2. Planning and implementation of surveillance

2.1 Legal and institutional basis

2.1.1 Laws, regulations, and standards

Effective programmes to control drinking-water quality depend ideally on the existence of adequate legislation, standards, and codes. One of the functions of the basic legislation is to define the functions, authority, and responsibilities of the water-supply agency and the surveillance agency. Standards and codes should specify the quality of the water to be supplied to the consumer, the practices to be followed in selecting and developing water sources and in treatment processes and distribution systems, and procedures for approving water systems in terms of water quality. The precise nature of the legislation in each country will depend on national, constitutional, and other considerations.

Experience has shown that the basic legislation should be limited to general principles and to specifying offences and penalties for its contravention. The authority to establish and revise drinking-water standards, codes of practice, and other technical regulations should be delegated to the appropriate government minister—preferably the minister of health—who is responsible for ensuring the quality of water supplies and the protection of public health. The authority to establish and enforce quality standards and regulations may be vested in a ministry other than that usually responsible for public and/or environmental health. Consideration should then be given to requiring that water-quality standards are promulgated only after approval by the public health or environmental health authority so as to ensure their conformity with health-protection principles.

Such legislation commonly makes provision for the establishment and amendment of drinking-water quality standards and guidelines, as well as regulations for the development of drinking-water sources, and the production, maintenance, and distribution of safe drinking-water. It also generally establishes the legal functions and responsibilities of the water-supply agency, and states clearly that, as an organization that sells and/or supplies water to the consumer, this agency has a legal duty to supply safe and wholesome water that meets legally established water-quality standards. In addition, the agency is responsible for providing continuous and effective quality assurance and quality control of water.
supplies, including inspection, supervision, preventive maintenance, routine testing of water quality, and remedial actions as required.

The water-supply agency should be deemed responsible for the safety and quality of the water supply up to a defined point in the distribution system, generally the house connection or public standpost.

A country-wide or regional water-supply company or governmental organization often supplies drinking-water to a municipal water-supply agency or a local water-distribution company or group. As the “wholesaler”, the primary supplier should be legally responsible for the water quality up to the point of connection to the pipelines of the local supplier; the organization that supplies the public directly then becomes the “retailer”. In other words, each organization should carry legal responsibility for the quality of the water supply up to the point of delivery to the “customer”.

Governments should also consider introducing legislation that would enable individuals or community organizations to take legal action to enforce water-quality standards and regulations. They should consider making legal provisions for water-supply agencies to initiate legal action to protect their water sources and distribution systems from sources of pollution. This is particularly important in areas where no effective government programme is in operation to control pollution.

The surveillance agency should be given the necessary powers to administer and enforce laws, regulations, standards, and codes concerned with water quality. It should also be able to delegate those powers to other specified agencies such as municipal councils, local health departments, regional authorities, nongovernmental (community) organizations, universities, and qualified, government-authorized private testing services.

Many countries lack basic legislation of this sort, and in others the existing legislation is seriously outdated. However, many interim measures to ensure drinking-water quality can be enforced under existing general health, food, and welfare legislation. Implementation of programmes to provide safe drinking-water should not be delayed because of a lack of appropriate legislation.

Even where legally binding guidelines or standards for drinking-water have yet to be promulgated it may be possible to encourage, and even enforce, the supply of safe drinking-water through educational efforts or commercial, contractual arrangements between customer and supplier based on civil law.

The application of water-supply legislation is considered in Chapter 8.

2.1.2 Institutional framework for water-quality surveillance

The main role of surveillance in the management of community water supplies is to assess the safety and acceptability of the water distributed to the public so that consumers are consistently and reliably protected from the health hazards of contaminated supplies. Surveillance therefore adds considerably to the value of
water, especially for domestic use. It facilitates the recovery of its cost and increases its health benefits.

Water-quality surveillance requires an institutional framework that reflects its objectives and functions and gives key responsibilities to the relevant bodies—not just the agencies in charge of supplying water and promoting health but all institutions with relevant normative, developmental, educational, and control functions.

At the centre of this framework major responsibility for surveillance is shared between two agencies whose activities should be both mutually exclusive and complementary. The water-supply agency is responsible for the quality and safety of the water that it produces and distributes, while the surveillance agency has overall responsibility for ensuring that all drinking-water supplies under its jurisdiction are free from health hazards. Indirectly, however, health hazards related to the ingestion or other utilization of contaminated water from unprotected sources may be the fault of the water-supply agency if it has failed to fulfil its mandate, thus causing the public to use unsafe supplies.

The water-supply agency also differs from the surveillance agency in the sense that it carries out routine testing and monitoring of the quality of the water that it produces, while the public health protection agency conducts independent surveillance audits of water quality to determine whether the water-supply agency is fulfilling its responsibility.

The key basic principle in the implementation of a reliable programme of surveillance of drinking-water quality is that this two-tier system is absolutely necessary. It is imperative that the public health protection agency is adequately equipped to fulfil its regulation functions. If it is not, surveillance tasks can be subcontracted by the surveillance agency to a third party, such as a private company, at a cost that can be recovered, e.g. in the selling price of water. Monitoring by the water-supply agency of the quality of its own product, or that of an affiliated company, should never be considered as a satisfactory substitute for independent surveillance.

Another important principle is that the institutional and legal arrangements for water-quality surveillance should lend themselves to both decentralization and intersectoral cooperation. Like all water-related activities, water-quality promotion and control are fragmented horizontally between a large number of producers, users, and planning, financing, and monitoring agencies, as well as vertically between national and regional agencies with limited potential for decentralization, numerous local authorities with scarce resources, and a very large number of consumption points, especially in developing countries.

