

Annex 1

SPECIMEN SURVEILLANCE PROGRAMMES

SURVEILLANCE OF DRINKING-WATER QUALITY—LEVEL I

Description: This is an initial programme proposed for adoption in those countries that at present have no formal programme and a severely limited economic development.

Laws and regulations: Basic legal authority creating or designating the surveillance agency and empowering it to carry out the duties below.

Drinking water standards: Adoption of bacteriological standards in urban water systems.

Standard methods of analysis: As needed for above, plus residual chlorine testing.

Laboratory: Develop a central laboratory, possibly as part of the national health ministry laboratory.

Sanitary surveys: Programme for capital and major cities.

Approval of sources: Programme for capital and major cities.

Reporting requirements: Waterworks in major cities required to submit one sample of their finished water each month for analysis by the surveillance agency.

Design standards: Informal technical assistance.

Regulation of special water supplies: Government hospitals and major air, rail, and sea terminals.

Training: In-service training for surveillance staff; participation in international training programmes, if and when available; use of short-term consultants.

Technical assistance: On request, but no full-time staff on this task.

SURVEILLANCE OF DRINKING-WATER QUALITY—LEVEL II

Description: This is a basic programme for formal adoption in those countries that at present have nominal or superficial programmes with severe limitations on scope and effectiveness.

Laws and regulations: Basic legal authority authorizing the programme and powers sufficient to carry out programme below, including development of agency regulations.

Drinking-water standards: Adoption of bacteriological and physical standards in urban areas.

Standard methods of analysis: As needed for above, plus residual chlorine testing.

Laboratory: Establishment of a central water supply laboratory.

Sanitary surveys: Required for all city water supplies, emphasis on source and treatment.

Reporting requirements: All cities required to submit monthly samples. Major cities to report their own bacteriological tests. All supplies to monitor and report chlorine dosage and residual concentrations.

Approval of sources: All cities.

Design standards: Informal technical assistance.

Regulation of special supplies: Government hospitals, major transportation terminals, schools, army ports, prisons, large encampments, and tanker supplies in larger cities.

Training programme: Development of seminars for waterworks operators; some staff to be sent on international fellowships; use of consultant instructors; promotion of training efforts by local universities and technical institutions.

Technical assistance: As requested, limited programmes.

SURVEILLANCE OF DRINKING-WATER QUALITY—LEVEL III

Description: A programme intended for those countries that already have established programmes in major cities and are seeking to provide surveillance on a broader national or regional scale.

Laws and regulations: Basic legal authority plus well codified administrative regulations.

Drinking-water standards: Bacteriological, plus standards for turbidity, taste, colour, odour, and toxic substances.

Standard methods of analysis: Those appropriate to drinking-water standards.

Laboratory: Central water laboratory with capability for complete analyses; provision of key laboratory supplies to waterworks laboratories and training programmes for laboratory workers; regional laboratories if and when needed.

Sanitary surveys: Periodically in urban areas and a partial rural programme; routinely for new drinking-water sources in larger systems.

Approval of source: As above.

Reporting requirements: Regulations requiring plants to maintain records of operation. Samples to be submitted periodically to central laboratory.

Design standards: Publication of informal guidelines; consultation to be available.

Training: Development of short courses for surveillance and waterworks personnel; promotion of training efforts of local educational institutions, with financial support if necessary, and participation of professional staff in international training programmes including study tours and “internships” by senior staff.

Technical assistance: Advisory services on cross-connexions, plumbing, additives, material specifications, and rural water supplies.

Regulation of special water supplies: As for level II, plus all urban supplies, fairs, markets, housing projects, and larger bottlers and ice manufacturers.

SURVEILLANCE OF DRINKING-WATER QUALITY—LEVEL IV

Description: Programme intended for countries with well established surveillance programmes that seek to extend the service to the whole country and to increase the scope and effectiveness of surveys (particularly countries that are at “takeoff” point in their economic development).

Laws and regulations: Complete powers, but advisory rather than mandatory regulations for those activities lacking sufficient personnel for proper enforcement. Police power in any situation where a clear threat to health can be demonstrated.

Drinking-water standards: *International standards for drinking-water* or the equivalent, with appropriate adaptation to local conditions and publication in the national language.

Standard methods: International standard methods for drinking-water analysis published locally in the national language.

