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1989 RWS WORKS PROGRAMME

Vanuatu

LGC	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	REMARKS
Banks							GAUA/SOLA						
Santo				SANTO/MALO PHASE 1									2 x WORK CREWS
Ambae		VANDUE		VUINCALATO									FROM 1988
Pentecost		LUBULTAMATA							NTH PENTECOST				
Malekula	MBWITIN/MASKELYNES			VAO ISLAND (Rain ct.)				MALEKULA PHASE 3 (MAE)					
Paama									SMALL PROJECTS				
Ambrym								NORTH AMBRYM					
Epi									NW EPI				NW EPI AUG 89 - APR 90
Shepherds				TONGOA/SHEPHERDS SMALL ISLANDS RAINWATER									
Efate								SMALL PROJECTS (MAGALILIU)					
Tafea			LENAKEL (IRRU) / SMALL PROJECTS / MIDDLE BUSH										MIDDLE BUSH JUL 89 - JUN 90
Courses		VILLAGE PLUMBER			VILLAGE PLUMBER			BASIC/INTERMEDIATE PLUMBER					
Mech Tour													
Spell													

WORLD HEALTH ORGANIZATION

WESTERN PACIFIC REGION

ORGANISATION MONDIALE DE LA SANTE

REGION DU PACIFIQUE OCCIDENTAL

REGIONAL CENTRE FOR THE PROMOTION OF
ENVIRONMENTAL PLANNING AND APPLIED STUDIES (PEPAS)

REGIONAL WORKSHOP ON DRINKING-WATER QUALITY MONITORING AND SURVEILLANCE

Kuala Lumpur, Malaysia
27 February - 3 March 1989

ICP/RUD/001-PROG.112

15 November 1988

ENGLISH ONLY

INFORMATION BULLETIN NO. 1

This is the first of a series of information bulletins which will be issued between now and the convening of the Workshop.

1. Background information

It is estimated that approximately 80% of all illnesses in the world are due to unsafe or insufficient water supplies and sanitation and about 25 000 people die daily because adequate safe drinking-water is not available. Epidemiological studies indicate that unsafe water is the major cause of waterborne diseases, such as cholera, typhoid, paratyphoid, diarrhoea and hepatitis. Many chronic heart and kidney problems are associated with the long-term consumption of water of poor chemical quality.

The United Nations, in recognition of these problems, inaugurated the International Drinking-Water Supply and Sanitation Decade (Decade) programme (1981-1990) on 10 November 1980 with the goal that all people should have access to safe drinking water and adequate sanitation by 1990. WHO considers water supply and sanitation a very important component of primary health care; their availability is necessary for the achievement of the goal of "Health for All by the Year 2000" envisaged by WHO.

Since the inauguration of the Decade programme, many countries have made special efforts to construct safe water supply systems. Yet, statistics have shown that the incidence of waterborne-related illnesses is very high. While a water supply system may be considered to be initially safe, there are many factors which may render the water unsafe during its operation. It is therefore imperative that the water quality of a system be safeguarded at all times for the benefit of the consumers.

Drinking-water is considered safe if it is free of harmful micro-organisms and contains chemicals in concentrations which are not harmful to the consumers. To have assurance of continuing good quality drinking-water, an effective water quality monitoring and surveillance programme must be instituted and rigorously carried out in a system. Such a programme should involve regular sampling of water supplies for determination of its physical, chemical and bacteriological quality and the institution of measures when necessary to protect its safe quality.

The Regional Committee of the Western Pacific, at its thirty-fifth session, recognizing the importance of safe drinking-water, has requested the Regional Director to cooperate with Member States in the development of national programmes for monitoring, surveillance and control of drinking-water supplies to ensure their safe use (Resolution WPR/RC35.R15). In connection with this Resolution, PEPAS was directed to intensify its support for promoting national Decade programmes in Member States. This workshop is formulated as part of the response to the directive of the Regional Committee to assure consumers of safe drinking-water supplies.

2. Objectives

The objectives of the workshop are:

(a) to provide a forum for the exchange of information and views on drinking-water quality monitoring and surveillance in the countries or areas of the Region;

(b) to review and evaluate problems and constraints associated with drinking-water quality monitoring and surveillance and the potential health hazards associated with the consumption of unsafe drinking-water;

(c) to familiarize the participants with the methods and procedures of drinking-water quality monitoring and surveillance (and its health implications);

(d) to promote the institution of an effective drinking-water quality monitoring and surveillance programme in the development of national water supply projects; and

(e) to develop a step-by-step workplan and methodologies for implementing national programmes for water quality monitoring and surveillance, particularly for small communities.

3. Duration, dates and site

Five working days, from 27 February to 3 March 1989, at PEPAS, Kuala Lumpur, Malaysia

4. Working hours

Working hours for the workshop will be as follows:

Monday through Friday	Working session	0900 - 1030
	Coffee break	1030 - 1045
	Working session	1045 - 1215
	Lunch break	1215 - 1345
	Working session	1345 - 1515
	Tea break	1515 - 1530
	Working session	1530 - 1700

PEPAS office hours

Monday to Friday	Working hours	0830 - 1700
	Lunch	1200 - 1230

Government office hours

Monday to Thursday	Working hours	0800 - 1615
	Lunch	1245 - 1400
Friday	Working hours	0800 - 1615
	Lunch	1215 - 1445
Saturday	Working hours	0800 - 1245

Banking hours

Monday to Friday	1000 - 1500
Saturday	0930 - 1130

5. Working language

The working language of the meeting will be English. No translation facilities will be made available.

6. Travel of participants

WHO is responsible for the cost of economy or excursion class air travel by the most direct route, for participants from their place of residence to Kuala Lumpur and return by the first available flight after the closure of the workshop. Participants will receive information regarding the name and address of the airline to be contacted for their tickets. They will receive their daily allowance from the WHO Regional Office before departure or from PEPAS on arrival in Kuala Lumpur. All participants should see that their return reservations are confirmed before leaving their country for Kuala Lumpur. PEPAS will provide assistance for reconfirmation if required.

7. Daily allowance

Participants will be paid a daily subsistence allowance partly in Malaysian Ringgit and partly in US$ travellers cheques for the duration of the meeting including travel time. WHO accepts no responsibility for payment of hotel bills, meals, taxis or any other financial commitments and all personal liabilities should be settled direct by the participants.

Participants from Malaysia residing within commuting distance of the venue of the workshop will be paid one-third of the daily allowance rate.

8. Visas

Overseas participants should obtain an entry visa at the nearest Malaysian Embassy in their respective countries prior to arrival in Malaysia to cover the period of stay in Kuala Lumpur.

9. Insurance

WHO does not provide insurance cover for participants or their belongings and participants are expected to make their own arrangements for accident, illness and luggage insurance if so desired.

10. Currency

The monetary unit in Malaysia is the Malaysian Ringgit (Mal $). The WHO's present official rate of exchange is US$1 to Mal$2.57. There is no restriction on the export and import of foreign currency notes nor on the import and export of other forms of payment instruments such as travellers cheques and cashiers' orders.

11. Cashing of cheques

Travellers cheques can be cashed at Bank Bumiputra within the University campus or any bank convenient to participants. Local cheques can be cashed at the Bank of America (next to the Hilton Hotel) or at the Holiday Inn On the Park, where special arrangements have been made.

12. Accommodation

All overseas participants, representatives and observers have been booked in the Holiday Inn On the Park which is located at Jalan Pinang, Kuala Lumpur. The daily charges for rooms are approximately:

Single - Mal$70 (nett)
Double - Mal$80 (nett)

These are exceptionally favourable rates given only to WHO-sponsored guests. All rooms are air-conditioned and equipped with TV and refrigerator. Participants should inform PEPAS as soon as possible of their requirements.

Please note that there are two Holiday Inns in Kuala Lumpur. Please specify Holiday Inn On the Park when taking a taxi.

13. Transportation

Arrangements have been made to transport participants daily from the Holiday Inn on the Park to the University campus and back during the period of the workshop. PEPAS will not be responsible for transporting any participant who does not register at the Holiday Inn On the Park.

14. Arrival reception

Participants will not be met at the airport but are requested to take a taxi to the Holiday Inn On the Park. A voucher should be bought from the booth outside the arrival hall of the airport. The taxi fare is about Mal$15 (non air-conditioned) or Mal$20 (air-conditioned).

15. Communications

Postal address: World Health Organization
Western Pacific Regional Centre for the Promotion of Environmental Planning and Applied Studies (PEPAS)
c/o P O Box 12550
50782 Kuala Lumpur
Malaysia

Tel:	9480311, 9480312, 9480861
Fascimile:	(603) 9482349
Telex no:	WHO MA 31064
Cable address:	UNISANTE KUALALUMPUR

16. Climate

In general, the climate shows no great change in temperature throughout the year and ranges from an average minimum of 21°C to an average maximum of 32°C. The relative humidity is high. The days are hot and somewhat uncomfortable because of the high humidity. Rain may be expected anytime throughout the year.

17. Luncheon and coffee breaks

Arrangements for lunch have been made with the University caterer. Tea/coffee will also be served during coffee breaks between sessions. The nominal cost for lunch is about Mal$7.50 per person per day and the amount will be deducted from the payment of per diem. If you have dietary restrictions please inform us as soon as possible.

18. Dress

On the first day, you are requested to wear a lounge suit or long sleeved batik shirt. A group photograph will be taken on the first morning. On subsequent days, dress will be informal.

19. Country reports

Guidelines for preparation of country reports have been sent to all participants.

20. Background material

The receptionist at the Holiday Inn on the Park will hand you a file containing background information. Please bring with you to Kuala Lumpur any material which has been sent to you in advance of your travel.

Note for representatives/observers

Please note that the information contained in Sections on travel, daily allowance and country reports is not applicable to representatives/observers attending the workshop. They are required to make their own arrangements for travel and payment of daily allowance.

Participants	Designation and address
16. Mr Elison Sese Bovu	Senior Environmental Health Officer Environmental Health Section Health Department P.O. Box 207, Port Vila Vanuatu
17. Dr Hoang Thi Nghia	Head, Laboratory of Water Hygiene National Institute of Hygiene and Epidemiology 1 Yersin Street, Hanoi Viet Nam
18. Mr Ainini Tiumalu	Health Inspector Public Health Division Health Department Apia, Western Samoa

Representatives

1. Mr Ranjith Wirasinha	Asian Development Bank, Philippines
2. Mr T. K. Tjiook	International Reference Centre for Community Water Supply and Sanitation, The Netherlands
3. Mr Mohd Pauzi Zakaria	Department of Environmental Sciences, University Pertanian Malaysia, Serdang, Selangor, Malaysia

Secretariat

1. Dr Paul Guo	Acting Director/Water Quality Management Adviser, PEPAS
2. Dr Keith Bentley	Chemical Safety Adviser, PEPAS
3. Dr Bruce Fisher	Decade Engineer, PEPAS
4. Dr Hishashi Ogawa	Environmental Systems Engineer, PEPAS
5. Mr J. Hazbun	Technical Officer, WHO, Vila
6. *Dr Barry Lloyd	WHO Consultant
7. **Dr Yosumoto Magara	WHO Consultant
8. Mr Satya Sardana	Administrative Officer, PEPAS
9. Ms Tan Yit May	Special Assistant, PEPAS

Guest lecturers

1.	Dr Saleha Abdul Aziz	Universiti Pertanian Malaysia
2.	Dr Chen Changjie	People's Republic of China
3.	Ir Mukundan Sugunan Pillay	Malaysia

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* Dr B. Lloyd
Head of Environmental Health Unit
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** Dr Y. Magara
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REGIONAL WORKSHOP ON DRINKING WATER QUALITY MONITORING & SURVEILLANCE

Kuala Lumpur, Malaysia
27 February - 3 March 1989

ICP/RUD/001-PROG.112

24 February 1989

ENGLISH ONLY

INFORMATION BULLETIN NO. 2

	Participants	Designation and address
1.	Dr Chen Changjie	Director Institute of Environmental Health Monitoring 29 Nan Wei Road Beijing 100050 People's Republic of China
2.	Dr Geng Jingzhong	Deputy Director Environment Health & Radiation Division Sanitary & Antiepidemic Department Ministry of Public Health Hou-Hai, Beijing People's Republic of China
3.	Mr Uraia N. Lesu	Chief Health Inspector Ministry of Health Box 2223 Suva, Fiji
4.	Dr Yang Soo Lee	Junior Sanitary Official c/o Public Health & Sanitation 31 Taepyung-ro 1 ga Chung-gu, Seoul Republic of Korea
5.	Dr Nouantha Manipousay	Water Decade Secretariat Vientiane Laos
6.	Mr Oth Keomanivong	Water Supply Services of Vientiane (Nam Papa) Vientiane Laos
7.	Mr Mukundan Sugunan Pillay	Chief Public Health Engineer Engineering Division, Ministry of Health Jalan Dungun, Block E 50490 Kuala Lumpur Malaysia

	Participants	Designation and address
8.	Mr Foo Seng Chow	Chemist Selangor Water Works Department Jalan Pantai Baru 59990 Kuala Lumpur Malaysia
9.	Mr Jose Xavier	Safe Drinking Water Specialist Environmental Protection Agency P.O. Box 178 Kolonia, Yap Federated States of Micronesia 96943
10.	Mr Lucio Abraham	Assistant Executive Officer Palau Environmental Quality Protection Board P.O. Box 1144 Koror Palau 96940
11.	Mr Kaoga Galowa	Senior Health Inspector Health Department P.O. Box 3991, Boroko Papua New Guinea
12.	Ms Eleonor G. Corpuz	Senior Sanitary Engineer Regional Health Office No. XI Bajada, Davao City Philippines
13.	Mr Samuel Kafukese	Health Inspector Ministry of Health & Medical Services P.O. Box 349 Honiara Solomon Islands
14.	Mr Lelea Tuitupou	Health Inspector Public Health Division P.O.Box 59, Ministry of Health Nuku' alofa Tonga
15.	Mr Filipe Fatongia Koloi	Manager-Engineer Ministry of Health P.O. Box 59 Nuku'alofa Tonga

WORLD HEALTH ORGANIZATION

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ENVIRONMENTAL PLANNING AND APPLIED STUDIES (PEPAS)

REGIONAL WORKSHOP ON DRINKING WATER
QUALITY MONITORING AND SURVEILLANCE

ICP/RUD/001-PROG.112

Kuala Lumpur, Malaysia
27 February - 3 March 1989

ENGLISH ONLY

THE INTERNATIONAL DRINKING WATER SUPPLY AND SANITATION DECADE IN THE WESTERN PACIFIC REGION

by

Mr B. W. M. Fisher
WHO Decade Engineer

1. ORIGINS AND HISTORY OF THE DECADE

The first record of the Decade concept was made at the Habitat Conference in Vancouver, Canada in1976 where it was suggested that a special effort should be made to get clean water and adequate sanitation to all by 1990. This was subsequently supported at the United Nations Water Conference in Mar del Plata, USSR in 1977 where a suggestion was made that the 1980s be declared "The International Drinking Water Supply and Sanitation Decade".