Intersectoral cooperation is required in all activities related to the promotion and surveillance of water quality, from the normative functions to the actual supply of water, the surveillance of water quality, and the implementation of preventive and remedial measures. At the normative stage, those agencies responsible for the protection of public health and for the supply of water should, in
consultation with one another, agree on safe and feasible water-quality standards. To ensure that these standards are also acceptable to consumers, the communities served should always be involved, together with the major water users, including industrial or agricultural concerns that may compete for the same water source or public supply.

Other normative and regulatory functions belong to such ministries as those responsible for public works, housing, natural resources, or the environment, which are concerned with the design of water-supply and waste-disposal systems, equipment standards, plumbing codes and rules, water allocation, protection and conservation, and waste collection, treatment, and disposal. The economic planning unit (for resources allocation), the ministries and agencies in charge of internal affairs and local government (for community issues), and the ministry of finance (in relation to water tariffs) should be consulted on issues within their respective areas of competence. Private autonomous water suppliers should also be involved in drawing up standards if this is justified by their individual or collective size and importance; the national regulations, adjusted as necessary, should always be applicable to such water suppliers. Successful intersectoral coordination requires the involvement of agencies responsible for community development and hygiene education in all activities and at all levels; these agencies are usually more easily decentralized than the water authorities. Public health agencies are often closer to the community than those responsible for its water supply. At local level, they also interact with other sectors, e.g. education, and their combined action is essential to ensure active community involvement.

Public health surveillance teams operate at national, provincial, and district levels, as well as in cities or at rural health centres. However, public health laboratories may be available only in large cities, in which case the use of field kits for water-quality testing (see pp. 65–66) by mobile surveillance teams may help to bridge the gap between fixed laboratories and remote communities. Where they are able to operate in remote areas with widely scattered populations, surveillance teams can also provide essential epidemiological information that can be used in planning, and information on major faults that is valuable in the organization of maintenance. Where water-quality surveillance teams cannot operate, nongovernmental organizations can help, and community volunteers can also be trained. In some countries, religious missions, aid agencies, and scientific institutes play important roles in water-quality surveillance.

2.2 Planning

2.2.1 General considerations

To be successful, water-supply surveillance and quality control must be well planned, and the definition of objectives is fundamental to any planning process. In addition to the main objectives of surveillance and quality control identified in section 1.4, there will be a number of complementary objectives. These will vary according to the conditions under which the activities are to be implemented and
will most commonly encompass the activities to be undertaken during implementation. Examples include the following:

- provision of equipment and training;
- determination of trends in the quality of the drinking-water supply service with time as shown by specific indicators;
- provision of information to public authorities for general public health protection purposes (i.e., information dissemination);
- identification of sources of contamination;
- investigation of piped distribution networks;
- identification of remedial strategies;
- assessment of the performance of water-treatment plants;
- involvement of communities in the surveillance process.

Targets provide the link between objectives and the plan of work, and should be reviewed at regular intervals, perhaps annually. In developing a surveillance programme, early targets would typically include:

- preparation of a comprehensive water-supply inventory;
- development of preliminary standard methodologies (e.g., for analytical procedures, field work, and reporting);
- establishment of regional laboratories capable of undertaking specified analyses;
- training of staff responsible for water sample analysis at regional and local levels;
- preliminary survey visits to a number of communities, and involving community members in surveys and briefings as a preparation for their role in community-based surveillance;
- implementation targets such as coverage (number of communities visited);
- analysis of the data produced and dissemination of the findings to each community, to the local and regional authorities, to the water-supply and health agencies at regional and national levels, and to a national institution responsible for planning and coordination;
- community-based education in hygiene.

Surveillance should clearly not be limited to data collection. For example, if it is noted that there is a particular need to promote public involvement in questions of water supply or to undertake appropriate health education, it may be decided that particular emphasis should be placed on these activities. It is important to ensure that specific objectives and targets are not overambitious: they should be clearly defined and achievable within a sensible, defined time-scale.

Objectives should not be established in the capital city and imposed on those required to implement the programme nationally. They must be discussed and agreed at all levels following a period of genuine and broad-based consultation, starting at the community level. If people are committed to a common goal and a common set of objectives, many of the problems commonly encountered during implementation will be overcome simply and with good will.
2.2.2 Strategies

The community management of water-supply services was one of the basic principles laid down at the Global Consultation on Safe Water and Sanitation in New Delhi in September 1990, which marked the end of the International Drinking-Water Supply and Sanitation Decade. Application of this principle implies that decisions must be taken at the lowest appropriate level, after public consultation and with the involvement of users in the planning and implementation of water-supply projects. Government programmes should provide assistance and support to communities in managing their own water-quality control systems.

The implementation of water-supply programmes and the accompanying surveillance is a national responsibility. To a varying degree, responsibility for the operation of supply and surveillance systems should be delegated to all administrative levels, down to the community and the individual served. National authorities should therefore develop mechanisms for collaboration at all levels; this is particularly important if full advantage is to be taken of community-based approaches and self-reliance as tools for achieving sustainability. Women must be involved in all aspects of water-supply and surveillance systems, including planning, decision-making, implementation, and evaluation. In addition, broad-based educational programmes should be established, with particular emphasis on hygiene, local management, and risk reduction.