Laboratory: Establishment of a fully equipped central reference laboratory and regional facilities. Central laboratory to provide many services including training, technical assistance, bacteriological media, standards, and evaluation of other laboratories.

Sanitary surveys: All urban areas including distribution systems; most larger rural community supplies to be surveyed at regular intervals.

Approval of sources: All new sources for community water systems require preconstructional agreement between the waterworks management and the surveillance agency.

Reporting requirements: Regulations requiring larger plants to maintain records of operation and laboratory analyses; samples to be submitted to, or taken by, the surveillance agency on an established schedule.

Design standards: Formal programme for preconstructional agreement of new works for largest systems; published guidelines.

Plumbing code: Codified and enforced in major cities and for major manufacturers of plumbing fixtures.

Training: Strongly supported programmes of short courses; support for institutional training and educational programmes; and operation of a technical institute if necessary.

Technical assistance: Active programme with full-time staff.

Regulation of special supplies: All supplies serving significant population numbers and bottled water production and ice manufacture.

Other: Cross-connexion control programme; formal participation in health education programme of the health ministry.

Annex 2

MEDICAL EXAMINATION OF WATERWORKS OPERATORS

The following extract is taken from *Safeguards to be adopted in the operation and management of waterworks* published by the United Kingdom Ministry of Housing and Local Government, Welsh Office (32).

“(i) Care should be exercised in the selection of men to be employed on works where a risk to the purity of the water supply is likely to arise. The clinical history of each man, particularly with reference to any infection capable of being water-borne, should be thoroughly investigated and he should be examined by testing his blood to determine whether or not he is likely to be a typhoid carrier. When blood tests give a positive result which is not attributable to preventive inoculation, he should not be so employed unless repeated examination of his stools and urine fails to show the presence of pathogenic bacteria.”

“(ii) If preliminary blood tests are not used, bacteriological examination of stools and urine must be carried out on at least three occasions at weekly intervals in all cases. This should reveal 70–80 per cent of chronic carriers.”

“(iii) If any employee is known to have any disease that could be water-borne or is suffering from an illness associated with looseness of the bowels or an illness necessitating his absence from work for more than five days there should be standing arrangements to ensure that he is not employed on work where a risk to the purity of the water supply is likely to arise until he has been seen by the undertaking's medical officer who will decide whether examination on the lines indicated above is necessary to show that it is safe for him to be so employed. Standing arrangements should also be in force to ensure that each member of the staff is examined by the undertaking's medical officer at intervals of not more than three years.”

Annex 3

TRAINING COURSES^a

COURSE: SANITARY SURVEYS

Trainees: Municipal waterworks supervisors and senior operators;
public health sanitarians and sanitary technicians;
junior sanitary engineers

Duration of course: 3 consecutive days; alternatively, 6 evening sessions
each lasting 3 hours, plus a 1-day field trip during daylight hours

Class size: 10–20 persons

Physical facilities:

Classroom in plant, school, or office building equipped with black-board and sufficient student desks

Laboratory for water testing (chemical and bacteriological) in water treatment plant or government institution

Field trips to municipal waterworks source, treatment and distribution plant, rural water supplies using wells

Equipment and supplies:

For demonstrations: prepared flip-charts (one set), mimeographed documents and survey forms (one set per student)

For practical classes: residual chlorine comparators (1 per 4 students), sterile sample collection bottles (2 per student)

Transportation needs: A bus or cars or trucks for field trips every day

Course curricula for sanitary surveys

Day	Time	Duration	Location	Curriculum details	References ^a
1	08.00–09.00	1 hour	Class-room	Sanitary surveys: definition timing and frequency rural water supplies town water supplies major city waterworks	A, pp. 23–25, 36–44
	09.00–10.00	1 hour	Class-room	Personnel: qualifications water plant operators training operators occupational health and safety public relations	A, pp. 30–35 B, pp. 246–250

^a Adapted, in part, from Rajagopalan & Shiffman (30).