The Economic and Social Council of the United Nations formed a resolution on 4 August 1977 accepting the Report of the Water Conference in Mar del Plata, and declared 1981-1990 as the International Drinking Water Supply and Sanitation Decade. The Decade was formally launched by the General Assembly of the United Nations through a special one-day meeting on 10 November 1980.

UNDP was designated as the coordinating agency and WHO through its Global Strategy of Health for All as the technical lead agency.

The Proclamation of the Decade primarily called upon Member States to assume a commitment to bring about a substantial improvement in the standards and levels of services in water supply and sanitation by the year 1990. It called upon governments to develop the necessary policies and set the targets to this end, and to take all appropriate steps to achieve these targets. It also called upon governments, organizations and United Nations agencies to continue and where possible, increase technical and financial cooperation with developing countries in order to enable countries to achieve their targets.

Recognizing that existing programmes and policies had serious shortcomings, WHO developed the following Decade guidelines for establishing national strategies and for planning and designing appropriate programmes:

(1) Development of complementary programmes for sanitation and water supply;

(2) Development (use) of strategies that stress the coverage of the underserved populations, both rural and urban;

(3) Generation of replicable, self-reliant and self-sustaining programmes;

(4) Use of socially relevant appropriate technology that is affordable;

(5) Community participation at all stages of project development, implementation and operation;

(6) Linkage of water supply and sanitation with other health improvements;

(7) Establishment of close relation between water supply and sanitation projects and programmes and other sectors, as a basis for community development.

2. PRESENT SITUATION

2.1 General

At the outset of the International Drinking Water Supply and Sanitation Decade, WHO assumed the responsibility for monitoring it's implementation and for reporting on other Decade developments.

The main method of obtaining the basic information required is through forms called Country Sector Digests, which were sent to all countries to provide baseline data as at December 1980 and subsequently for updates in December 1983 and December 1985. The forms not only include coverage levels and targets of water supply and sanitation, but also, data on ranking of constraints, programme costs, manpower, etc.

The global baseline data which is summarized in the WHO Offset publication no. 85 was compiled from only 87 out of about 140 possible countries. In the Western Pacific Region, the countries who did not contribute data comprised the People's Republic of China and several smaller Pacific Island countries where difficulties were understandable because of the relative remoteness of parts of China and some of these small island communities.

The coverage figures for water supply are intended to be for safe water supplies. This includes treated surface waters and untreated but uncontaminated waters such as from protected springs, boreholes and sanitary wells. In practice, however, the figures often include water supplies that are subject to pollution in rural areas. This is a reasonable compromise in some instances where treatment would not be feasible or justifiable at the present stage of the country's water supply programme. To classify a water supply as safe also implies that the water quality is monitored at least by sanitary surveys if not by regular water sampling. An increasing number of water supplies in the region are becoming more subject to pollution because of population growth and industrial development extending habitation into water catchment areas.

2.2 Coverage data for the Western Pacific Region

As the Region comprises 35 countries or areas of great diversity in terms of population, geographical area, socio-economic development and per capita income, a regional summary and review becomes more meaningful if Member States with common features are grouped and analysed together. Six groups of countries or areas and one distinctly different Member State (China) are listed in Tables I and II with water supply and sanitation service levels for the beginning of the Decade and for the end of 1987.

Group A comprises the highly developed countries of Australia, Japan and New Zealand where water supply and sanitation baselines are provided to cover more than 90% of the population. The technology is usually of a high level, giving excellent standards of service. In Group B, the

TABLE I: WATER SUPPLY SERVICE LEVELS
Western Pacific Region
(December 1981 - December 1987)

GROUPS (see below)	POPULATION (x 1 000)		% SERVED WATER SUPPLY			
			1981		1987	
	1981	1987	Urban	Rural	Urban	Rural
A	135 710	141 230	99	99	99	99
B	102 670	116 930	68	50	81	64
C	1 258	1 484	90	68	92	68
D	3 510	4 092	62	11	82	21
E	3 810	3 796	60	8	60	14
F	7 920	8 500	95	95	95	95
China	1 007 760	N.A.	85	30	95	50

Group A - Australia, Japan, New Zealand
Group B - Malaysia, Philippines, Republic of Korea
Group C - American Samoa, Cook Islands, Fiji, French Polynesia, Guam, Kiribati, (Nauru), Niue, (Tokelau), Trust Territory of the Pacific Islands, Tuvalu, Tonga, Samoa, (Wallis and Futuna)
Group D - New Caledonia, Papua New Guinea, Solomon Islands, Vanuatu
Group E - Lao People's Democratic Republic, (Viet Nam)
Group F - (Brunei Darussalam), Hong Kong, Macao, Singapore
China - Listed separately

Note: - The countries/areas in parenthesis are not included in the above table since some data are not available.
- For Group F, there is no rural population in Singapore
N.A. - Not available

TABLE II: SANITATION SERVICE LEVELS
Western Pacific Region
(December 1981 - December 1987)

GROUPS (see below)	POPULATION (x 1 000)		% SERVED SANITATION			
			1981		1987	
	1981	1987	Urban	Rural	Urban	Rural
A	135 710	141 230	99	99	99	99
B	102 670	116 930	72	61	91	71
C	1 258	1 484	69	65	91	71
D	3 510	4 092	96	5	84	32
E	3 810	3 796	10	2	10	4
F	7 920	8 500	95	80	95	80
China	1 007 760	N.A.	90	90	95	N.A.

Group A - Australia, Japan, New Zealand
Group B - Malaysia, Philippines, Republic of Korea
Group C - American Samoa, Cook Islands, Fiji, French Polynesia, Guam, Kiribati, (Nauru), Niue, (Tokelau), Trust Territory of the Pacific Islands, Tuvalu, Tonga, Samoa, (Wallis and Futuna)
Group D - New Caledonia, Papua New Guinea, Solomon Islands, Vanuatu
Group E - Lao People's Democratic Republic, (Viet Nam)
Group F - (Brunei Darussalam), Hong Kong, Macao, Singapore
China - Listed separately

Note: - The countries/areas in parenthesis are not included in the above table since some data are not available.
- For Group F, there is no rural population in Singapore
N.A. - Not available

countries of Malaysia, Philippines and the Republic of Korea represent the more advanced developing countries. All three have attained high levels of water supply and sanitation services in their urban centres and their rural programmes have been successfully enlarged in recent years.

The South Pacific islands consist of two groups. Group C, which is made up of the smaller islands, has realized consistent progress in its water supply and sanitation programmes over the last two decades. For example, both Cook Islands and Tonga will achieve 100% coverage by 1990.

Islands such as French Polynesia, Guam, New Caledonia and the Trust Territory of the Pacific Islands are also expected to achieve their targets of full coverage. However, in some areas of some of the island communities, operation and maintenance problems are causing a reversal in coverage trends.

The remaining group of South Pacific island communities (Group D) is composed of Papua New Guinea, Solomon Islands and Vanuatu. These countries are showing good improvement in coverage levels although the figures are distorted in some cases by improved sources of data.

The water supply and sanitation programmes of the Lao People's Democratic Republic and the Socialist Republic of Viet Nam in Group E have only become operational in recent years and detailed information is quite difficult to obtain in some cases. Both countries are keen to enlarge the services and considerable improvement in the future is expected.

The last group consists of Brunei Darussalam, Hong Kong, Macao and Singapore (Group F). Although high levels of water and sewage services have already been provided to their dense urban populations, there are serious problems caused by shortage of available water resources. These countries have good chances of meeting Decade goals of complete coverage by adequate facilities.

China is listed separately from other countries because of its extremely large population of over 1 billion. A National Action Committee has been designated (Office of the National Patriotic Health Campaign Committee) and the Government is giving strong support to Decade activities. To gain an accurate picture of levels of water supply and sanitation coverage is obviously a major task and the figures given would contain estimated numbers only in many areas. Obviously, it would be misleading to give overall totals for the Western Pacific Region as the results would be heavily weighted in respect to whatever figures were adopted for China.

The overall picture in the Region excluding China compared with the global situation is given in Table III. It is observed that progress in the Region has been quite good though there is plenty of scope for renewed efforts in the last years of the Decade.

2.3 Other Decade information

One of the main items in the Decade Proclamation is the call on

TABLE III: WESTERN PACIFIC REGION AND GLOBAL PROGRESS IN FIRST HALF OF THE DECADE

	Urban Water supply 1981/1985 Percent coverage	Urban Sanitation 1981/1985 Percent coverage	Rural Water supply 1981/1985 Percent coverage	Rural Sanitation 1981/1985 Percent coverage
Western Pacific Region	71/77	75/92	46/56	55/63
Global	72/77	54/60	32/36	14/16

Figures exclude Australia, China, Japan and New Zealand governments to set Decade targets, and several countries in the Region, not including the industrialized countries, have not only set targets but revised them from time to time in the light of their progress. A summary of the countries and targets in the Western Pacific Region is given in Table IV. The targets of several countries are proving to be a little optimistic but hopefully this will continue to encourage greater efforts in the future.

The ranking of major sector constraints has also been obtained from most of the developing countries in the Region. As would be expected, funding limitations and insufficiency of professional and sub-professional staff have usually received the highest ratings in the country returns. Poor operation and maintenance of water supply and sanitation facilities and inadequate cost recovery frameworks are ranked next. Inappropriate technology is not now rated a major constraint in the Region probably reflecting the large amount of research and training that has been carried out during the Decade. However, that there may be still room for improvement is evident from the cost figures obtained for the provision of water supply and sanitation services. Some of the higher costs per person served are due to a high standard of service being provided or a higher cost structure but it is likely that in some cases, cheaper technologies could be used that would be equally effective. High costs may also be a result of inadequate involvement of communities though most countries show high percentages of communities with active participation in the programmes.

Examples of problems observed in Pacific Island countries in achieving Decade aims are many and cover a wide variety. A few of them are given as follows:

(1) Inappropriate technology

a. Inappropriate construction of latrine slabs
b. Provision of communal village latrines
c. Inappropriate design of pedestal latrines allied with unsuitable cleansing materials available
d. Spring loaded taps not accepted by community
e. Inappropriate water quality testing equipment
f. Inappropriate design of water tanks
g. Incorrect use of pipes and fittings
h. Incorrect siting of wells in relation to latrines
i. Inadequate water supply for pour flush latrines

(2) Institutional development

a. No provision for supply of spare parts
b. No provision for cost recovery from consumers in village schemes.
c. No enforcement of urban rate collection
d. No co-ordination between agencies working in the sector
e. No provision for maintenance staff

TABLE IV WESTERN PACIFIC REGION - COUNTRY TARGETS IN PERCENTAGES

Country	Urban		Rural	
	Water	Sanitation	Water	Sanitation
American Samoa	100	100	-	-
China	100	-	80	-
Cook Islands	100	100	100	95
Fiji	100	100	-	-
Kiribati	100	100	100	100
Laos	-	-	-	-
Malaysia	100	100	75	100
Nauru	-	-	-	-
Papua New Guinea	92	70	30	50
Philippines	80	90	75	60
Korea	97	-	-	-
Samoa	100	100	80	80
Solomon Islands	100	100	70	70
Tonga	100	100	100	100
Tuvalu	100	100	100	100
Vanuatu	100	100	100	65

Note: Some countries particulary industrialized countries have no Decade targets. Source - Sector digests and country reports.

(3) Community education and participation

a. No consultation with community on choice of design
b. Insufficient community education on use of installations
c. Insufficient assistance from village in construction of supplies resulting in a lack of responsibility toward the completed work
d. Insufficient help given to the community by design and construction agencies

(4) Human resource development

a. Insufficient community training
b. Insufficient technical staff
c. Lack of plans and budget for provision of staff training
d. Lack of hygiene education

As workshop participants will be given an opportunity to present their country reports later on, I shall only give a few general remarks about the status of drinking water quality in this region. The treatment and quality of urban water supplies are generally adequate in all countries of the Region apart from the least developed ones where often the basic needs are supplies and equipment. Apia in Western Samoa has just completed the commissioning of full water treatment facilities for this capital city. The Decade returns show that nearly all rural supplies do not have quality surveillance undertaken on a routine basis. Some countries have obtained membrane filter field kits for bacteriological examination but in keeping with the experience in other parts of the world, these have usually quickly been discarded from use if indeed they have been used at all.

As previously indicated, the coverage figures given for rural water supplies often include supplies of water that cannot be described as safe. Tests in the Philippines have shown that handpumped supplies are often polluted, and untreated surface waters and open wells are virtually always polluted to some extent. In the countrywide tests carried out in the Philippines, the use of a simple test based on the detection of hydrogen sulphide producing organisms has shown good agreement with other methods and indicated that over 80% of the rural schemes had some pollution at that time.

3. CONCLUSION

It is apparent that Decade activities will have to extend beyond the Decade. It should be possible to extend the emphasis on water supply and sanitation with revised targets into the next decade to ensure that the provision of safe water and adequate sanitation presents no barrier in the march toward "Health for all by the year 2000".

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QUALITY MONITORING AND SURVEILLANCE

ICP/RUD/001-PROG.112

Kuala Lumpur, Malaysia
27 February - 3 March 1989

ENGLISH ONLY

CHEMICAL AND PHYSICAL ASPECTS OF WATER QUALITY MONITORING

by

Dr Y. Magara

Chemical and Physical Aspects of Water Quality Monitoring.