Where it represents a new activity for health or environmental-protection agencies, the implementation of surveillance activities should begin at the pilot level, progress to regional level, and then expand to national level. The principle of initial pilot-scale implementation is important and has been found to be widely applicable. Other procedures for progressive implementation also exist; thus it may sometimes be appropriate to begin with larger centres of population and work down to small-community supplies. In both cases, it is important for activities to be initiated on the pilot scale and to be subject to evaluation and improvement.

Any approach in which extension to the national level takes place too rapidly has a number of potential disadvantages. This is especially true where implementation at pilot and regional levels depends on a national authority. In these circumstances, extension to a national surveillance or quality-control programme may make sudden and severe demands on the human and financial resources of this body. Careful preparation in terms of training and resource provision is always required.

Quality-control activities should be initiated as each new supply system is constructed, and should be continued on a routine basis thereafter. There is thus no question of a staged implementation of these activities unless the quality-control function has never been initiated or has collapsed and requires rehabilitation. Only the progressive implementation of water-supply surveillance is considered here, since in many countries it may represent a new activity. How-
ever, much of the detail concerning inventories, the design of forms, training, and field work is also relevant to the quality-control activities of a water supplier.

The limited availability of resources (especially in developing countries) makes it advisable to start surveillance with a basic programme that develops in a planned manner. Activities in the early stages must generate enough useful data to demonstrate the value of surveillance. Thereafter, the objective should be to progress to more advanced surveillance as resources and conditions permit. Three distinct phases may be identified—initial, intermediate, and advanced. The activities associated with each phase are summarized in Table 2.1.

### 2.3 Implementation

Surveillance activities differ from country to country and region to region, between urban and rural communities, and according to the types of water supply. They should be adapted to local conditions and to the availability of local financial resources, personnel, infrastructure, and knowledge-base. Factors influencing surveillance activities include:

- the type and size of water-supply systems;
- the equipment, both existing and available;
- local employment practices, and the level of training of personnel;
- opportunities for community participation;
- geographical conditions (e.g. the accessibility of systems);
- climatological conditions (which may hamper activities during certain seasons);
- communication and transport infrastructure.

In practice, the sequence of activities in the development of surveillance is usually similar to that summarized in Fig. 2.1.

#### 2.3.1 Inventories

Methods of providing drinking-water vary widely. They may include the use of piped supplies with or without treatment and with or without pumping (supplied via domestic connection or public standpipe), delivery by tanker truck or carriage by pack animals, or collection from groundwater sources (springs or wells) or surface sources (lakes, rivers, and streams). All members of the population receive water by some means, and it is important for the surveillance agency to build up a picture of the frequency of use of the different types of supply, especially as a preliminary step in the planning of a surveillance programme. There is little to be gained from undertaking the surveillance of piped water supplies alone if these are available to only a small proportion of the population. Although the supply agency should be responsible for the quality control of all its supplies, its water sources will only rarely include open dug wells and private supplies, which may be more highly contaminated. For these sources surveillance is of paramount importance.
Table 2.1 Activities to be undertaken in the initial, intermediate, and advanced phases of water-supply surveillance

**Initial phase**
- Establish requirements for institutional development
- Provide training for staff involved in programme
- Start inventories of supply systems
- Undertake sample surveys to identify priority areas
- Develop methodologies suitable for the area
- Commence routine surveillance in priority areas
- Limit water-quality analysis to critical parameters and known problem substances
- Establish reporting, filing, and communications systems (paper-based, rather than computerized)
- Make improvements according to identified priorities
- Establish reporting to local suppliers, communities, and regional authorities
- Establish liaison with communities; identify community roles in surveillance and means of promoting community participation

**Intermediate phase**
- Train staff involved in programme
- Complete inventories of supply systems
- Establish and expand systematic routine surveillance
- Expand analytical capability (often by means of regional laboratories, national laboratories being largely responsible for analytical quality control and training of regional laboratory staff)
- Undertake surveys for chemical contaminants using wider range of analytical methods
- Evaluate all methodologies (sampling, analysis, etc.)
- Use draft standard methods (e.g. analytical methods, fieldwork procedures)
- Establish (and possibly computerize) database archive
- Identify common problems, improve activities to address them at regional and national levels
- Expand reporting to include interpretation at national level
- Draft or revise national standards and legislation
- Use legal enforcement where possible
- Involve communities routinely in surveillance implementation

**Advanced phase**
- Train staff involved in programme
- Establish routine surveillance for all health and acceptability parameters at defined frequencies
- Use full network of central, regional, and local laboratories (including analytical quality control)
- Use national standards and legislation
- Improve water services on the basis of national and local priorities, hygiene education, and enforcement of standards
- Disseminate data at all levels (local, regional, and national)
- Involve communities routinely in surveillance implementation
2. PLANNING AND IMPLEMENTATION OF SURVEILLANCE

Fig. 2.1 Sequence of activities in the development of surveillance

1. Make an inventory of communities, populations, and water supplies
2. Investigate means of involving communities in surveillance
3. Develop report forms for data collection
4. Organize training
5. Plan preliminary survey
6. Undertake fieldwork
7. Collate and interpret results
8. Promote improvement by prioritization, hygiene, and legal action
9. Report to consumers, suppliers, and planners, and monitor follow-up and improvement

Develop routine yearly plan for visits to all communities
Evaluate methods, report forms, and staff; revise methods and forms and improve training
An inventory of all existing water-supply systems should be prepared by the surveillance agency, drawing on local community knowledge. It should include a register of communities, together with data on their total population; this information is often available through censuses. Descriptions of all known water-supply systems should be included, with details of physical components, administrative arrangements, and population served, supplemented by other relevant information (for example, on access and transport requirements).