Course curricula for sanitary surveys (*continued*)

Day	Time	Duration	Location	Curriculum details	References ^a
2	10.00–11.00	1 hour	Class-room	Programme administration: organization records follow-up measures	A, pp. 20–26, 59–62 B, pp. 244–245
	13.00–17.00	4 hours	Field	Field trip to typical rural water system	A, Annex 4, pp. 82–99
	08.00–10.00	2 hours	Class-room	Water sources (a) Groundwaters: aquifer characteristics pollutional influences development protection of wells, springs, etc. (b) Surface waters: watershed considerations analyses intake structures	A, Annex 4, pp. 82–99 C, pp. 57–120 B, pp. 11–13 C, pp. 161–170 E, pp. 6–9 E, pp. 6–9
	10.00–12.00	2 hours	Class-room	Water treatment: conditioning filtration (i) rapid sand filters (ii) slow sand filters disinfection equipment records	A, pp. 84–86 C, pp. 171–193 B, pp. 94–133
	13.00–17.00	4 hours	Field	Field visit to municipal water plant	A, Annex 4, pp. 82–99
3	08.00–10.00	2 hours	Class-room	Distribution systems: design of networks siting and construction of storage reservoirs disinfection of new work taking samples losses in system records	A, Annex 4, pp. 87–90 C, pp. 194–223 D, p. 9
	10.00–11.00	1 hour	Class-room	Water distribution problems (a) Water leaks: effect on quality methods of treating leaks (b) Cross-connexions: physical correction backflow prevention finding cross-connexions control programme	A, Annex 5, pp. 100–107 E, pp. 47–52

Course curricula for sanitary surveys (*continued*)

Day	Time	Duration	Location	Curriculum details	References ^a
3	11.00- 12.00	1 hour	Class- room	Evaluation	A, Annex 4, pp. 82-99
	13.00- 17.00	4 hours	Field	Visit to different elements of a municipal water distribution system	

^a The references refer to the following publications:

A — this monograph;

B — Cox (17);

C — Wagner & Lanox (28);

D — United States Environmental Protection Agency (33);

E — United Kingdom, Welsh Office, Ministry of Housing and Local Government (32).

COURSE: BACTERIOLOGICAL SAMPLING AND TESTING BY MEANS OF MEMBRANE FILTERS

Trainees: Operators from larger municipal waterworks;
waterworks chemists and bacteriologists;
laboratory chemists and bacteriologists;
laboratory assistants

All having had previous training and experience in bacteriological analysis of waters

Duration of course: 5 days (students will carry out membrane-filter tests)

Class size: Maximum of 8 students per instructor

Physical facilities:

Classroom in office building, school, or plant equipped with desk space

Laboratory for water testing (chemical and bacteriological) in water treatment plant, school, or government institution

Field trips to municipal waterworks source, treatment, and distribution plant for sample collection; also visits to dug wells if readily accessible

Workshop for laboratory tests

Equipment and supplies:

For demonstrations: residual chlorine comparators (1 per 4 students) stills, sterilizers, media, bottles, membrane filters, incubators, etc., for bacteriological analysis

For practical classes: same equipment needed

Transportation needs: A bus or cars or trucks for field trips on days 2, 3, and 4

Course curricula for bacteriological sampling and testing
by means of membrane filters

Day	Time	Duration	Location	Curriculum details	References ^a
1	08.00–10.00	2 hours	Class-room	Water-borne diseases Indicator organisms Coliform group of organisms Standards for water safety Disinfection	B, pp. 174–181
	10.00–12.00	2 hours	Class-room	The membrane filter: advantages and disadvantages filter characteristics Media Field equipment Laboratory equipment Incubation	B, pp. 347–352 A, pp. 53–54; Annex 8, pp. 122–125
	13.00–17.00	4 hours	Laboratory	Familiarization in use of membrane filter and field monitoring equipment following demonstration of techniques Collection and analysis of sample from the building system	E
2	08.00–09.00	1 hour	Class-room	Sampling theory Frequency of sampling Size of samples Number of samples Economic limitations	A, pp. 44–48 B, p. 279
	09.00–10.00	1 hour	Class-room	Selection of sampling points; representative samples Point of entry to distribution system Principal portions of system Avoidance of dead-ends Limitation of raw water testing	A, p. 48 C, pp. 271–275
	10.00–11.00	1 hour	Class-room	Field sampling procedures: transportation considerations prompt versus delayed examinations shipment of samples	D
	11.00–12.00	1 hour	Class-room	Laboratory bacteriology: sterilization nutrient media incubation	
	13.00–17.00	4 hours	Laboratory and field	Field collection of samples from distribution system point followed by laboratory examinations using membrane filter	A, Annex 8, pp. 122–125 E
3	08.00–09.00	1 hour	Class-room	Recording results of tests: statistical validity monthly summarizations systems evaluations	