Yasumoto Magara

1. Introduction

Water is utilized for many purposes for domestic consumption (including drinking) as well as for industrial and commercial use. Even for domestic use, water is consumed by such highly-sensitive groups as infants, the elderly, and physically-ill persons not to mention those of us who are in good health. Water, moreover, is utilized without discrimination by the rich and poor. Water is used for many purposes and by many groups, but its overriding consideration is that it should be safe to drink.

There are, however, many impurities in water as shown in Table-1. Drinking water should contain no impurities that cause significant adverse health effects. Such impurities, moreover, should not diminish the availability of water, or its esthetic and organoleptic properties. Impurities should also be monitored to protect facilities against corrosion.

Table 1 Classification of Drinking Water Impurities

	Hazardous	Aesthetic
Non-removable by treatment	Heavy metals:Hg,Cd Pesticides VOCs Synthetic chemicals	Odpurous substances MBAS Phenols Inorganic salts
Originated by Treatment	Organic Chlorides	Inorganic salts
Originated in Distribution	Pipe materials:Pb BaP, Asbestos, etc.	Iron, Manganese, Inorganic salts.

Impurities in drinking water are classified into three types, such as (1) impurities that cannot be removed by the water treatment process, (2) impurities that are added or produced in the water treatment system, and (3) impurities that are picked up in the water distribution system.

For the proper management of drinking water quality, every aspect of a water supply system should be examined, from the water's source to its distribution.

2. Raw water quality

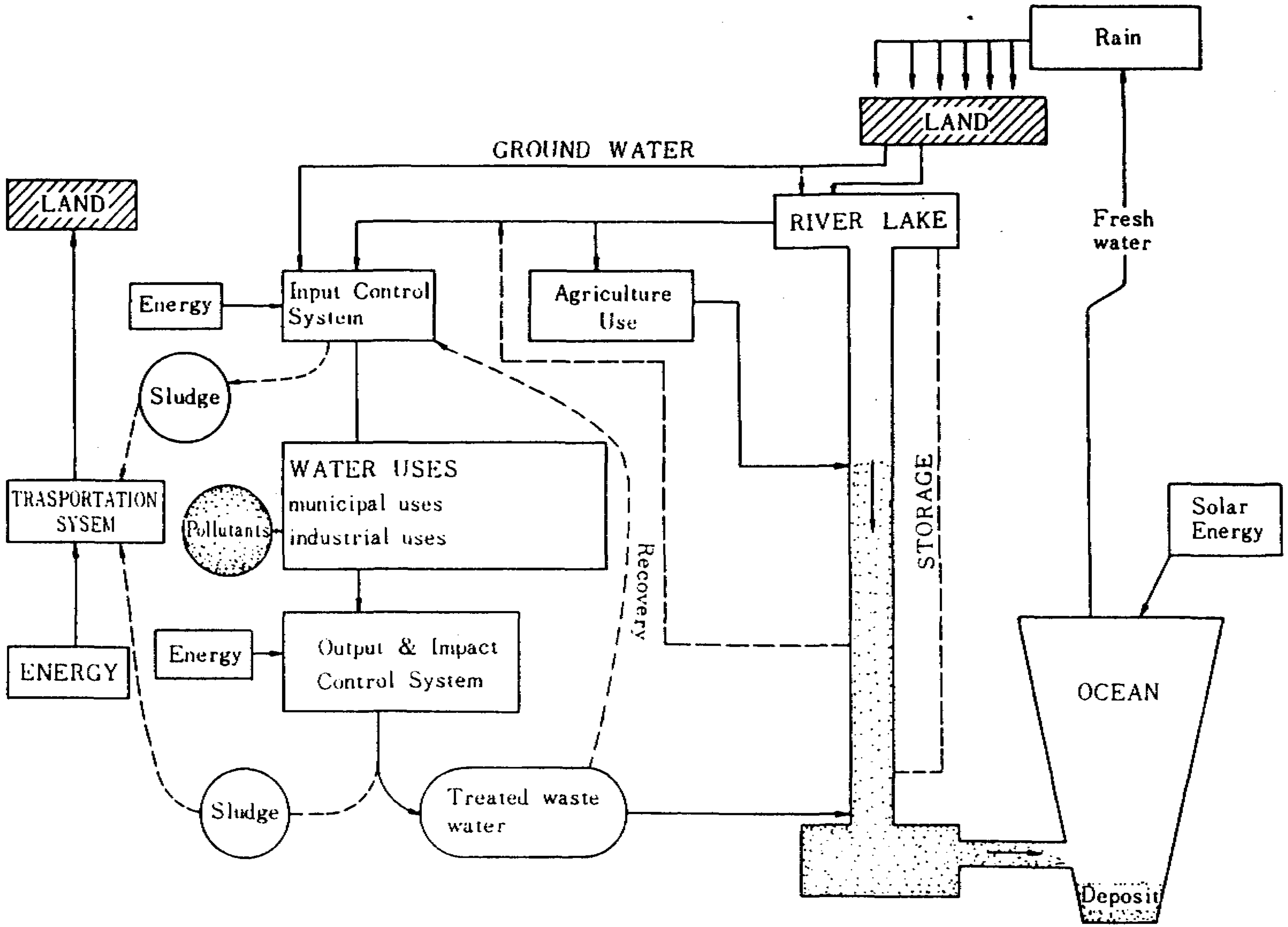
Water in a chemically pure form rarely occurs in nature. Water is commonly found to host a wide variety of constituents, deriving from both the natural and living environments (Figure 1).

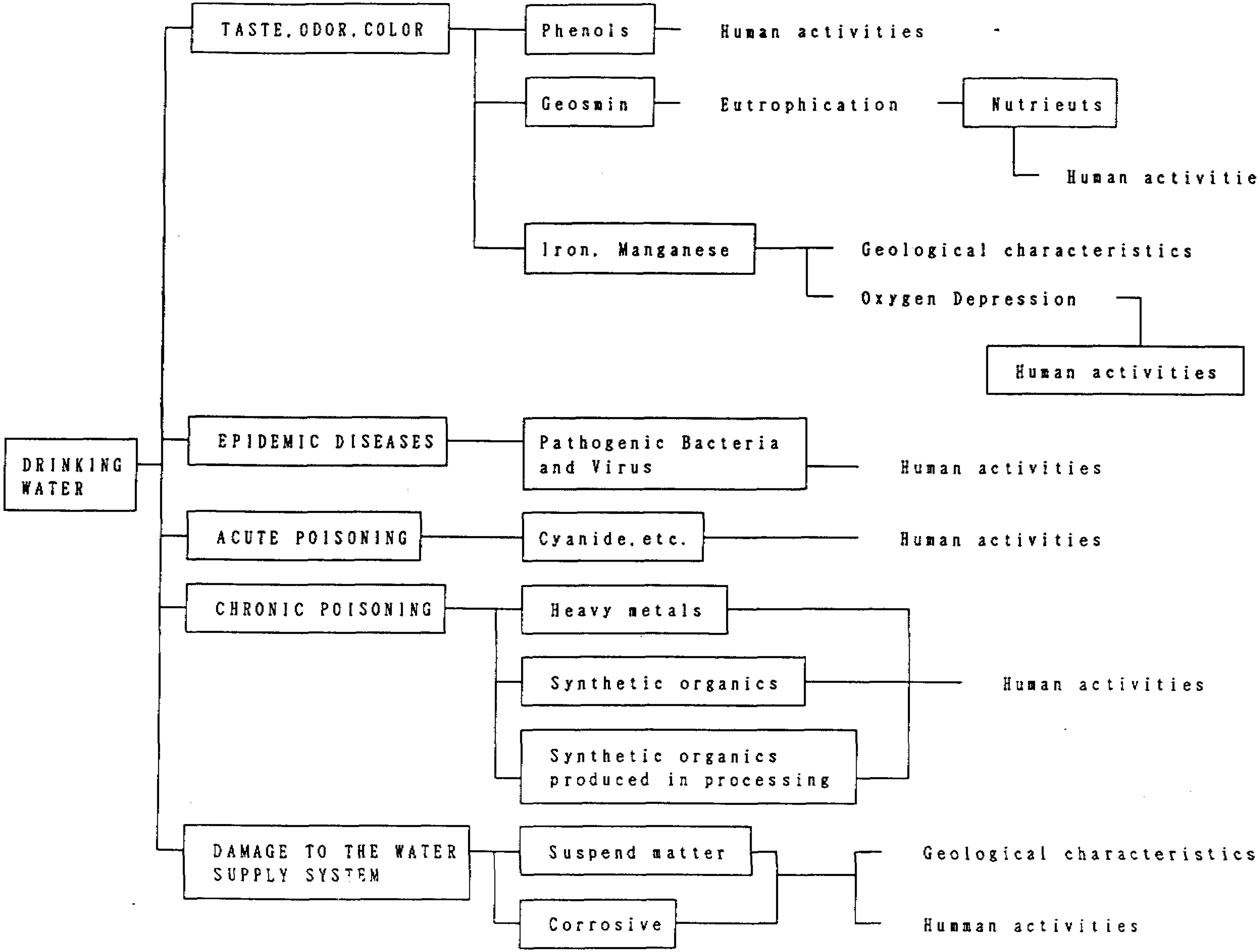
The input control system shown in Figure 1 corresponds to the water treatment system. An impact control system is a man-made system to control the pollutants from the living environment and to measure the impact of the discharge upon the received water. Unless these system are suited to human community activities, such serious problems can result as water shortages, outbreaks of epidemic diseases, and water pollution.

The effects of pollution on water resources are classified into several categories (Table 2), according to their adverse effect on water utilization.

Water itself, however, would not become the means of spreading diseases were it not for its pollution by the excreta of pathogen carriers. A countermeasure to these pathogenic organisms is chlorination. But such disinfection is considerably affected by the amount of reductants in the water such as ammonium nitrogen, and ferric and manganese ions.

Some chemicals contained in industrial and domestic water, surface runoff, or produced in the purification process, may cause acute or chronic poisoning. The evidence of chronic disease resulting from the ingestion of chemicals from tapwater is scarce. The purification process, however, is limited in its ability to


Rain
LAND
GROUND WATER
LAND
RIVER LAKE
Fresh water
Energy
Input Control System
Agriculture Use
Sludge
WATER USES
municipal uses
industrial uses
TRASPORTATION SYSEM
Pollutants
Recovery
STORAGE
Solar Energy
Energy
Output & Impact Control System
ENERGY
OCEAN
Sludge
Treated waste water
Deposit


DRINKING WATER
TASTE, ODOR, COLOR
Phenols
Human activities
Geosmin
Eutrophication
Nutrieuts
Human activities
Iron, Manganese
Geological characteristics
Oxygen Depression
Human activities
EPIDEMIC DISEASES
Pathogenic Bacteria and Virus
Human activities
ACUTE POISONING
Cyanide, etc.
Human activities
CHRONIC POISONING
Heavy metals
Synthetic organics
Synthetic organics produced in processing
Human activities
DAMAGE TO THE WATER SUPPLY SYSTEM
Suspend matter
Corrosive
Geological characteristics
Humman activities

remove a number of hazardous impurities. For this reason, the concentration of these hazardous chemicals in raw water should be less than that of the drinking water quality standard.

The responsibility of waterworks is always to check the mean exposure level. If the mean exposed level is exceeded, the waterworks should request the basin management office to effect an improvement of water quality, and sometimes add auxiliary facilities to the water treatment process.

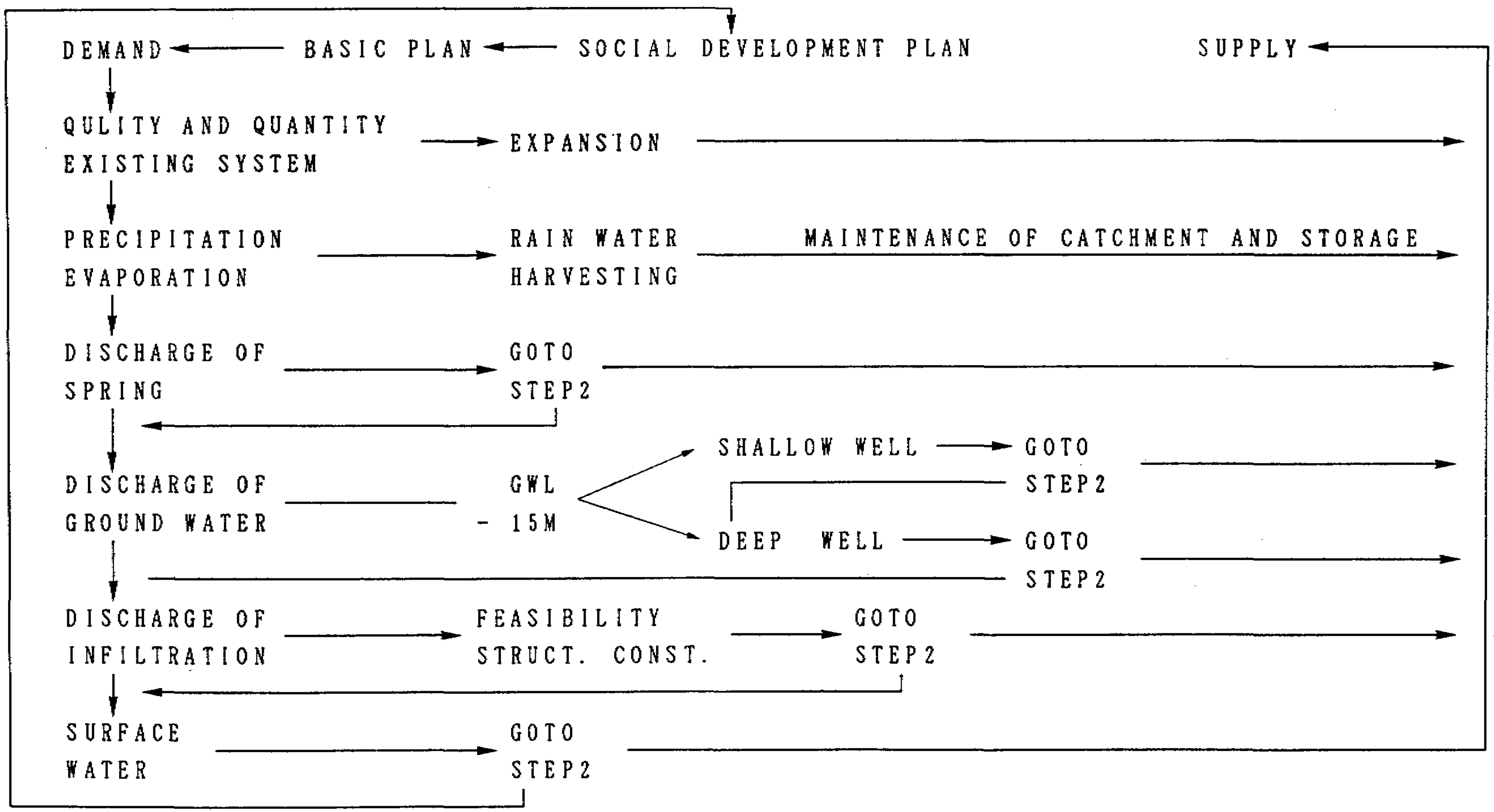
Some chemicals that are accidentally discharged from industry may also cause acute poisoning. It is difficult to predict the incidental occurrence or to prepare countermeasures. Thus, the monitoring of raw water quality using bioassay techniques is the only measure effective against these hazardous chemicals. If the symptoms are observed by a biosensor, water intake should be halted until the polluted water passed downstream.