Some of the information required for an initial inventory may be collected by means of a desk study but should be checked in the field through inspection and meetings with community groups and local leaders. This is especially important when information on water-supply systems is obtained from a central agency. It is then almost inevitable that the records will be incomplete, because systems may have been constructed by different agencies, possibly before records were kept, or by individuals or the communities themselves. A typical form for use in making an inventory of community water supplies is illustrated in Fig. 2.2; it should be adapted according to local circumstances.

Where the initial inventory fails to show the means of supply to a significant proportion of the population, a survey should be undertaken to determine whether the information is incomplete and the means by which water is supplied to the remainder of the population.

In addition to a general overview of how the population obtains water for domestic purposes, the inventory provides a preliminary assessment of the workload of the surveillance agency and the field support required to involve the community in surveillance. This enables the cost of implementation to be estimated. It is important for such estimates to be realistic. Since it is unlikely that all existing supplies will have been identified, additional surveys may be necessary if, for example, open dug wells are found to be an important source of water and therefore to merit attention. It is also unlikely that estimates of travel time and transportation requirements will be accurate, and some allowance should be made for errors.

2.3.2 Designing forms

Simple-to-use community survey and sanitary inspection forms must be carefully developed. These should take the form of pictorial or written checklists that ensure standardized responses and assist the person doing the work to make a rapid assessment of water-supply service quality. Examples of report forms are given in Fig. 2.2 (community surveys) and Annex 2 (sanitary inspection); their design is described in detail in section 3.3. However, community water supplies vary widely, and it is important to evaluate the forms in the light of, and adapt them to suit, specific regional or national conditions. Where appropriate, separate forms should be designed for use by communities in assessing their own water supplies.

The sanitary survey report form may include details that also appear on the inventory, but since the information in the latter is not likely to change very
much, it is more practical for the two to be separate. The sanitary survey report form should contain sanitary inspection details and therefore at least a checklist of the components of the system, including those for which the risk of contamination is greatest. The form should also include assessments of water-supply service indicators other than water quality, namely cost, coverage, continuity, and quantity.

In countries where there are many different types of supply, several different sanitary survey report forms may be necessary; a standard form may otherwise run to several pages.

The design, evaluation, and revision of sanitary survey report forms is important in the development of a surveillance programme. Only essential information should be collected, so that field staff are not burdened with collecting superfluous data. The order in which questions are arranged should coincide with that in

**Fig. 2.2 Typical form for making an inventory of community water supplies**

<table>
<thead>
<tr>
<th>Date of visit</th>
<th>Name of community:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agency responsible for supply</td>
<td></td>
</tr>
<tr>
<td>Community representative responsible for supply</td>
<td></td>
</tr>
<tr>
<td>Total population:</td>
<td></td>
</tr>
<tr>
<td>Population served by:</td>
<td></td>
</tr>
<tr>
<td>— house connections</td>
<td></td>
</tr>
<tr>
<td>— standposts</td>
<td></td>
</tr>
<tr>
<td>— protected springs/wells</td>
<td></td>
</tr>
<tr>
<td>— other</td>
<td></td>
</tr>
<tr>
<td>Distance to monitoring base: . . . . km</td>
<td></td>
</tr>
<tr>
<td>Travail time from monitoring base: . . . . hours, by . . . . (means of travel)</td>
<td></td>
</tr>
<tr>
<td>For piped systems:</td>
<td></td>
</tr>
<tr>
<td>— source type:</td>
<td></td>
</tr>
<tr>
<td>— treatment components:</td>
<td></td>
</tr>
<tr>
<td>— infiltration galleries</td>
<td>Y/N</td>
</tr>
<tr>
<td>— surface-water intake</td>
<td>Y/N</td>
</tr>
<tr>
<td>— sedimentation</td>
<td>Y/N</td>
</tr>
<tr>
<td>— prefiltration</td>
<td>Y/N</td>
</tr>
<tr>
<td>— slow sand filtration</td>
<td>Y/N</td>
</tr>
<tr>
<td>— aeration</td>
<td>Y/N</td>
</tr>
<tr>
<td>— disinfection</td>
<td>Y/N</td>
</tr>
<tr>
<td>— number of reservoirs</td>
<td>. . .</td>
</tr>
<tr>
<td>— number of standposts</td>
<td>. . .</td>
</tr>
<tr>
<td>— number of household connections</td>
<td>. . .</td>
</tr>
<tr>
<td>Health post/centre</td>
<td>Y/N</td>
</tr>
<tr>
<td>School</td>
<td>Y/N</td>
</tr>
</tbody>
</table>
which work is to be undertaken. Where there is to be on-the-spot reporting, the form should incorporate or be accompanied by an appropriate extra section for reporting the community responsible for, or the caretaker of, the supply. Clearly worded questions that will yield yes/no answers should be used wherever possible: standardized answers permit statistical analysis, which minimizes subjectivity in reporting and maximizes the usefulness of findings.

2.3.3 Training

The quality of the information produced by a surveillance programme will depend largely on that of the work undertaken by the staff responsible for liaison with communities, filling in the sanitary survey report form, and undertaking water-quality analysis. The personnel responsible for data collection in the field therefore need to be trained in a number of skills, including interviewing, working with communities, observation, sampling, and water-quality analysis. Adequate training in these areas will help ensure that surveillance findings are standardized throughout the programme and not subject to regional or local variations.

