
- prepares reports.

Network Preparation Team : 1 or 2 Technicians Specialised in Pipe Works

- conducts network surveys
- conducts repair / replacement of valves,
- conducts repair / replacement of pipes,
- carries-out prove testing,
- conducts installation of District and Waste meters,

Leak Detection Team : 2 Technicians Specialised in Leak Detection 2 teams

- conducts reading of waste & district meters
- carries-out Night Flow measurements and Step Tests,
- carries-out leak detection,
- evaluates leaks and determine programme of repair works.

All other manpower needed for the field surveys, and all field operation and works are to be taken from relevant WSED services and branches.

Passive leakage control (repair of visible leaks and operations upon request of consumers) remains the "maintenance and repair" tasks of the township staff.

6.1.3 Awareness and Co-ordination

It must be emphasised that Water Loss Control is the duty of each one of the WSED and not only UFW team. Internal awareness should be motivated from senior management downwards.

UFW team is a horizontal structure within the organisation chart of the WSED. This means that all sections or services of the WSED are involved in the work and should co-operate with the UFW team.

6.2 TRAINING

To transform the existing pratice into some form of active control, a new spirit of enthusiasm - backed by funds - has to be implemented. The best start is to arrange for about three selected employees to be transferred for a period of up to ten weeks to a developed country where they will be given special training using modern equipment and will work with trained inspectors employed by another water authority.

If two or more employees working in the area of repairs could under go similar training, it will be advantageous to the Authority. They can learn to appreciate the standards of workmanship required to ensure the best possible repair under difficult conditions.

If this is not feasible, an alternative might be to engage some other authority or a specialised consultant/contractor to undertake all additional training "on the spot," providing any additional equipment required as part of the training. The training might also be related to a contract for the first phase of leak detection.

If possible, one of the employees selected should be an engineer or technician with an aptitude for teaching. She should then undertake the selection and some training of additional employees required to build up the organisation in the area of effective leakage and waste control.

This initial training of a few selected employees should be part of an ongoing program. As the division expands, one of the incentives for new recruits should be the potential to be selected for training abroad.

Overseas training should provide short, formal courses at specialised training centres that include:

(a) theory of leakage control;

(b) practical demonstrations and experience in the use of a wide variety of equipment; and

(c) maintenance of and simple repairs to all equipment.

This should be followed by a lengthy period of hands-on operational work during the daytime and at night, covering all forms of active control including record-keeping and analysis of results. This hands-on experience should include electronic detection of pipelines and cables, experiments on measurement of waste under different pressures, and flow measurements. It should also include tapping mains under pressure, insertion of pitot and turbine flow meters, repairs to pipes and services, flushing mains and sterilisation, testing valves to ensure tight shut-off, the use of portable test flow meters, pressure gauges and recorders, and setting up a district metering system and a waste meter district.

In the first instance, training might be limited to three or four carefully selected employees who will be directly engaged in leak detection and one engineer or technician. The latter can then play a key role in organising the intensified service and recruiting and training additional inspectors.

Arranging for such training is one of the first steps to be taken in implementing a program for improved leak control. The recommended optimum solution is that overseas training is supplemented by on-the-job training as part of the terms of reference for the technical assistance team.

6.2.1 Technical Assistance

When an authority is unable to devote the time of its own staff to a detailed study of the economic justification for and the establishment and operation of an active leak control program, there is a clear need for assistance by foreign consultants (which may include a foreign water authority). When this is necessary, it is essential for the associated contract to include a major item for training an adequate number of the local staff to continue the program.

It must be stressed that leak control is not a short-term activity, which once begun can then come to an end. Experience shows that unless the control program is perpetuated indefinitely, soon after cessation the UFW figure is as high as ever. The need for appointing a competent, long-term consultant to assist the authority should be seriously considered.

A key part of any contract with a consultant is the establishment of an effective permanent organisation in the authority and a commitment to continue advising the authority on the detailed solutions of problems encountered during the first year or longer. Of equal importance is provision by the authority of a sufficient number of suitably motivated, intelligent, and qualified "counterpart" employees to undertake on-the-spot training and take over the operation at the end of the consultant's contract.

The organisation must be established either before or at the very beginning of the consultant's contract, if it is to be fully effective. There are far too many consultant's reports scattered around the world recommending institutional changes, personnel training, purchase of equipment, and overall programs for improved leak control that have never been implemented and are at best coated with dust -- or at worst, lost.

In order to avoid this it is often better for an authority to set up an organisation with the help only of an individual consultant for initial advice and subsequent follow up as necessary to help renew enthusiasm and initiative as well as to overcome difficulties.

Areas to be considered for some form of technical assistance include:
- General UFW Technical Management Assistance (e.g. Technical Assistance Unit)
- Mapping survey and capture
- Information systems
- DMA design & Implementation
- Meter sizing & selection
- Meter Testing & Calibration
- Metering Policy
- Byelaws & Technical standards Policy & Implementation

6.2.2 Material and Equipment Resources

Having identified and trained the staff needed for the UFW control plan, it is important that due consideration is also given to ensuring adequate materials and equipment are provided to do the job effectively.

Much equipment and material will be needed, but in three main categories:

1. Office-based drawing and data records and functional equipment for staff

2. Equipment and transport for fieldwork including specialist leak detection equipment

3. Repair materials, tools and equipment of the type and quantity necessary to get repairs effected in a timely and effective manner.

These elements need to be considered and defined in preparing detailed budgets for the project and a first tranche will be needed at a very early stage. The exact requirements will be determined by the policies and decisions on priorities, activities and resource allocation; to be made at a later stage when the UFW control plan is to be implemented.

Sufficient allowance within these categories, especially 2 & 3 must be made for training and practice materials, to allow staff to gain the necessary skills.