Water that is unpalatable as a result of taste, odor, or color should not cause any direct health hazard. Consumers will become anxious, however, particularly concerning the safety of unpalatable water. It is characteristic of these problems that they are observed whenever water quality has been degraded by eutrophication of the water source, etc.. In this case, the water purification plant should add an auxiliary unit process, such as adsorption.

Raw water and tapwater should not contain corrosive substances that shorten the life of the facilities. Furthermore, the quality of raw water should be sufficiently high that only low-cost treatment is required.

As shown in Table 2, raw water quality is affected by the geological properties of the catchment area as well as by human activities. The matrix of the pollutants and their sources, and the behavior of the water source are summarized in Table 3. Thus, water quality depends on a large number of hydrological, physical, chemical, and biological factors. Each of these characteristics can be evaluated independently, but a combination of factors must be evaluated in testing the security of the raw water for water supply purposes.

SYSTEM SELECTION CHART STEP1



3. The water treatment system

Water treatment can be defined as technical operations that by combining several treatment processes, fulfill any gaps existing between raw water and purified water. The water purification processes that are applied in drinking water supply are: (1) the separation of impurities from water, (2) increasing and sizing the particles, and (3) the deactivation of microorganisms.

Solid-liquid separation by straining, screening, sedimentation, and filtration are commonly used separation processes in a conventional water purification system. If, however, raw water contains soluble impurities that must be removed, an interphase transfer process such as adsorption ion exchange, aeration, extraction, or electric dialysis--are applied for water purification. The treatability of the solid-liquid separation processes is affected by the size, density, concentration, and physicochemical reactivity of the raw water's discrete particles.

The discrete particles in natural water cannot be effectively removed by a simple solid liquid separation process. Therefore, the physicochemical properties of the discrete particles are arranged to improve their treatability by coagulation and flocculation.

One of the most important water purification processes is the inactivation of microorganisms by disinfection. Chlorination and ozonation are disinfection processes that reduce the potential of infectious diseases borne in drinking water.

The unit process commonly adopted in drinking-water supply is limited in its ability to remove impurities. These limits vary according to the impurities' size, chemical reactivity, concentration, and also from the point of view of economics (Figures 3 and 4).

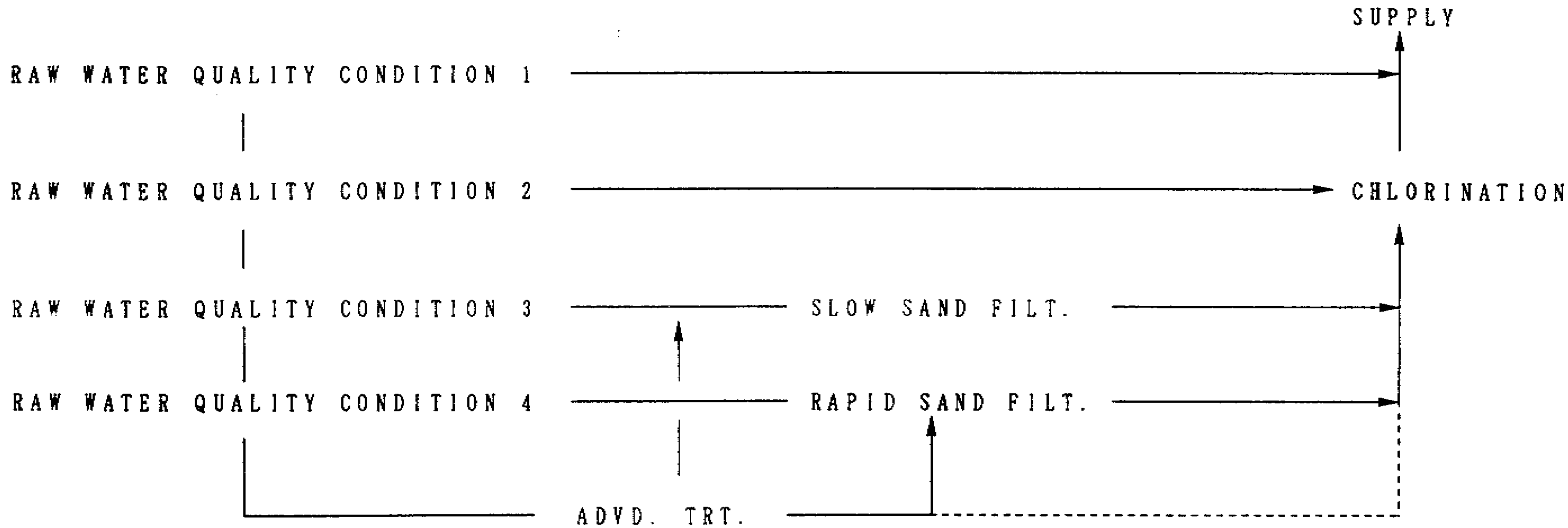
Water purification systems that must fill the gaps between raw water and drinking water quality, function according to the methods diagrammed in Figures 3 through 5. It should be remembered that the unit processes that are common in the drinking-water purification

Table 4.7 Pollutants and their origins

Pollutant / Source	Inorganics						Organics								Organism	
	Sand soil	Fe, Mn	Acid, base	CN	Salt	Heavy metals	Algae, organic particulates	NH_4	MB. AS	Pesticides	Fumic	Taste and odorous substances	Oil	Persitent chemicals	Pathogenic bacteria, virus	Radio-actives
Domestic waste					○		○	○	○		○			△	○	
Industrial waste	○	○	○	○		○	○	○	○			○	○	○		○
Agriculture run-off	○						○	○		○	△					
Barn run-off							○	○			△			△	○	
Mine waste	○	○	○			○										
Construction work	○									△						
Natural pollution	○	△	○		○	○	○				○					○
Other (Accident)	○		○	○	○								○	○		○
Behavior of pollutants																
River	±	(±)				(±)	(±)	(±)	(−)	(−)		(−)			(−)	
Lake and reservoir	−	(±)	+	−		(±)	+	±	−	(−) +		−				
Underground water	−	+	−	(−)		(−)	−	−	(−)			−				

Notes: ○ : main source △ : source + : increase − : decrease

SYSTEM SELECTION CHART STEP2



SYSTEM SELECTION CHART STEP3

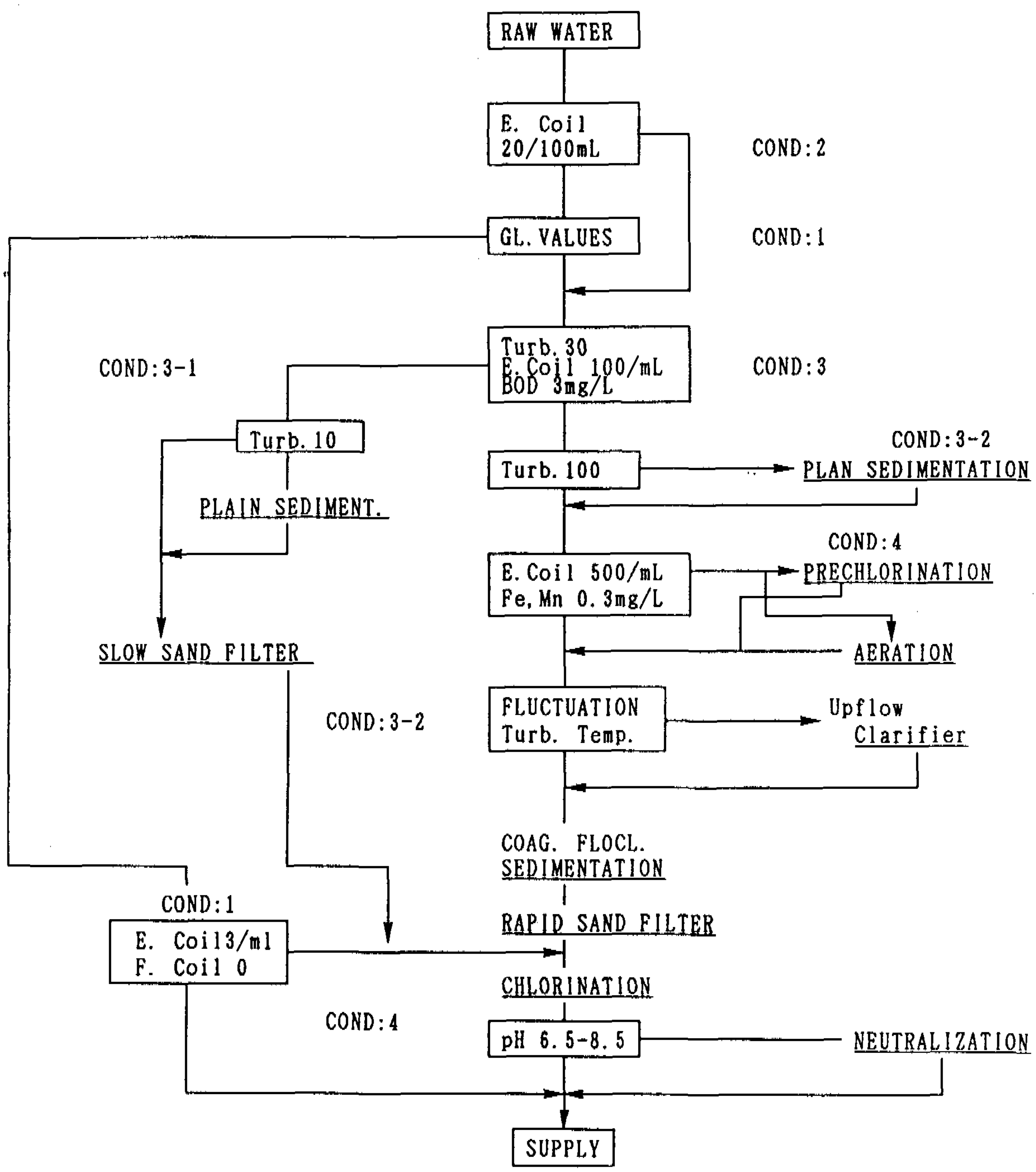


Table ~~4.10~~ 5 Water quality maintenance

	Standard		Action
Fish	When a large amount of dead fish float near the intake mouth.		Emergency stop.
	When fish in monitor tank die for no reason.	A large amount at intake mouth.	Emergency stop.
		Nothing unusual at intake mouth.	Emergency stop.
Observation (by naked eye)	When color or turbidity change suddenly due to unknown reasons.		Emergency stop.
	When odor or taste change suddenly due to unknown reasons.		Emergency stop.
	Oil film on surface		Reinforce monitoring. Stop intake according to situation.
Cyanide Organic Phosphorus Mercury	When detected.		Emergency stop.
Cadmium Lead Chromium Arsenic	over 0.01 ppm over 0.1 ppm over 0.05 ppm over 0.05 ppm		Emergency stop.
pH	Exceeds the 6.5-8.6 range		Stop intake or decrease volume according to situation.
Turbidity	over 3,000 degrees		Stop intake or decrease volume according to situation.
Odor	over TO 300		Stop intake or decrease volume according to situation.
Potassium Permananate Consumption (excluding suspended matter)	over 20 ppm		Stop intake or decrease volume according to situation
BOD	over 10 ppm		Stop intake or decrease volume according to situation.
Electric conductivity	over 400 /cm		Decrease volume when over 350. Stop intake when over 400.

microorganisms. In other words, water purification systems cannot effectively remove soluble contaminants. Therefore, raw water should not contain soluble impurities in amounts that do not accord with drinking-water quality standards.

The selection of a water treatment system is strongly affected by the type of water source. An example of a system selection chart for a small-scale water supply is given in Figure 5.

Rainwater is one of the most attractive water sources where plentiful precipitation can maintain an assured small-scale water supply. It is necessary, however, to educate community residents to maintain sanitary conditions in the rainwater harvesting area, rainwater collection facility, and storage tanks.

It is clear that water quality deteriorates as a result of the existence in the environment of toxic substances that affect springs, groundwater, infiltrated water, and surface water. The costs for the intake and transmission of water are also of the same order as the costs involved in securing water quality. Therefore, intake and transmission considerations should implement the surveillance of quantity and quality of water sources, to select the optimal method for providing the most stable and economical water supply system. Raw water purification systems should be selected from one of the following schemes, such as disinfection, slow sand-filtration-disinfection, and rapid sand filtration-disinfection. An auxiliary treatment process such as neutralization and prechlorination is added to the above treatment system as required.

Many nations' drinking water quality standards are composed according to microbiological aspects,acute and/or chronic poisonings, and aesthetic and organoleptic substances. These countries' conventional water purification systems have been developed to remove turbid substances and to inactivate microorganisms. Therefore, it is unreasonable to anticipate further treatability of the impurities mentioned above. Thus, it should be unacceptable to select raw water that contains concentrations of impurities in levels unacceptable according to drinking-water quality standards. But the efficacy of treatment is relatively high for pH, iron, and manganese. If there is no alternative raw water source, it must be accepted as the water source.

In case of piped water systems, the disinfection process is unavoidable because of the risks of contamination in the distribution system. In a small-scale water supply, however, with community participation to protect the water source and if the raw water contains no fecal bacteria (a fecal coliform count of less than three per 100 ml and a turbidity unit of five or less) water can be supplied directly without any treatment.