The importance of training cannot be overemphasized. The training strategies adopted will depend on:

— the previous training and experience of the staff allocated to surveillance;
— the range of activities to be undertaken by the surveillance agency and its staff (e.g. hygiene education may or may not be the responsibility of field staff);
— local water supply practice;
— the practical organization of surveillance (e.g. whether water-quality testing is to be undertaken on site by field staff or in laboratories).

To ensure that the surveillance agency functions effectively, adequate training should be provided for staff at all levels. Separate training courses are required for field staff, laboratory staff, regional and national managers, and so on. Although not strictly training activities, workshops and seminars for the dissemination of surveillance findings are also important for promotional and motivational reasons.

It is advisable for the surveillance agency to develop a comprehensive strategy for human resource development. This should include clear definition of lines of responsibility and accountability, job descriptions, career structures, and mechanisms for enhancing the motivation of staff at all levels. A training strategy suitable for a four-tier surveillance agency is shown in Fig. 2.3.

For field staff responsible for liaison with communities, on-site water-quality testing, sanitary inspection, and data reporting, the minimum training period should be 2 weeks. This assumes that staff have a general background in environmental health; considerably longer may be required if they have not already received some vocational training. A subject list for a 2-week training course suitable for sanitary technicians working in the field is given in Table 2.2.
Fig. 2.3 Training strategy for surveillance

- Information flow, data processing, and reporting
- Programme management, planning and administration
- Field supervision and technician training
- Evaluation of portable and laboratory test equipment

- Programme philosophy and general objectives
- Strategy, implementation plan, and current status
- Information management for sector prioritization
- Recent findings

- Directors
  - Regional coordinators
  - Health regions
  - Health region directors
  - Directors of environmental health
  - Surveillance supervisors
  - Technicians
  - Regional laboratory staff
  - Health areas
  - Technicians
  - Community
  - Water and health
    - Sanitary inspection
    - Hygiene
    - Monitoring of water supplies

- Training for regional laboratory staff:
  - Analytical techniques
  - Laboratory management
  - Information flow and data management

WHO 90538
Table 2.2 Typical subjects for 2-week training module in water-supply surveillance for sanitary technicians

<table>
<thead>
<tr>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health, faecal–oral disease transmission</td>
</tr>
<tr>
<td>Barriers for the control of transmissible diseases</td>
</tr>
<tr>
<td>Water, food, sanitation, and health education</td>
</tr>
<tr>
<td>Water-supply surveillance and quality control</td>
</tr>
<tr>
<td>Water supply: system types and basic characteristics</td>
</tr>
<tr>
<td>Protection of point-source supplies</td>
</tr>
<tr>
<td>Gravity-fed systems from protected sources—characteristics and terminology</td>
</tr>
<tr>
<td>Components of gravity-fed systems from protected sources—points of risk</td>
</tr>
<tr>
<td>Evaluation and sanitary inspection of gravity-fed systems from protected sources</td>
</tr>
<tr>
<td>Field visit to gravity-fed system from protected spring source</td>
</tr>
<tr>
<td>Indicators of faecal contamination, water-quality standards</td>
</tr>
<tr>
<td>Demonstration of, and laboratory practice with, water-testing equipment</td>
</tr>
<tr>
<td>Sampling and sample preservation</td>
</tr>
<tr>
<td>Water-treatment principles</td>
</tr>
<tr>
<td>Components of rural drinking-water treatment systems</td>
</tr>
<tr>
<td>Field visit to rural treatment plant, including inspection, sampling, and analysis</td>
</tr>
<tr>
<td>Information flow in the surveillance programme: reporting</td>
</tr>
<tr>
<td>Service evaluation (cost, quantity, continuity), water-quality evaluation</td>
</tr>
<tr>
<td>Fieldwork on evaluation of service quality and water quality in the distribution network</td>
</tr>
<tr>
<td>Sanitary inspections and inspection report forms</td>
</tr>
<tr>
<td>Field visit: sanitary inspection and sampling</td>
</tr>
<tr>
<td>Working with communities</td>
</tr>
<tr>
<td>Participatory learning techniques</td>
</tr>
<tr>
<td>Workshop session for planning of implementation activities</td>
</tr>
<tr>
<td>Round-table discussion</td>
</tr>
<tr>
<td>Course evaluation</td>
</tr>
<tr>
<td>Assessment of participants (pre- and post-training)</td>
</tr>
</tbody>
</table>

Training should not be viewed as a once-only activity, but as a continuous commitment, with follow-up courses, review workshops, and field supervision all contributing to in-service training.

2.3.4 Preliminary surveys

The drawing up of work schedules will be determined largely by local conditions such as distance and accessibility (travel time), travel problems of a seasonal nature, and availability of staff, costs, and transport. Targets for minimum frequencies for sanitary inspection and water-quality analysis are given in Chapters 3 and 4 respectively. In many countries even these targets may be difficult to meet in the short term, and they should then be viewed as medium-term goals.
2.3.5 Undertaking fieldwork

Information on community surveys and sanitary inspection, and on water sampling and analysis is given in Chapters 3 and 4 respectively. Nevertheless, it is worth considering here two important aspects of field methodology in the context of planning for water-quality surveillance and quality control. Firstly, staff responsible for field activities should ideally give local authorities advance notice of their visit, especially when a representative of the authority concerned must be present to provide access to parts of the supply system; staff should be accompanied by a representative of the supply agency whenever possible. Secondly, after on-site inspection and an analysis of the findings, problems or defects may be pointed out in the field to the local authorities or the representatives of the supply agency.