Course curricula for bacteriological sampling and testing
by means of membrane filters (*continued*)

Day	Time	Duration	Location	Curriculum details	References ^a
3	09.00-10.00	1 hour	Class-room	Positive samples: disinfection requirements repeat testing	C, pp. 46-50 A, pp. 58-61 E
	10.00-11.00	1 hour	Class-room	Monitoring programme: equipment and supplies needed transportation considerations	
	11.00-12.00	1 hour	Class-room	Securing corrective action: liaison between agencies administrative channels water authority health authority	
	13.00-17.00	4 hours	Laboratory and field	Field collection of samples from distribution system points followed by laboratory work recording results of previous day's examinations	
4	08.00-17.00	1 day	Field and laboratory	Continuation of supervised collection of field samples and laboratory examinations by the membrane-filter technique until proficiency is demonstrated (i.e., about 10 samples and examinations per student for those without previous experience)	
5	08.00-12.00	4 hours	Class-room	Summarizing of findings: interpretation preparation of report forms question and answer period course evaluation	

^a The references refer to the following publications:

A — this monograph;

B — Cox (17);

C — Wagner & Lanoix (28);

D — Panezai et al. (34);

E — manufacturers' literature dealing with the particular equipment employed.

The reader is also referred to the various publications mentioned in Chapter 7.

COURSE: CONTROL OF CROSS-CONNEXIONS

Trainees: Municipal waterworks distribution foremen;
sanitarians and public health inspectors;
plumbers

Duration of course: 2 days

Class size: 6-12 persons

Physical facilities:

Classroom in office building, school, or plant (if equipped with desks)

Field trips to water distribution system, industrial sites, wells, pumping station, etc.

Equipment and supplies:

For demonstrations: sounding rods, dyes, pressure gauges, flip charts, vacuum breakers, check valves, vacuum tank or pump for demonstration of back-siphonage

For practical classes: residual chlorine comparators (1 per 4 students)

Transportation needs: 1 bus

Course curricula for control of cross-connexions

Day	Time	Duration	Location	Curriculum details	References [#]
1	08.00–09.00	1 hour	Class-room	Definitions Historical review and examples Hydraulic principles, negative pressures	A, Annex 5, pp. 100–101 D, pp. 3–8; E, pp. 7–10 D, pp. 9–18
	09.00–10.00	1 hour	Class-room	Sanitary surveys, dual systems: methods of elimination separation of supplies air gap installations; how measured	A, Annex 5, pp. 102–104 D, p. 46 D, pp. 19, 51 E, p. 48
	10.00–12.00	2 hours	Class-room demonstrations	Backflow and siphonage prevention: non-pressure vacuum breakers pressure vacuum breakers reduced pressure principle backflow preventer check valves	E, p. 13 D, p. 27 D, p. 17, Fig. 18 D, p. 30 D, pp. 29, 30
	13.00–17.00	4 hours	Field	Field trip to distribution portions of municipal waterworks, pumping stations, storage, etc.	

Course curricula for control of cross-connexions (*continued*)

Day	Time	Duration	Location	Curriculum details	References ^a
2	08.00–09.00	1 hour	Class-room	Plumbing codes, ordinances, legislation	A, pp. 27–29 B, p. 251 D, pp. 35–42 E, pp. 37–38 D, pp. 32–34
	09.00–11.00	2 hours	Class-room	Control programme organization: manpower considerations educational campaigns cooperation with industry design reviews plant inspections	C, pp. 245–246 C, p. 23
	11.00–12.00	1 hour	Class-room	Enforcement measures	A, pp. 59–60
	13.00–17.00	4 hours	Field	Field trip to visit representative commercial and industrial operations with and without auxiliary water sources	

^a The references refer to the following publications:

- A — this monograph;
 B — Cox (17);
 C — Wagner & Lanoix (28);
 D — United States Environmental Protection Agency (35);
 E — United Kingdom Department of the Environment (36).