Untreated water should implement that which has been disinfected, except in rare instances such as the conditions just mentioned. The over-reliance on disinfection, however, in small-scale water supply sometimes leads to serious outbreaks of pathogenic disease because of insufficient disinfection resulting from misoperation and/or accidental contamination during the water distribution process.

Slow sand filtration should be selected for raw water whose quality is less than 30 turbidity units and 100 for coliform groups. It is common that such raw water is uncontaminated by hazardous pollutants. Even so, the biological oxygen demand (BOD) of raw water should stand at less than 3 mg/l to maintain the sand layer's aerobic, biological, film-filtration function. Changing the sand filter arrangement by scraping the top layer of sand affects the turbidity of raw water. It is recommended, therefore, to apply plain sedimentation prior to filtration when the raw water turbidity exceeds ten turbidity units.

Raw water that contains more then 30 turbidity units should be treated by the conventional coagulation-flocculation-rapid sand filtration system. It is usual for the turbidity of surface water in tropical regions to be extremely high because of the topsoil's high erosion rate and the strong precipitation in the rainy season. Such high turbidity requires treatment entailing the ample use of chemicals, and the management of such a treatment system requires a skilled operator. It is therefore recommended to apply plain sedimentation or a coarse infiltration gallery to diminish the turbidity prior to chemical treatment.

When raw water is heavily contaminated by microorganisms and also contains high volumes of iron and manganese, prechlorination (superchlorination) processing is necessary. But it is better to select another water source that does not require prechlorination because it is difficult to anticipate a stable supply of chlorine and highly skilled operators especially for a small-scale water supply.

4. Chemical and physical aspects of water quality

Water quality monitoring of the flow from the water source to the consumer should be implemented. There are three kinds of water quality monitoring: monitoring at the water source, monitoring at the water purification plant, and monitoring in the distribution system.

4.1 Raw water quality

It is essential to implement raw water quality monitoring to select a proper water source and purification system. Moreover, raw water quality monitoring is necessary to obtain a future perspective of water quality conditions and necessary countermeasures. The principal water quality parameters and their aspects are as follows.

(1) Groundwater

Free carbonic acid: Highly acidic groundwater containing free carbonic acid not only corrodes steel pipes, but it deteriorates concrete structures, mortar-lined pipes, and asbestos cement pipes. The maximum permissible level of free carbonic acid is 20 mg/l.

Iron and manganese: Iron and manganese cause water to turn red or even black. Even if the manganese is in a concentration as small as less than 0.05 mg/l, it accumulates in the pipes over a long period of time and can flush out as a result of a sudden change in the distribution system's flow rate. To prevent this problem, it is necessary to remove the manganese and iron if they exceed 0.1 mg/l or 0.01 mg/l, respectively.

Iron bacteria and sulfur bacteria: An overgrowth of iron bacteria may cause red water, offensive odors, and pipe blockage. It is required periodically to monitor iron bacteria for early detection and to treat the condition, if necessary.
A deep well often emits an offensive odor of hydrogen sulfide and sometimes causes problems as a result of an overgrowth of sulfur bacterial.

Small animals: Shrimp, boat bugs, and water flies live underground and may come through the water tap when there is no filtration process. This phenomenon does not entail a sanitary problem, but some sort of filter should be provided.

Hazardous chemicals: Most groundwater is generally of stable and satisfactory quality. If contaminated, however, groundwater quality is very difficult to restore. For this reason, groundwater cultivation basins are strictly protected from pollution. Hazardous synthetic chemicals such as trichloroethylene produce adverse effects on health by infinite concentrations on the ppb order. It is difficult, however, to monitor such contamination by monitoring general water quality by such factors as temperature, pH, alkalinity, appearance, taste, and odor. Some actual cases in Japan of groundwater pollution by trichloroethylene were brought to light by a change in general water quality.

(2) Lakes and reservoirs

Plankton and algae: Stagnant water provided with sunlight and ample nutrients generally give rise to overgrowths of algae. A situation that causes problems in water purification and diminishes the water's esthetic properties. The effect of algae on water quality and water treatment differ according to the algal species. To resolve this problem, it is periodically necessary--as often as once a week--to monitor the type as well as the number of algae in raw water. The best solution for this problem is to reduce the reservoir's inflow of nutrients. If the reservoir, however, is used exclusively for water supply, the application of copper sulfate to the reservoir is an attractive method.

Iron and manganese: Iron and manganese can cause some water quality problems, as has been mentioned above. In a reservoir's bottom layer and sediments, organic substances in the water consume dissolved oxygen, and then iron and manganese are reduced and dissolved into the water. As preventive measures, selective intake from a superior water quality layer, and aeration to maintain an aerobic condition throughout the reservoir are applied in many waterworks.

Turbidity: The turbidity of reservoir and lake water is rather low because of the sedimentation of turbid substances during long periods of retention. A highly turbid intrusion of water, however, brought about by the density current sometimes reaches the water intake and causes difficulties as a result of the high turbidity of the raw water. The recommended countermeasure is to change the depth of the intake to avoid intaking such a highly turbid reservoir layer.

(3) Rivers

River water quality has a large fluctuation compared with groundwater, lakes, and reservoirs. Therefore, intensive water quality monitoring as well as hydrological monitoring should be implemented to meet requirements.

The monitoring program should be established to be able to observe compliance with established standards and to observe the behavior of specific pollutants in the river basin. Prior to designing a monitoring program, it is essential to gain a comprehensive picture of all the study area's activities that may impact upon water quality. Normally, the general geography of the

[illegible]

Frequency		[illegible]
Daily	Basic parameters	pH, Color, Turbidity, Alkalinity Odor
Monthly	Organic Pollutants Microorganism	Cl^-, $KMnO_4$ [illegible] NO_3, NH_4 SPC, Coli., Plankton
Yearly	Geochemical	DO, Acidity, Ca, Mg, Fe, Mn, Si, K, Na, SO_4, CO_3, HCO_3, PO_4 Total residue
	Hazardous	Cr, Cu, Zn, As, Cd, Se, Hg, Pb, F, Org-Hg, Org-P, PCBs, Phenols, etc.
	Others	BOD

catchment, its geological features, and its hydrology will be sufficiently well known to compile a map of the system in which the physical features likely to influence water quality especially the points of effluents' discharge and withdrawal can be located, and a flow balance attempted.

The location of sampling stations may be divided into two categories: (1) a basic station, and (2) a series of auxiliary stations. The basic station is located at the points of intake to supply information essential for plant operation. The auxiliary stations are established to investigate the effect of pollutants discharged into streams, and to determine the self-purification capacity of streams.

Sampling frequency depends on the purpose of the monitoring, as well as the water quality fluctuation over a period of time. Japan's Waterworks Law designates sampling frequencies for raw water quality evaluation as shown in Table 4.

(4) Water purification plants

Because the water quality aspects relating to slow sand filtration have already been mentioned, the following is a description of the aspects relating to rapid sand filtration.

The most important operation of rapid sand filtration is to destabilize the electrokinematic properties of colloidal and turbid substances in raw water. The application of the proper coagulants is necessary. The coagulant dosage is determined by the turbidity, pH, and alkalinity of raw water. For this reason it is necessary to monitor those parameters frequently--at least once a day. The optimal coagulant dosage is further determined by using the jar test.

The required frequency of the jar test is increased when the turbidity or quality of raw water fluctuates markedly. When the turbidity increases from time to time as a result of floods, etc., it is necessary to measure properly the feeding coagulant. These measurements are taken in accordance with the prepared chart of relationships between such data as daily raw water turbidity, pH, alkalinity, and coagulant dosage. Adjustments are made based on the results of the jar test.

If the rapid filter is improperly managed because of careless filter washing and/or poor coagulation-sedimentation, the turbid substances percolate into the filtrate. The indices for filter operation include the head loss resulting from trapped turbid substances, and the turbidity of the filtrate.

A disinfection process is essential in the rapid sand filtration system. This is because chemical coagulation, sedimentation, and rapid filtration provide no barriers to microorganisms. Chlorine, liquid chlorine, and sodium or calcium hypochlorite are used as disinfectants because they are strong sterilizers, low in cost, and easy to handle. Chlorine is dissociated in the water into hypochlorous acid and hypochlorous ions. Although the dissociation is affected by the pH, both dissociated components react with reductants such as ammonium nitrogen, and their efficiency as a disinfectant is reduced.

To obtain the proper chlorine dosage it is necessary to monitor the water's reductants. Because there are many kinds of reductants in water, the chlorine dosage is usually determined by monitoring the residual chlorine concentration of the fully processed water, along with the chlorine demand.

(5) Tap and/or service water

The final goal for water supply is that the water quality at the point of service should meet the drinking water standard. Even if the water at the outlet of the water purification plant or at the inlet of the distribution system satisfies the drinking-water quality standard, the water at the service point may not. It has probably collected impurities while passing through the water distribution system because of the dissolution of pipe materials. If

the distribution system is not well maintained, microorganisms may have grown, polluted water may have entered into the system, etc.

As a minimum requirement, chlorine must be maintained at every water service point in the distribution area in order to guard against microorganism pollution. Therefore, the residual chlorine concentration should be periodically monitored at the end terminal of the water distribution system.

Consumers evaluate water quality by its appearance, such as the following.

(1) Red and/or blackish water: Red water is caused by iron. When the cause is the incomplete removal of iron and/or iron bacteria from raw water, proper countermeasures at the treatment plant should be taken. When red water is caused by the erosion of iron from the pipes, it is necessary to clean and/or replace the pipes, and improve the water quality by pH adjustment with lime and/or soda to diminish its corrosiveness. The corrosivity of water is a product of

pH, alkalinity, hardness, total residue, and temperature. Accordingly, these water quality parameters should be monitored periodically.

Blackish water is caused by manganese. It is necessary to remove the manganese by prechlorination or by potassium permanganate treatment at the water treatment plant.

(2) Turbid water: White, turbid water is caused by fine air bubbles that are introduced into water by cavitation. The bubbles disappear when water is allowed to stand. It is necessary to check the water pressure and the leakage in the neighborhoods of the service points. White water is also caused by zinc dissolved from galvanized steel pipe.

(3) Blue water: Blue water is caused by copper dissolved from copper piping. It is necessary to improve water quality by a pH adjustment, and to replace the copper piping with another material.

(4) Foreign matter: Turbid substances in fully processed water in the water treatment system, accumulate in the distribution reservoir and main pipes. Accumulated deposits are flushed out and increase the turbidity of the water when a sudden change in hydrological conditions occurs. It is necessary periodically to drain the distribution reservoir and distribution main to prevent this problem.

(5) Microorganisms: Incomplete processing at the water treatment plant and inadequate management of the facilities may cause the generation of earthworms, mosquito larvae, boat bugs, water fleas, and iron bacteria. If these microorganisms appear, it is necessary to improve the water treatment plant management.

5. Raw water quality monitoring and information utilization

When water pollution gradually becomes severe it can be managed, to a certain degree, by conventional methods. Further action must be taken, however, to improve the facilities or to introduce advanced treatment processes such as activated carbon adsorption to anticipate future trends based on the water quality monitoring data.

To cope with the accidental variance of raw water quality, the water supplier should be able to obtain a total and accurate picture. He should be capable of taking appropriate action regarding the water supply, such as discontinuing or reducing the water intake, strengthening monitoring, or reinforcing the water purification process. The action and measures necessary to maintain water quality at a safe level are summarized in Table 5.

WORLD HEALTH ORGANIZATION
WESTERN PACIFIC REGION

ORGANISATION MONDIALE DE LA SANTE
REGION DU PACIFIQUE OCCIDENTAL

REGIONAL CENTRE FOR THE PROMOTION OF
ENVIRONMENTAL PLANNING AND APPLIED STUDIES (PEPAS)

REGIONAL WORKSHOP ON DRINKING WATER
QUALITY MONITORING AND SURVEILLANCE

ICP/RUD/001-PROG.112

Kuala Lumpur, Malaysia
27 February - 3 March 1989

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DESIGN OF DRINKING WATER QUALITY MONITORING NETWORK

by

Dr Y. Magara

Design of Drinking Water Quality Monitoring Network

Yasumoto Magara

1. Introduction

Since the water quality test of drinking water is the essentials of water quality control, it is desirable for each water supply authorities concern to carry out the said test by itself. In medium- and small-sized water supply authorities , however, they would encounter considerable difficulties due to their financial restraints or limited manpower resources in getting fully provided with equipment for water quality tests to be carried out by themselves and ensuring the scientists and engineers of water quality, so that they need to jointly equip themselves with their testing setups.

Its basic idea is to seek to get fully provided with a water quality testing setup, which is embodied by the establishment of Water Quality Control Center to play the central role of water quality control with supplementation furnished by the water quality control setups and maneuver ability of the existing purification plants, etc., so that the control operations on the water quality of raw water,purified water and tap water of all water services in a unit area may be able to be performed, the said unit area being determined so as to cover a water supply population of over about 250,000 from the technical and financial viewpoints.

The operations belonging to water quality control cover planning for water quality control, the collection and analysis of information, periodical and temporary water quality test, qualitative test of chemicals and materials,investigation of water quality accidents, purification process control, research study of water treatment, etc. Generally speaking, however, it would be appropriate that the respective concerns deal with the water quality tests to be conducted always in conformity at individual purification plants as in the case of purified water control, or water collection including the sampling in the extensive supply field and simple water qulity test and that the remaining operations are undertaken by the Center.

In such a case, a unified control setup would probably be desirable taking into consideration the efficiency of water quality control in the community, but if this sort of setup cannot be adopted immediately, it is necessary to work out the well coordinated formation of setup, for example, allowing the existing water control setups to share part of the said setup and so on while ensuring the exchange of opinions among the water supply authorities.

2. Items of Joint Water Quality Test

Water quality control shall be conducted in relation to raw water, water in process of purification and tap water, and the items of test are as specified in Table 1.

In addition, Table 2 is the classification of the items into those to be tested by water service operating concerns by themselves and those to be jointly tested. According to this classification, all of the water quality tests shall be carried out by themselves in the so-called large-scale water supply authorities covering a water supply population of over 250,000, whereas the tests of D level for less than 250,000 and of B and C levels for less than 100,000 shall be carried out on a joint test basis. Since the water quality test of A level covers simple test items as well as daily test items, all the items shall be tested by themselves regardless of the scale of the water supply operation.