2.3.6 Establishing routine surveillance

When the preliminary survey has been successfully completed, it is possible to plan for routine surveillance. The findings of the preliminary survey may have profound implications for subsequent surveillance activities; for example, surveillance should take due account of the most widely used method of supplying water for domestic purposes or the one that presents the greatest public health risk to the population.

The methods and strategies employed in the preliminary survey should be evaluated and then revised as necessary. This revision should be reflected in training, planning for routine surveillance, expansion of surveillance coverage, surveillance management, and strategies for the promotion of remedial action.

2.3.7 Evaluation

Evaluation is an essential stage in the implementation of surveillance programmes. It is greatly assisted by clearly defined project objectives and targets against which progress can be measured. For evaluation to be worth while, it must have clearly defined goals, which should include comparisons with the objectives and targets adopted at the outset. Evaluation should involve personnel from all levels and should result in change when this is indicated. When initial targets have been met, new targets can be defined. A dual-cycle procedure for the evaluation of water-supply surveillance and for promoting and monitoring improvements is illustrated in Fig. 2.4.

2.4 Information management

2.4.1 Flow and use of information

A general scheme for the flow of information between and within the water-supply and surveillance agencies is shown in Fig. 2.5. Clearly there is an obligation on the part of both agencies to communicate effectively—both laterally and
vertically—in order to maximize the quality of service to consumers and to protect public health.

2.4.2 Information exchange with suppliers

As the first stage, the surveillance agency should report to the local office of the water supplier. Such reporting should be followed up and, if recommended and feasible corrective action is not undertaken in a reasonable time, notification to a higher authority may be required. The level to which such notifications should be sent may vary according to the supply agency but, in general, it should be the level with ultimate responsibility for the supply.

As a minimum, the information provided by the surveillance agency to the supplier should include:

- a summary of the quality of the service being provided and the condition of the supply; and
- an indication of those aspects considered inadequate and requiring action (with reference to national legislation).
Fig. 2.5 General scheme for the flow of information between and within the water-supply and surveillance agencies
In some circumstances, it may also be necessary to recommend remedial action, such as emergency disinfection of the supply. Some recommendations may require action not only by the supplier, but also by the surveillance agency. For example, if there is severe faecal contamination of drinking-water, this cannot be remedied in the short term, and it may be considered advisable for the population to boil the water. Warning people of the need for this may then be the responsibility of the health authorities (i.e. the surveillance agency). As a further example, if the water supply is of good quality but not continuous, people are forced to store the water in the home, where it may become contaminated; unless a continuous supply can be established quickly, an educational programme on household water storage may be recommended. This is again likely to be the responsibility of the surveillance agency or another agency within the health sector.

The exchange of information between the surveillance and supply agencies should not be limited to complaints about failures. The two agencies must coordinate their activities to ensure regional prioritization, and this requires effective communication and reporting strategy. Reports intended to assist in the setting of regional priorities need not be frequent; annual reporting is likely to be adequate, especially if the report is timed to coincide with the programming of supply agency investments for the following year. Such reports should classify communities and systems in order of priority for intervention based on social and public health criteria. Banding or scores assigned to each community may be used for this purpose (see Chapter 5). Prioritization should not be based solely on water quality, but should also take account of all parameters of drinking-water supply service.

2.4.3 Information exchange within the surveillance agency

It is essential that the field worker or local laboratory maintains detailed files on all water supplies in the area. Files should include the results of all inspections and analyses in chronological order. They should be used in conjunction with the inventory, which should include an outline plan of each system, together with details of system components and the population served.

At local level, information is most commonly stored on paper, with perhaps one file per water supply. At regional and national levels, the need for greater data analysis will increasingly justify computerization, although this level of sophistication remains inappropriate at local level in many countries.

The local water-surveillance office should report to each community authority and the relevant supply agency as soon as possible after a field visit. The information should also be passed on to regional authorities to allow follow-up if recommendations for remedial action are not implemented; this may be less urgent and can be done at less frequent intervals, e.g. weekly or monthly. However, there must be a rapid means of reporting in case of emergency.
Regional centres may report to the national surveillance authority quarterly or half-yearly.

2.4.4 Information exchange with consumers

The right of consumers to information on health-related parameters of the water supplied to them for domestic purposes is fundamental. However, in many communities, the simple right of access to information will not ensure that individuals are aware of the quality of the water supplied to them; furthermore, the probability of consuming unsafe water is relatively high. The agencies responsible for monitoring should therefore develop strategies for disseminating the health-related results they obtain.

What information is reported to consumers will largely be decided on the basis of the data produced. Nevertheless, raw data (such as the concentrations of contaminants) should be accompanied by some type of interpretation whenever possible, such as compliance or noncompliance with national standards, for the benefit of nonspecialists. The dissemination of information on drinking-water quality must be linked to recommendations for action (e.g. boiling) where appropriate, to community participation in monitoring, and to public education on water-quality issues.

Where reporting incorporates recommendations for remedial action at local level, it may be appropriate to employ pictorial report forms. In some programmes these have been printed alongside the field report forms. In the field, the points that require attention are highlighted, e.g. by circling. The pictorial summary is then torn off and given to the responsible person, together with a full explanation of the actions recommended. Examples of pictorial forms are given in Annex 2.