COURSE: OPERATION OF WATER TREATMENT PLANTS

Trainees: Waterworks supervisors, operators, and chemists;
 sanitarians;
 engineers

Duration of course: 5 days

Class size: 10–20 persons

Physical facilities:

Classroom in office building, school, or plant (to be preferred if desks and space can be arranged)

Laboratory for water testing (chemical and bacteriological) in plant, school, or governmental institution

Workshop (laboratory control of operation) in plant equipped with suitable laboratory

Field trips to pumping station, source, and well supply

Equipment and supplies:

For demonstrations: jar tests, apparatus for measuring pH, alkalinity, turbidity, chlorine demand, residual chlorine, taste, colour, odour, etc.

For practical classes: residual chlorine comparators (1 per 4 students)

Transportation needs: 1 bus

Course curricula for operation of water treatment plants

Day	Time	Duration	Location	Curriculum details	References ^a
1	08.00–09.00	1 hour	Class-room	Source protection measures: pollution control watershed considerations protection of wells and springs	A , pp. 63–64; Annex 4, pp. 82–84 B , pp. 1–13
	09.00–10.00	1 hour	Class-room	Reservoir considerations: storage effects stratification and overturn intake locations algal growths	B , pp. 14–20
	10.00–11.00	1 hour	Class-room	Taste and odour problems: causes treatment (i) copper sulfate (ii) aeration (iii) chlorination (iv) adsorption	B , pp. 29–53
	11.00–12.00	1 hour	Class-room	Coagulation and flocculation: coagulant chemicals jar testing dosing and mixing floc formation; flocculation aids	B , pp. 54–78
	13.00–15.00	2 hours	Class-room	Sedimentation: basin designs, detention time inflow distribution settling times effluent weirs sludge removal short-circuiting	B , pp. 79–93
	15.00–17.00	2 hours	Class-room	Slow sand filters: design considerations flow controls rates of operation cleaning	D B , pp. 94–99; 178 C , pp. 175– 178
				Rapid sand filters: design considerations rates of operation backwash methods rate controls Pressure filters	B , pp. 99–127 B , pp. 127– 128

Course curricula for operation of water treatment plants (continued)

Day	Time	Duration	Location	Curriculum details	References [#]
2	08.00-12.00	4 hours	Class-room	Disinfection: chlorine measurement prechlorination postchlorination breakpoint chlorination super-chlorination Disinfection chemicals: hypochlorinators chlorinators	B, pp. 134-171; C, pp. 185-193; E, p. 31
	13.00-17.00	4 hours	Field	Field visit to water sources utilized in the area for water production and accomplishment of supervised sanitary surveys of the various sources	A, Annex 1, pp. 67-70; Annex 4, pp. 82-99; Annex 6, pp. 108-115
3	08.00-09.00	1 hour	Class-room	Public health principles of water quality: physical chemical bacteriological biological	B, pp. 172-182; E
	09.00-10.00	1 hour	Class-room	Laboratory and testing procedures	
	10.00-12.00	2 hours	Class-room	Sampling requirements: representative samples sampling time composite samples sampling equipment	
	13.00-17.00	4 hours	Field	Visit to surface water treatment plant; supervised sanitary survey of various treatment units	A, Annex 4, pp. 84-90; Annex 6, pp. 108-115
4	08.00-09.00	1 hour	Class-room	Water plant records: daily measurements and tests periodic measurements and tests permanent record requirements	
	09.00-10.00	1 hour	Class-room	Computation of solutions and doses; plant arithmetic	B, pp. 254-256
	10.00-11.00	1 hour	Class-room	Storage of chemicals and supplies: precautions with chemicals protective equipment emergency measures	

Course curricula for operation of water treatment plants (*continued*)

Day	Time	Duration	Location	Curriculum details	References ^a
4	11.00– 12.00	1 hour	Class- room	Pumping stations and distribution system pressure requirements	A , Annex 4, pp. 82-83; Annex 6, pp. 108-115
	13.00– 17.00	4 hours	Field	Visit to groundwater develop- ments in local area — wells, springs, galleries, etc.; supervised sanitary survey of system ele- ments	
5	08.00– 12.00 13.00– 15.00	6 hours	Labora- tory	Demonstration and practice: chlorine residual testing turbidity determinations pH testing jar test for coagulant dosages. other tests	
	15.00– 17.00	2 hours	Class- room	Review of course material; questions and answers; evaluation of course	

^a The references refer to the following publications:

- A** — this monograph;
- B** — Cox (17);
- C** — Wagner & Lanoix (28);
- D** — Huisman & Wood (29);
- E** — United States Environmental Protection Agency (33).