3. Contents of Operations and Operating Cost Estimate

Water Quality Control Center undertakes water quality tests, etc. for several water service concerns, the following contents of its operations being conceivable:

(1) Collection and analysis of information for planning water qaulity control;

Table 1 Item and Level in Water Quality Control

Level	Item	Remark
A	pH, colority, turbidity, residual chlorine, taste, odour and alkalinity	Necessary items for daily test
B	Ammonia nitrogen, nitrite nitrogen, nitrate nitrogen, chlorine ion, potassium permanganate consumption, chlorine demand, and free carbonic acid	Necessary items for monthly test
C	General bacteria, E. coli group and other bioassay	Items of bioassay
D	Hardness, total residues, fluorine, cyanogen, hexavalent chromium, manganese, iron, copper, zinc, arsenic, mercury (inorganic), lead, phenols, organic phosphorus, and methylene blue active substance, trihalomethanes	Items falling under requirements
	BOD, suspended matters, organic mercury, PCBs, and cadmium	Items related to wastewater std.
	Alubuminoid nitrogen, sulfate ion, phosphoric acid, silicic acid, sodium, and potassium	Others

Table 2 Joint Water Quality Test Items

	Scale by Water Supply Polulation (000)					
level	500 or more	250 to 500	100 to 250	50 to 100	5 to 50	less than 5
A	o	o	o	o	o	o
B	o	o	o	^	^	^
		self-test			joint test	
C	o	o	o	^	^	^
D	o	o	^	^	^	^

(Note) Raw city water, water in process of purification and tap water should all be subject to the above allotments.

(2) Water quality test and assessment for management of water sources and purification plants (including main distributing pipes);
(3) Water quality test and assessment to confirm the safety of tap water;
(4) Water quality test and assessment of items related to the standards of waste water from purification plant;
(5) Qualitative test of chemicals and materials;
(6) Investigation of water quality accidents; and
(7) Research study of water treatment, etc.

That is to say, Water Quality Control Center performs the central role of water quality control in the concerned area. Although the quality control conducted by large-scale water supply authorities, the Center is required for elaborate control because there are many other small-sized water supply authorities concerns under its control and all the more because it covers many water sources in number and kind as well.

It is considered that there are nationwidely many areas where the aforementioned Water Quality Control Center should be established for water quality control of the entire area. What personnel would be required, approximately how much would be the cost for it, and to what extent the said cost would influence the water supply cost, when Water Quality Control Center was established were estimated for the M area of the Tohoku districts and the S area of the Kyushu districts in Japan.

The test frequencies of the respective test items were determined as in Table 3 based on the provisions of the Water Works Law and the test requirements.

Table 3 Frequency of Water Quality Test Purpose

Level	Raw water	Water in process of purification	Tap water	Waste water standard item
A	Daily	Daily	Daily	Daily
B	Monthly	Monthly	Monthly	Monthly
C	Monthly	Monthly	Monthly	Monthly
D	Annually	Annually	Annually	Annually

Personnel required for the test was divided between the case in which the number of samples was 1 and one in which that was 10 (where the samples made up a mass) and was set up for the respective levels as specified in Table 4 in consideration of the time needed for preparing reagents and testing. In addition, the expenses to be incurred for the respective levels were determined as in Table 5. In calculations, further, reagent cost, equipment cost, charges for utilities and water and the costs of fixtures and supplies per sample were computed and totalled for the individual items of the respective levels. It was decided that the test methods should be subject to the "Ministerial ordinance" or the "Standard Mebliods for Drinking Water Quality Examination," and the lives of machines and instruments and the durable lives of fixtures and supplies were based on the actual values recorded by Y City. Those are refened in Annex.

The number of places of water collection for control of tap water was set up as follows:

Water Supply Population	No. of Places
Less than 5,000	1
5,000 to 50,000	1 per 10,000 prs.
50,000 to 100,000	5 + 1 per 20,000 prs. for population exceeding 50,000
100,000 to 250,000	8 + 1 per 40,000 prs. for population exceeding 100,000

Table 4 Personnel Required for Test

	In case that no. of samples is 1	In case that no. of samples is 10	Unit:
B	(1.29)	2.43	when no. of samples is 1 [prs./1 sample]
C	(0.65)	2.08	when no. of samples is 10 [prs./10 samples]
D	7.37	(14.97)	

(Calculation method: The total of required time for the reagent preparation and testing for each item of each level [actual time recorded by Y City] was divided by the actual working hours per person/day [5 hrs.].)

Table 5 Test Expense per Sample

	Required expense per sample
1 set of B-level items	¥2,000
1 set of C-level items	¥2,600
1 set of D-level items	¥30,000

A. Case of M Area of Tohohuku Districts

Centering on Y City, M area has 7 cities and 7 towns. The number of water service concerns in the area is 5.9, which is broken down as in Table 6.

Table 6 No. of Water Service Concerns, etc. in M Area

Scale by Water Supply Population	No. of Water ~~Services~~ supplies	Annual Water Supply (000 m^3/year)	No. of Places of Required Test for Tap Water
Less than 5,000	47	1,642	47
5,000 to 50,000	11	17,792	29
50,000 to 100,000	0	0	0
100,000 to 250,000	1	18,191	76
	59	37,585	87

a) Number of Samples

The samples which were brought into Water Quality Control Center were counted, resulting in the values as indicated in Table 7.

Table 7 No. of Samples Undergoing Joint
Water Quality Test for M Area

Purpose of Test	Scale by Water Supply Populaion (000)			
	Class	100 - 250	5 - 50	Less than 5
Raw water	B C D	- - 1	132 132 11	564 564 47
Water in process of purification	B C D	- - 1	132 132 11	564 564 47
Tap water	B C D	- - 11	348 348 29	564 564 47
Waste water standard item	D	12	-	-
	Total number of samples B: 2,304 C: 2,304 D: 217			

b) Test Expenses

B: 2,304 x 2,000 = ¥4,608,000

C: 2,304 x 2,600 = ¥5,990,400

D: 217 x 30,000 = ¥6,510,000

Sub-total = ¥17,110,400

(Not including personnel expenses, sample collection and transport expenses)

c) Fixed Number of Required Personnel

B: 2,304 x 1/250 x 2.43/10 = 2.24

C: 2,304 x 1/250 x 2.08/10 = 1.92

D: 217 x 1/250 x 7.37/1 = 6.40

Sub-total 10.56 prs.

Accordingly, the organization of Center is set up as follows:

```
                  Supervisor in charge       Senior     Junior
              ,----of physico-chemistry------staff(3)--staff(6)
              |
              |
Head of       |   Supervisor in charge       Senior     Junior
Center--------+----of biology/bacteriology---staff(1)--staff(1)
              |
              |
              L---------------------Clerk(2)---Chauffeur(1)
```

d) Personnel Expenses

Head of Center	¥7,000,000 x 1 =	¥7,000,000
Supervisor	¥5,000,000 x 2 =	¥10,000,000
Senior staff	¥4,000,000 x 5 =	¥20,000,000
Junior staff	¥2,500,000 x 9 =	¥22,500,000
	Sub-total	¥59,500,000

e) Expenses

Test expenses	¥17,110,400	
Personnel expenses	59,500,000	
Transport expenses, etc.	1,710,000	(1% of test expenses)

f) Unit Cost per m^3 of Water Supply

$$78,252.4/37,585,000=2.08¥/m^3$$

B. Case of S Area of Kyushu Districts

Centering on S City, S area has 2 cities, 12 towns and 4 villages. The number of water service concerns in the area is 51, which is broken down as in Table 8.

a) Number of Samples

The samples which were brought into Center were counted under the conditions as established in the preceding section, resulting in the figures as indicated in Table 9.

Table 8 No. of Water Service Concerns, etc. in S Area

Scale by Water Supply Population	No. of Water Services	Annual Water Supply (000 m^3/year)	No. of Places of Required Test for tap Water
Less than 5,000	44	1,697	44
5,000 to 50,000	6	3,627	13
50,000 to 100,000	0	0	0
100,000 to 250,000	1	12,238	10
	51	17,562	67

Table 9 No. of Samples Undergoing Joint Water Quality Test for S Area

Purpose of Test	Scale by Water Supply Population(000)			
	Class	100 - 250	5 - 50	Less than 5
Raw water	B	-	72	528
	C	-	72	528
	D	1	6	44
Water in process of purification	B	-	72	528
	C	-	72	528
	D	1	6	44
Tap water	B	-	156	528
	C	-	156	528
	D	10	13	44
Waste water standard item	D	12	-	-

Total no. of samples = B: 1,884 C: 1,884 D: 181

b) Test Expenses

B: 1,884 x 2,000 = ¥3,768,000

C: 1,884 x 2,600 = ¥4,898,400

D: 181 x 30,000 = ¥5,430,000

Sub-total ¥14,096,000
(Not including personnel expenses, sample collection and transport expenses)

c) Fixed Number of Required Personnel

B: 1,884 x 1/250 x 2.43/10 = 1.83

C: 1,884 x 1/250 x 2.08/10 = 1.57

D: 181 x 1/250 x 7.37/1 = 5.34

Sub-total 8.74

Accordingly, the organization of Center is set up as follows:

```
                Supervisor in charge     Senior    Junior
            ,----of physico-chemistry-----staff(3)--staff(4)
            |
            |
Head of     |   Supervisor in charge     Senior    Junior
Center------+----of biology/bacteriology--staff(1)--staff(1)
            |
            |
            L-------------------Clerk(2)----Chauffeur(1)
```

d) Personnel Expenses

Head of Center ¥7,000,000 x 1 = ¥7,000,000

Supervisor ¥5,000,000 x 2 = ¥10,000,000

Senior staff ¥4,000,000 x 5 = ¥20,000,000

Junior staff ¥2,500,000 x 7 = ¥17,500,000

Sub-total ¥54,500,000

e) Expenses

Test expenses	¥14,096,000	
Personnel expenses	54,500,000	
Transport expenses, etc.	1,409,000	(1% of test expenses)
Sub-total	¥70,005,000	

f) Unit Cost per m^3 of Water Supply

$$70,005,000/17,562,000=3.98¥/m^3$$

4. Self-testing Setup

(1) Water Supply Authorities Covering Water Supply Population of Less Than 100,000

In the water supply authorities of this scale, the tests of water quality items of B, C and D levels are to be undertaken jointly at Water Quality Control Center, whereas for self-testing the concerns should establish the setup which will permit them to surely conduct the daily test and the like. The realities of self-testing equipment of A level in Japan are not satisfactory in consideration of such percentages as 86% for the scale with population 50,000 to 100,000, 72% for that with 10,000 to 50,000, and 59% for that with less than

10,000. Consequently, the water supply authorities must make efforts to equip themselves with the self-testing setups of A level while maintaining close contacts with Water Quality Control Center.

(2) Water Supply Authorities Covering Water Supply Population of 100,000 to 250,000

The water supply authorities of this scale have been equipped with the setups in which they can undertake the water quality tests of B and C levels by themselves. The realities are accounted for by the rate of equipment holding, such as 83% for B level and 65% for C level, and the concerns should endeavor to get further equipped with self-testing setups as well as play the pivotal role of Water Quality Control Center.

(3) Water Supply Authorities Covering Water Supply Population of Over 250,000

The water supply authorities of this scale have made it a goal to carry out all the water quality tests by themselves. The realities indicate that the rate of equipment holding represents 90% or higher for all of A, B, C and D levels, leading to an evaluation that the self-testing setup has been by and large built up in this segment. The water supply authorities of this scale, however, are required for sophisticated water quality control over the whole water service due to the factors that the water source is divided into several ones because of their operations in large scale and that they are embracing a vast water supply area. These water supply authorities are requested to lead the technological level of drinking water quality control and, dependent upon the area, to take the central position of Water Quality Control Center, standing as the leader of water quality control in the said area.

Anex 1. List of Necessary Expenses for Each Item Water Quality Yens

Water Quality Item	No. of Samples Per Year	Expenses Estimated Per One Sample: Chemicals	Apparatus & Equipt.	Utility	Endurables	Total Estimated Expenses Per One Sample	*1	Remark
Turbidity	5,000	0.08	20.57	4.29	9.51	34.45		
Colourity	5,000	1.32	5.43	3.89	36.44	47.08		
pH Value (Electrode Method)	5,000	14.60	8.67	3.64	3.29	30.20		
pH Value (Amerometric Titrotion Method)	5,000	3.08	6.01	3.93	1.29	14.31	386.70	
Odor	5,000	95.66	1.31	3.85	111.30	212.12		
Taste	5,000	0.00	1.31	3.85	30.36	35.52		
Alkarinity	5,000	0.50	2.43	3.48	6.61	13.02		
Ammonium Nitrogen	250	2.08	132.60	112.90	136.38	383.96		
Nitrous Nitrogen	250	2.13	22.20	67.99	222.75	315.07		
Nitrate Nitrogen	250	15.39	275.43	94.81	226.00	611.63		
Chlorine Ion	250	1.20	48.60	69.64	100.57	220.01	1,999.79	
Potassium Permanganate Consumption	250	2.47	50.28	127.03	140.21	319.99		
Chlorine Demand	250	0.00	24.20	78.51	46.42	149.13		
General Bacteria	250	38.40	387.02	262.06	164.63	852.11	2,649.22	
Coliform Bacteria	250	79.07	232.14	262.06	164.63	737.90		
Total Microoragnisms	250	19.08	527.99	70.18	441.96	1,059.21		
Cyanides	250	15.28	67.56	107.87	729.40	920.11		
Mercury	250	105.95	451.70	77.34	1,984.21	2,619.20		
Organic Phosphrus	250	297.26	58.77	82.31	884.23	1,322.57		
Copper	250	100.10	451.70	77.34	1,433.54	2,062.68		
Lead	250	67.00	451.70	77.34	1,457.54	2,053.58		
Zinc	250	13.00	451.70	77.34	1,433.54	1,975.58		
Fluorine	250	71.07	67.56	107.87	903.49	1,149.99		
Phenols	250	14.26	67.56	107.87	1,069.06	1,258.75		

MBAS (Methylene Blue Active Substancer)	250	115.58	53.06	72.83	585.24	826.71	29,513.03	
Hexavalent Chromium	250	3.67	43.56	72.83	322.40	442.46		
Arsenic	250	115.48	73.08	78.41	641.12	908.09		
Hardness	250	26.42	22.20	65.37	462.19	576.18		
Cadmium	250	66.60	451.70	74.71	1,457.54	2,050.55		
PCBS (Polychlorobiphenyls)	250	99.52	631.70	87.91	2,568.00	3,387.13		
Albuminoid Nitrogen	250	13.13	46.20	100.41	688.68	848.42		
Total Residues	250	0.00	27.91	74.30	1.20	103.41		
Sulfate Ion	250	36.77	69.96	71.85	216.14	394.72		
Phosphate Ion	250	2.86	43.56	70.21	605.40	722.03		
Silic Acid	250	7.23	69.96	71.85	209.00	358.04		
Sodium	250	0.54	568.60	68.49	358.76	996.39		
Potassium	250	1.19	568.60	68.49	358.76	997.04		
B O D (Biochemical Oxygen Demande)	250	19.57	598.20	415.77	574.75	1,608.29		
Suspended Solids (SS)	250	0.00	126.33	65.37	98.00	289.70		
Organic Mercury	250	144.54	631.70	87.91	777.26	1,641.41		

NOTE : Excluding expenses for labor, sampling, and transportation.
*1) Estimated Expenses for One Group of Tests Per One Samples.