The delivery of notifications may be difficult, especially in remote communities in developing countries, and methods of solving this problem must therefore be found. Where notifications must be delivered by the monitoring agency itself and distances are considerable, this may become expensive. It may then be more cost-effective to use on-site testing equipment and for field staff to remain in communities overnight. When such staff are adequately trained in the interpretation of results and notification of findings, they can provide an immediate report to the community before returning to their base or proceeding to the next community. However, delayed reporting following sample analysis in a local or regional laboratory remains the most common practice. Suitable means for forwarding reports must then be used. Different means of communication will be found to be appropriate, depending on those available, the urgency of taking corrective action, and the feasibility of implementing the recommended remedial action. Written notification, which may take several days to arrive, will often be adequate, but if urgent action is warranted, e.g. notifying the population of the need to boil its water, more rapid means of communication may be appropriate
(telephone, telegram, radio, etc.). Rapid notification should always be followed up by written confirmation.

2.4.5 Communication with local and national government

At national level, priorities should be set and disseminated, with recommendations, by means of an annual report. The report should be circulated to all surveillance and supply agencies, the national planning authorities, and agencies involved in coordination within the water-supply sector, e.g. ministries responsible for local government, natural resources, health, and finance. Depending on local circumstances, it may be sent to external support agencies as well, and some nongovernmental organizations may also be recipients. Information exchange with national planning authorities may provide a means of establishing a mutually supportive relationship between surveillance and supply agencies.

Local government should ensure that the agency that supplies drinking-water to the area complies with the surveillance legislation and regulations. Annual reports should be made available which should include information on all breaches of standards and any exemptions or permitted deviations of water quality from national standards. Local government should also actively promote surveillance within the area that it administers, and encourage both producers and consumers to regard surveillance as a positive means of protecting the quality of the water supply.

2.4.6 Communication linkage between surveillance and remedial action

Once routine water-supply surveillance activities are established, the links between remedial measures and surveillance should be institutionalized. The most important activities, which should be carried out in the following sequence, are:

- The regional agency responsible for water-supply surveillance prepares an annual plan and fixes a target number of water supplies to be inspected, sampled, and analysed on the basis of inventories.
- Action is coordinated with the community. Sanitary technicians carry out sanitary inspections with community representatives/volunteers. Water samples are analysed on site or transported to a laboratory for analysis.
- The results of the sanitary inspection and water-quality analysis are combined and communicated to the community during the visit if analysis is undertaken on site, or forwarded as soon as possible if samples are processed in a laboratory. In the latter case, the results of the sanitary inspection can be communicated during the visit. The report(s) should indicate the risks identified and the points requiring attention.
- A monthly consolidated report is prepared, covering all points of risk for each facility and the results of analyses.
2. PLANNING AND IMPLEMENTATION OF SURVEILLANCE

• The monthly report is transmitted to the regional coordinator, who ranks the relative urgency of action for each facility (see also Chapter 5) and identifies high priorities for remedial action and for hygiene education.
• An urgent action list is sent by the regional coordinator to the appropriate authority for remedial action and to the sanitary technician responsible for monitoring such action.
• Remedial action is taken by the appropriate authority.
• The sanitary technician monitors the remedial action with the community. On completion, he or she repeats the inspection and analysis with the community and communicates the results to the regional coordinator, together with a summary of the remedial work undertaken.
• The coordinator compiles an annual summary of the remedial work undertaken and improvements achieved for review with the supply authorities and by senior staff of the surveillance agency. The report highlights the most common shortcomings, and is used as a basis for identifying the changes in strategy that the supply agency is required to make.
• An annual summary of priorities for hygiene education is compiled by the regional coordinator. A strategy for activities during the following year is agreed with the authority responsible for hygiene education, and the work-plan is communicated to the sanitary technicians responsible for surveillance.
• The sanitary technician monitors the hygiene education activities with the community. On completion, he or she evaluates improvements with the community and communicates the results to the regional coordinator, together with a summary of the educational activities undertaken.
• The common shortcomings identified in the annual report are addressed in the supply/construction agencies’ annual plans and resources allocated to training, rehabilitation, etc., as appropriate.

2.4.7 Use of computers

Data analysis at national level clearly requires the management of large volumes of data, which is a strong argument for computerization. The national agency receives the greatest quantity of data, all of which must be stored, and must also be able to undertake comprehensive data analysis to assist in the setting of priorities at national level.

Where computers are used for data management at national level, it may also be advantageous to extend computerization to the regional centres if they handle sufficient data to warrant it. This has the additional advantage of decentralizing the requirement for data input and reducing the total number of transcriptions, especially if the data are delivered from regional to national centres in computerized form, thereby reducing the chances of error.

At regional level, computerization provides an efficient means of storing information, and possibly also for comparing results with compliance criteria, such as national standards or interim goals agreed with the supplier. The type of
communication to be sent to the water supplier will vary according to the nature of the noncompliance, and a computer may also be used to produce appropriate standard letters.

Computerization should not be seen as a universal solution to all problems. As with any other data-management system, the results obtained will be only as good as the data received, and the need for effective data flow and efficient data input is paramount.

2.5 Support structure

Ideally, a special section should be established within the responsible agency to oversee and implement activities related to the surveillance programme. This requires a laboratory network, offices, transport, financial support, and adequate staffing.

2.5.1 Laboratory network

The laboratory network will vary widely according to a number of criteria. For water-supply surveillance laboratories, the parameters to be measured should be those known to be related to health together with those that may cause water to be rejected by consumers (see section 1.3.1). A laboratory infrastructure may already exist and may include hospital laboratories in the case of surveillance and laboratories at suppliers’ water-treatment plants.

In principle, all analyses should be undertaken in a laboratory as close as possible to the site of sampling, taking into account constraints such as staffing and equipment, both of which are largely related to the number of samples analysed and the required frequency of analysis. Prompt analysis minimizes deterioration in sample quality during transport (this is especially important for microbiological samples) and close proximity of the laboratory reduces the costs associated with sample transport.

The range of analyses conducted, the number of samples, and the frequency of sampling may need to be increased progressively with time. The strategy may initially require analysis only of thermotolerant (faecal) coliforms, chlorine residual, and turbidity, before it is expanded to incorporate regional laboratories with a limited analytical range. For quality-control purposes, the range and frequency of analyses may be specified in national standards, but should be increased if conditions deteriorate or if there is any reason to suspect that service quality may be endangered.

A structure based on a central laboratory, a number of regional laboratories, and simple district-level laboratories will almost always be necessary. It may be supplemented by providing field staff with portable equipment for on-site measurement of critical parameters, thus ensuring greater decentralization and more effective coverage (see pp. 65–66).
A central laboratory should be established to undertake a full range of physical, chemical, and microbiological tests. Such laboratories are sometimes referred to as “reference laboratories”, although they may not actually perform a reference function. The central laboratory should provide training for analytical staff at all levels, including staff using on-site testing equipment. It should also provide full quality assurance of its own analyses and external quality control for subsidiary laboratories. In addition, it should undertake certain more sophisticated analyses that cannot be decentralized because of the high capital cost of the equipment necessary. These may include, for example, analyses for heavy metals by atomic absorption spectroscopy, and for pesticides by gas chromatography.

Regional laboratories should be able to undertake a moderate range of analyses. They should also provide a support service to remote areas, making culture media and consumables available to staff conducting a limited number of tests using on-site or office-based testing equipment.

Examples of the initial and final laboratory service infrastructure for water-quality analysis are shown in Fig. 2.6.

2.5.2 Transport

The preferred means of transport will vary widely depending on the terrain, climatological conditions, and local custom; the possibilities include four-wheel-drive vehicles, pack animals, canoes, bicycles, and motorcycles, in addition to walking (which is always used to some extent). Factors to be taken into account in choosing a means of transport include the need to send samples to the laboratory as quickly as possible (see section 4.1.4), the adequacy of the various forms of transport for the conditions prevailing at the time of surveillance, and price, operating and maintenance costs, and expected useful working life of the transport.

It has been common practice to rely on four-wheel-drive vehicles in carrying out surveillance and quality-control activities in many countries. In some areas, motorcycles have proved particularly successful; they are generally capable of carrying both portable testing equipment and teaching materials, are a far cheaper alternative, and can transport field staff rapidly. They are also less likely to be requisitioned for other purposes.

2.5.3 Financial support

Substantial support for surveillance is generally provided by centralized institutions, such as regional or national governments, although they do not cover the total cost. Considerable contributions (which will often be mainly in kind) may also be made by the community itself. Costs may also be reduced by a variety of means, and the water-supply agency should operate on a cost-recovery basis.
The role and importance of community participation were described in section 1.6. Involving the community in decisions about the establishment of a surveillance programme can be used to create a sense of ownership and a willingness to share some of the costs of surveillance, maintenance, and remedial actions. One approach is to use existing structures in the community, such as water committees, to obtain contributions and to undertake simple maintenance.

A number of strategies may be adopted for minimizing the costs of surveillance. The highest costs are usually those associated with staff and transport, and it is therefore important to concentrate on these. Repeat journeys for resampling or for the delivery of reports to community authorities (essential if there is no...
suitable postal service or equivalent) are very expensive, and every effort should be made to reduce the need for them. In regions with remote water supplies, this can often be done by using on-site testing equipment, particularly if it is possible for field workers to stay overnight in communities and deliver the results the next morning. If this strategy is adopted, it is often appropriate for field staff to be responsible for health and hygiene education as well as surveillance activities.

2.5.4 Staffing

Staffing requirements for servicing a water-supply surveillance programme vary widely, and there is no generally applicable method of determining the number of staff needed for a given population or for a given number of water supplies. The following factors should be borne in mind when staff requirements are estimated:

- Travel to and from water supplies is a major problem for staff undertaking fieldwork (sampling, sanitary inspection, liaison with communities); realistic estimates of travel time should therefore be made at an early stage, and confirmed times entered on the inventory for planning purposes. In addition, seasonal factors such as monsoons may constrain travel at certain times and thus reduce the time available for the work.
- Decentralization of analysis and/or on-site testing becomes more attractive as travel times increase and where water supplies are more widely dispersed.
- The distribution of the workload between point sources, nuclear communities, and piped water supplies will influence the rate at which work is completed.
- The type of supply will also influence the time required, e.g. the sanitary inspection and on-site analysis take an hour in the case of a dug well, while inspection of a piped supply with a source several kilometres away, even for a small community, is likely to take a whole day.
- Greater community involvement will lead to more efficient and effective surveillance, either because it is supported by, and undertaken with, the community or because less frequent visits by the sanitary inspector are necessary.
- Field workers often play an educational role, e.g. in increasing awareness of the health implications of water supply.

Possible responsibilities of surveillance staff at various levels are suggested in Annex 3.