2. Expenses for Chemicals

	Name of Chemical	Class	Unit Amount (g or ml)	Price	Price Per 1g or 1ml	Necessary Amount Per Sample(g or ml)	Chemical Expenses Per Sample (Yen)	Chemical Expenses Per Year (Yen)
Turbidity	Kaolin		500	250	0.5			
	Sodium Pyrophosphate	S	500	680	1.4			
	Formalin	S	500	420	0.8			390.00
Colourity	Platinum Sodium Chloride	S	1	2,650	2,650.0			
	Platiunm Cobalt chloride	S	500	1,790	3.6			
	Hydrochloric Acid	S	500	350	0.7			6,605.00
pH Value (Electrode Method)	Phthalate Buffer Solution		500	1,000	2.0			
	Phosphate Buffer Solution		500	1,000	2.0			
	Borate Buffer Solution		500	1,000	2.0			73,000.00
(Colorimetric Method)	BTB Indicator		500	1,250	2.5	0.5	1.25	
	PR Indicator		500	1,250	2.5	0.5	1.25	
	Universal Indicator		100	1,650	16.5	0.5	8.25	3.58
Residual Chlorine (Amperometric Titration Method)	Iodine	S	500	2,450	4.9	0.09	0.441	
	Potassium Iodide	S	500	2,750	5.5	0.06	0.33	
	Phenylarsen Oxide		1	1,200	1,200.0	0.00096	1.152	
	Sodium Hydroxide	S	500	500	1.0	0.02	0.02	
	Chloroform	S	500	840	1.7	0.0023	0.0039	
	Potassium Phosphate, Monobasic	S	500	730	1.5	0.03	0.045	
	Sodium Phosphate, Dibadic	S	500	1,500	3.0	0.04	0.12	
	Sodium Hypochlorite		500	330	0.7	0.0046	0.0032	
	Acetic Acid	S	500	500	1.0	0.51	0.51	
	Sodium Acetate	S	500	920	1.8	0.25	0.45	3.08
(Colorimetric Method)	O-Tolidine hydrochloride		500	3,000	6.0	0.08	0.48	
	Hydrochloric Acid	S	500	350	0.7	0.09	0.063	
	Sodium Phosphate, Dibasic	S	500	1,500	3.0	0.04	0.12	
	Potassium Phosphate, Monobasic	S	500	730	1.5	0.08	0.12	
	Potassium Chromate	S	500	1,930	3.9	0.016	0.0624	
	Potassium Dichromate	S	500	1,340	2.7	0.0055	0.0149	0.86
Odor	Granulated Activated Carbon		500	1,330	2.7			
	Potassium Dichromate (for IND. use)		500	1,070	2.1			
	Sulfuric Acid (for IND. use)		500	430	0.9			478,320.00
Alkalinity (M-Alkalinity)	Methyl Red	S	1	340	340.0	0.000036	0.0122	
	Bromocresol Green	S	1	830	830.0	0.00018	0.1494	
	Ethyl Alcohol	S	500	890	1.8	0.18	0.324	
	Sulfuric Acid	S	500	590	1.2	0.0046	0.0055	
	Sodium Carbonate	S	500	700	1.4	0.0058	0.0081	
	Sodium Thiosulfate	S	500	550	1.1	0.0012	0.0013	0.50
Ammonium Nitrogen	Rochelle Salt	S	500	1,590	3.2	0.3	0.96	
	Mercury (II) Iodide	S	500	11,700	23.4	0.03	0.702	
	Potassium Iodide	S	500	2,750	5.5	0.03	0.165	
	Sodium Hydroxide	S	500	500	1.0	0.24	0.24	
	Ammonium Chloride	S	500	600	1.2	0.0076	0.0091	2.08
Nitrous Nitrogen	Tartaric Acid	S	500	2,550	5.1	0.36	1.836	
	α-Naphthylamine		100	4,000	40.0	0.0036	0.144	
	Chloroform	S	500	840	1.7	0.00125	0.0021	
	Sulfanilic Acid	S	500	2,000	4.0	0.036	0.144	
	Sodium Nitrite	S	500	640	1.3	0.0033	0.0043	2.13
Nitrate Nitrogen	Brucine Sulfate		25	6,750	270.0	0.01	2.7	
	Sulfanilic Acid	S	500	2,000	4.0	0.001	0.004	
	Hydrochloric Acid	S	500	350	0.7	0.03	0.021	

	Sulfuric Acid	S	500	590	1.2	10	12	
	Sodium Chloride	S	500	450	0.9	0.72	0.648	
	Potassium Nitrate	S	500	550	1.3	0.015	0.0195	15.39
Chlorine Ion	Silver Nitrate	S	500	28,800	57.6	0.02	1.152	
	Potassium Chromate	S	500	1,930	3.9	0.012	0.0468	
	Sodium Chloride	S	500	450	0.9	0.00096	0.0009	1.20
Potassium Permanganate Consumption	Potassium Permanganate	S	500	1,500	3.0	0.0057	0.0171	
	Sodium Oxalate	S	500	2,550	5.1	0.0096	0.049	
	Sulfuric Acid	S	500	590	1.2	2	2.4	2.47
Chlorine Demand	Potassium Iodide	S	500	2,750	5.5			
	Starch		500	480	1.0			
	Sulfuric Acid	S	500	590	1.2			
	Sodium Thiosulfate	S	500	550	1.1			
	Potassium Iodate	S	500	6,750	13.5			4.30
General Bacteria	Common Agar Medium		100	2,400	24.0	1.6	38.4	38.40
Coliform Bacteria	LB Culture Medium		300	3,200	10.7	2.1	22.47	
	BGLB Culture Medium		300	5,100	17.0	0.6	10.2	
	EMB Culture Medium		100	4,600	46.0		18.4	
	Gram's Stain Solution		1	7,000	7,000.0		28	79.07
Total Micro-Organisms	Formalin	S	500	420	0.8		1.68	
	Sodium Hydrogencarbonate	S	500	420	0.8		1.68	
	Ethyl Alcohol	S	500	890	1.8		3.56	
	Mountmedia			2,000			8	
	Sulfuric Acid	S	500	590	1.2		2.36	
	Hydrogen Peroxide	I	500	450	0.9		1.8	19.08
Cyanides	Phenolphthalein Indicator		500	1,250	2.5	0.24	0.6	
	Zinc Acetate	S	500	1,090	2.2	2.4	5.28	
	Chloramine T	S	500	3,850	7.7	0.00375	0.0289	
	Potassium Phosphate, Monobasic	S	500	730	1.5	0.04	0.06	
	Sodium Phosphate, Dibasic	S	500	1,500	3.0	0.05	0.15	
	1-Phenyl-3-Methyl-5-Pyrazolone		500	16,300	32.6	0.04	1.304	
	Bis(1-Phenyl-3-Methyl-5-Pyrazolone)		25	12,900	516.0	0.0036	1.8576	
	Pyridine	S	500	1,510	3.0	2	6	15.28
Organic Phosphorus	Ammonium Sulfanilate	S	500	2,250	4.5	0.04	0.18	
	N-(1-Naphthyl)-Ethylenediamine Dihydrochloride	S	25	7,250	290.0	0.08	23.2	
	N-Hexane	S	500	750	1.5	143	214.5	
	Hydrochloric Acid	S	500	350	0.7	2.35	1.645	
	Sodium Chloride	S	500	450	0.9	0.33	0.297	
	Sodium Sulfate, Anhydrous	S	500	550	1.1	0.3	0.33	
	Ethyl Alcohol	S	500	890	1.8	15	27	
	Paraffin		500	580	1.2	0.75	0.9	
	Sodium Nitrite	S	500	420	0.8	0.004	0.0032	
	Parathion		1	7,300	7,300.0		29.2	297.26
Fluorine	Alizarin-3-Methylamine-N, N-Diacetic Acid		1	5,450	5,450.0	0.0057	31.065	
	Sodium Hydroxide	S	500	500	1.0	0.004	0.004	
	Sodium Acetate	S	500	920	1.8	0.45	0.81	
	Acetic Acid	S	500	500	1.0	0.2	0.2	
	Lanthanum (Ⅲ) Oxide		25	750	30.0	0.004	0.12	
	Nitric Acid	S	500	460	0.9	0.02	0.018	
	Sodium Fluoride	S	500	3,450	6.9	0.0066	0.0455	
	Phenolphthalein		500	1,250	2.5	0.25	0.625	
	Sulfuric Acid	S	500	590	1.2	30	36	
	Silver Sulfate	S	500	33,000	66.0	0.033	2.178	71.07
Phenols	Granulated Activated Carbon	S	500	1,420	2.8	0.03	0.084	
	Copper Sulfate	S	500	950	1.9	0.3	0.57	

	4-Aminoantipyrine	S	500	13,700	27.4	0.008	0.2192	
	Methyl Orange	S	25	670	26.8	0.016	0.4288	
	Phosphoric Acid	S	500	500	1.0	0.75	0.75	
	Potassium Phosphate, Dibasic	S	500	920	1.8	1.5	2.7	
	Potassium Phosphate, Monobasic	S	500	730	1.5	1.1	1.65	
	Potassium Ferricyanide	S	500	1,900	3.8	0.017	0.0646	
	Phenol	S	500	840	1.7	0.03	0.051	
	Potassium Bromate	S	500	1,150	2.3	0.01	0.023	
	Potassium Bromide	S	500	920	1.8	0.3	0.54	
	Hydrochloric Acid	S	500	350	0.7	4.5	3.15	
	Starch		500	480	1.0	0.08	0.08	
	Potassium Iodide	S	500	2,750	5.5	0.7	3.85	
	Sodium Thiosulfate	S	500	550	1.1	0.086	0.0946	14.26
M B A S	Methylene Blue	S	500	12,300	24.6	0.0017	0.0418	
	Sulfuric Acid	S	500	590	1.2	0.11	0.132	
	Phenolphthalein	S	500	1,250	2.5	0.25	0.625	
	Sodium Phosphate, Monobasic	S	500	650	1.3	0.83	1.079	
	Sodium Dodecylbenzenesulfonate		500	1,830	3.7	0.03	0.111	
	Sodium Hydroxide	S	500	500	1.0	0.2	0.2	
	Chloroform	S	500	840	1.7	66.7	113.39	115.58
Hexavalent Chromium	Diphenylcarbazide	S	25	1,080	43.2	0.0033	0.1426	
	Ethyl Alcohol	S	500	890	1.8	1.67	3.006	
	Sulfuric Acid	S	500	590	1.2	0.4	0.48	
	Pottassium Dichromate	S	500	1,340	2.7	0.015	0.0405	3.67
Arsenic	Tin (II) Chloride	S	500	2,850	5.7	0.66	3.762	
	Potassium Iodide	S	500	2,750	5.5	1.16	6.38	
	Arsenic Trioxide	C	500	920	1.8	0.0044	0.0079	
	Sodium Hydroxide	S	500	500	1.0	1.5	1.5	
	Sulfuric Acid	S	500	590	1.2	0.2	0.24	
	Litmus Test Paper		300	560	1.9	0.2	0.38	
	Lead (II) Acetate	S	500	1,340	2.7	0.4	1.08	
	Acetic Acid	S	500	500	1.0	0.03	0.03	
	Silver Diethyldithiocarbamate		25	5,050	202.0	0.4	80.8	
	Brucine		25	6,250	250.0	0.075	18.75	
	Chloroform	S	500	840	1.7	1.5	2.55	115.48
Hardness	Potassium Cyanide	S	500	1,000	2.0	0.3	0.6	
	Ammonium Chloride	S	500	600	1.2	0.23	0.276	
	Ammonia Water	S	500	450	0.9	0.04	0.036	
	EBT Indicator		50	630	12.6	1.6	20.16	
	EDTA	S	25	490	19.6	0.13	2.548	
	Hydroxylamine Hydrochloride	S	500	2,450	4.9	0.04	0.196	
	Hydrochloric Acid	S	500	350	0.7	0.6	0.42	
	(Granular) Zinc	JIS	100	3,250	32.5	0.02	0.65	
	Acetone	S	500	440	0.9	1.7	1.53	26.42
Albuminoid Nitrogen	Sodium Hydroxide	S	500	500	1.0	9.7	9.7	
	Potassium Permanganate	S	500	1,500	3.0	0.53	1.59	
	Rochelle Salt	S	500	1,590	3.2	0.3	0.96	
	Mercury Iodide	S	500	11,700	23.4	0.03	0.702	
	Potassium Iodide	S	500	2,750	5.5	0.03	0.165	
	Ammounium Chloride	S	500	600	1.2	0.008	0.0096	13.13
Sulfate Ion	Barium Chromate	C	500	1,400	2.8	1	2.8	
	Acetic Acid	S	500	500	1.0	1	1	
	Hydrochloric Acid	S	500	350	0.7	0.08	0.056	
	Ethyl Alcohol	S	500	890	1.8	15	27	
	Potassium Chromate	S	500	1,930	3.9	0.5	1.95	

	Barium Chloride	S	500	1,000	2.0	0.5	1	
	Ammonia Water	S	500	450	0.9	1	0.9	
	BTB Indicator		50	630	12.6	0.1	1.26	
	Diphenylcarbazide	S	25	1,080	43.2	0.015	0.648	
	Calcium Chloride	S	500	580	1.2	0.0012	0.0014	
	Potassium Sulfate	S	500	730	1.5	0.1	0.15	36.77
Phosphate Ion	Sulfuric Acid	S	500	590	1.2	1.7	2.04	
	Ammonium Molybdate	S	500	2,700	5.4	0.14	0.756	
	Hydrochloric Acid	S	500	350	0.7	0.018	0.0126	
	Tin (Ⅱ) Chloride	S	500	2,850	5.7	0.0014	0.008	
	Potassium Phosphate, Monobasic	S	500	730	1.5	0.03	0.045	2.86
Silicic Acid	Ammonium Molybdate	S	500	2,700	5.4	0.83	4.482	
	Ammonia Water	S	500	450	0.9	0.39	0.351	
	Sodium Sulfite	S	500	420	0.8	2.83	2.264	
	Sodium Silicofluoride	S	500	3,550	7.1	0.017	0.1207	
	Hydrochloric Acid	S	500	350	0.7	0.021	0.0147	7.21
Sodium	Sodium Chloride	S	500	450	0.9	0.014	0.0126	
	Hydrochloric Acid	S	500	350	0.7	0.75	0.525	0.54
Potassium	Potassium Chloride	S	500	480	1.0	0.01	0.01	
	Sodium Chloride	S	500	450	0.9	0.014	0.0126	
	Hydrochloric Acid	S	500	350	0.7	1.67	1.169	1.19
B O D	Maganese Sulfate	S	500	1,000	2.0	1.6	3.2	
	Sodium Hydroxide	S	500	500	1.0	1.67	1.67	
	Potassium Iodide	S	500	2,750	5.5	0.5	2.75	
	Sodium Azide	I	500	4,750	9.5	0.033	0.3135	
	Sodium Fluoride	S	500	3,050	6.1	0.67	4.087	
	Starch		500	480	1.0	0.08	0.08	
	Sodium Thiosulfate	S	500	550	1.1	0.086	0.0946	
	Potassium Iodate	S	500	6,750	13.5	0.013	0.1755	
	Sulfuric Acid	S	500	590	1.2	6	7.2	19.57
Organic Mercury	Hydrochloric Acid	S	500	350	0.7	71.3	49.91	
	Benzene	S	500	420	0.8	75	60	
	L-Cystein	M S	25	4,000	160.0	0.15	24	
	Sodium Sulfate, Anhydrous	S	500	550	1.1	0.12	0.132	
	Silica-Gel		500	670	1.3	4.8	6.24	
	Soluble Starch	1	500	600	1.2	1.2	1.44	
	Methylmercury (Ⅱ) Chloride	M S	25	17,700	788.0	0.0033	2.6004	
	Ethylmercury (Ⅱ) Chloride	C	25	1,670	66.8	0.0033	0.2204	144.54
Mercury	Nitric Acid	Hg	500	1,750	3.5	5	17.5	
	Sulfuric Acid	Hg	500	1,750	3.5	10	35	
	Tin (Ⅱ) Chloride	Hg	100	1,750	17.5	0.5	8.75	
	Hydroxylamine Hydrochloride	Hg	100	3,800	38.0	0.8	30.4	
	Potassium Permanganate	Hg	250	2,500	10.0	0.1	1	
	Potassium Persulfate	Hg	500	2,300	4.6	0.5	2.3	
	Mercury Standard Soletion	Hg	100	1,100	11.0	1	11	105.95
Copper	Copper Standard Solution	AAA	100	1,000	10.0	1	10	
	Methyl Isobutyl Ketone	AAA	500	1,170	2.34	10	23.4	
	D D T C	AAA	10	840	84.0	0.5	42	
	Ammonium Citrate, Dibasic	AAA	500	1,670	33.34	5	16.7	
	Ammouni Sulfate	AAA	500	2,000	4.0	2	8	100.10
Lead	Methyl Isobutyl Ketone	AAA	500	1,170	2.34	10	23.4	
	A P D C	AAA	1	840	840.0	0.04	33.6	
	Lead Standard Solution	AAA	100	1,000	10.0	1	10	67.00
Zinc	Nitric Acid	AAA	500	730	1.5	2	3	
	Zinc Standard Solution	AAA	100	1,000	10.0	1	10	13.00

Cadmium	Methyl Isobutyl Ketone	AAA	500	1,170	2.3	10	23	
	A P D C	AAA	1	840	840.0	0.04	33.6	
	Cadmium Standard Solution	AAA	100	1,000	10.0	1	10	66.60
P C B	Ethyl Alcohol	RSC	500	1,750	3.5		7	
	N-Hexane	RSC	1000	1,630	1.6		6.52	
	Acetone	RSC	1000	1,630	1.6		6.52	
	Sodium Sulfate	RSC	500	820	1.6		3.28	
	Silicagel (For cdumn chromatograph)	PCB	500	3,750	7.5		15	
	PCB Standard Solution			4,000			16	
	PP DDE Standard Solution		250	11,300	45.2		45.2	99.52

(NOTE Class) S : Special
1 : First
C : For Chemistry
JIS : JIS Standard
M S : Manufacturer's Special
H g : For Hg
AAA : For Atomic Absorption Analysis
RSC : Reasent for Residnal Agricultural Chemicals
PCB : For PCB

3. *Expenses for Apparatuses and Equipment*

Name of Apparatus or Equipment	Price (Yen)	Life (Year)	Yearly Cost (Yen)	Cost Share Among Items of Water Quality Analysis	Remark
Stirrer	47,000	10	4,700	Turbidity : 10%	470
				pH value : 90%	4,230
Balance	20,000	5	4,000	All Items : 2.5% Each	100
Analytical Balance	125,000	10	12,500	All Items Except pH-value, Odor, Taste, Free	
Estimated Repair Cost	-		2,500	Carbonic Acid, General Bacteria, and Coliform	
(2% of the Price)				Bacteria : 3% Each	450
Hot Air Dryer	390,000	10	39,000	All Items Excluding Free Carbonic Acid	
Estimated Repair Cost	-		7,800	: 2.5% Each	1,170
Water Bath	70,000	10	7,000	Turbidity, Total Residues, Organic Phosphorus,	
Estimated Repair Cost	-		1,400	Odor, Taste, and Nitrate Nitrogen : 17% Each	1,428
Water Still	820,000	10	82,000	All Items : 2.5% Each	
Estimated Repair Cost	-		16,400		2,460
Certifugal Separator	400,000	10	40,000	Ammonium Nitrogen : 45%	21,600
Estimated Repair Cost	-		8,000	Colourity : 45%	21,600
				Total Microorganisms : 10%	4,800
Hot Plate (300W, 10-units type)	65,000	10	6,500	Potassium Permanganate Consumption : 90%	7,020
Estimated Repair Cost	-		1,300	Arsenic : 10%	780
Hot Plate (1.2Kw)	10,000	5	2,000	Nitrate Nitrogen, Residual Chlorine, Chlorine	
				Demand and Bacteria : 25% Each	500
Muffle Furnace	370,000	10	37,000	Chlorine Ion, Nitrate Nitrogen, Sulfate Ion,	
Estimated Repair Cost	-		7,400	Alkarinity, Arsenic, Silicic Acid, Potassium,	
				and Sodium : 12.5% Each	5,550
Distillation Apparatus	250,000	10	25,000	Ammonia Nitrogen, Cyanides, Fluorine, Phenols,	
Estimated Repair Cost	-		5,000	and Albminoid-N : 20% Each	6,000
High Pressure Steam Type Sterilizer	230,000	10	23,000	Bacteria : 95%	26,220
Estimated Repair Cost	-		4,600	Nitrate Nitrogen : 5%	1,380
Spectrophotometer	890,000	10	89,000	Nitrate Nitrogen : 50%	53,400
Estimated Repair Cost	-		17,800	Fluorine, MBAS, Phenol, Hexavalent-Cr, Arsenic,	
				Sulfate Ion, Phosphate Ion, Silicic Acid,	
				Cyanides, and Organic Phosphorus : 5% Each	5,340
pH Meter	200,000	10	20,000	pH Value : 100%	
Estimated Repair Cost	-		4,000		
Electrode Cost	-		10,000		34,000
Shaker	180,000	10	18,000	Mercury, Organic Mercury, Copper, Lead, Zinc,	
Estimated Repair Cost	-		3,600	Cadmium, Organic Phosphorus, PCB, and MBAS	
				: 11% Each	2,376
Refrigerator	300,000	10	30,000	All Items : 2.5% Each	
Estimated Repair Cost	-		6,000		900
Flame Photometer	2,000,000	10	200,000	Potassium : 50%	130,000
Estimated Repair Cost (Including Gas Cost) (3%)	-		60,000	Sodium : 50%	130,000
Incubator (For BOD)	1,200,000	10	120,000	BOD : 100%	
Estimated Repair Cost	-		24,000		144,000
Incubator (For Bacteria)	350,000	10	35,000	General Bacteria : 50%	21,000
Estimated Repair Cost	-		7,000	Coliform Bacteria : 50%	21,000

ECD Type Gas Chromatographic Apparatus	2,000,000	10	200,000	PCB : 50%	150,000
Estimated Repair Cost	-		100,000	Organic Mercury : 50%	150,000
(Including Gas, Column and Injector costs)	with Recorder				
(5% of the Price)					
Atomic Absorption Flame Spectrophotometer	3,500,000	10	350,000	Mercury, Lead, Copper, Zinc, and Cadmium	
Estimated Repair Cost	w/Compressor		175,000	: 20% Each	
(Including Gas) (5%)	and Recorder				105,000
Turbidity meter	795,000	10	79,500	Turbidity : 100%	
Estimated Repair Cost	-		15,900		95,400
Water Sumpler	100,000	10	10,000	All Items : 2.5% Each	
Estimated Repair Cost	-		2,000		300
Membrane Filter Equipment Set	20,000	3	6,667	Suspended Solid : 50%	26,033
Estimated Repair Cost(Including Filter Costs)	-		45,400	Total Microorganisms : 50%	26,033
Platinum Crucible	70,000	10	7,000	Sulfate Ion, Arsenic, Silicic Acid, Sodium, and	
Estimated Repair Cost	-		1,400	Potassium, Chlorine Ion, Nitrate Nitrogen,	
				Alkalinity : 12.5% Each	1,050
Camera	80,000	10	8,000	Total Microorganisms : 70%	20,160
Slide	60,000	10	6,000	General Bacteria : 5%	1,440
DPE Kit	100,000	10	10,000	Coliform Bacteria : 5%	1,440
Estimated Repair Cost	-		4,800	Other All Items : 0.5% Each	144
Microscope (With Ocular and Objective	700,000	10	70,000	Total Microorganisms : 90%	75,600
Lenses, Camera, and Exposure Meter, etc.)				General Bacteria : 5%	4,200
Estimated Repair Cost	-		14,000	Coliform Bacteria : 5%	4,200
Colony Counter	100,000	10	10,000	General Bacteria : 100%	
Estimated Repair Cost	-		2,000		12,000
Electronic Calculator	5,000	5	1,000	All Items : 2.5% Each	25
Drying Sterilizer	300,000	10	30,000	General Bacteria : 50%	18,000
Estimated Repair Cost	-		6,000	Coliform Bacteria : 50%	18,000
Constant Temperature Water Bath	74,000	10	7,400	General Bacteria : 50%	4,440
Estimated Repair Cost	-		1,480	Coliform Bacteria : 50%	4,440
Culture Media Dissolution Pot Set	40,000	5	8,000	General Bacteria : 50%	4,000
(For Bacteria Test)				Coliform Bacteria : 50%	4,000
Amperometric Titration Equipment	200,000	10	20,000	Residual Chlorine : 100%	
Estimated Repair Cost	-		4,000		24,000

4. Utility (Electricity and Water Supply)

Name of Apparatus or Equipment	Power Consumption (Kw)	Yearly Power Consumption (Kw)	Yearly Power Consumption (Yen)	Frequency of use (Indicated as the No. of Samples in a Year)	Cost and Cost Share Among Items of Water Quality Analysis	(Yen)
Stirrer	0.05	5.5	110	5,000 Samples Per Year	Turbidity : 10%	11
					pH Value : 90%	99
Analytical Balance	0.02	2.2	44		All Items Except pH-value, Odor, Taste, Free Carbonic Acid, General Bacteria and Coliform Bacteria : 3% Each	1.3
Hot Air Dryer	1.2	1,314	26,280		All Items Excluding Free Carbonic Acid : 2.5% Each	657
Water Bath	1.2	657	13,140		Turbidity, Evaporation Residue, Organic Phosphorus, Odor, Taste, and NO3-N :17% Each	2,233
Water Still	1.2	1,752	35,040		All Items : 2.5% Each	876
Centrifugal Separator	10	274	5,480		Ammonium Nitrogen : 45%	2,466
					Chromaticity : 45%	2,466
					Total Microorganisms : 10%	548
Turbidity Meter	0.2	110	2,200		Turbidity : 100%	2,200
Hot Plate (1.2Kw)	1.2	657	13,140	Residual Chlorine 5,000	Residual Chlorine : 20%	2,628
				Nitrate Nitrogen 250	Nitrate Nitrogen : 20%	2,628
				Chlorine Demand 250	Chlorine Demand : 20%	2,628
				General Bacteria 250	General Bacteria : 20%	2,628
				Coliform Bacteria 250	Coliform Bacteria : 20%	2,628
Hot Plate (300w, 10-units Type)	3	820	16,400	Potassium Permanganate 250	Potassium Permanganate : 90%	14,760
				Argenic 250	Argenic : 10%	1,640
Muffle Furnace	3	165	3,300		Chlorine Ion, Nitrate Nitrogen, Sulfate Ion, Alkarinity, Arsenic, Silicic Acid, Sodium and Potassium : 12.5% Each	412
Distillation Apparatus	3	2,190	43,800	Ammonia 250	Ammonium Nitrogen : 20%	8,760
				Cyanides 250	Cyanides : 20%	8,760
				Phenols 250	Phenols : 20%	8,760
				Fluorine 250	Fluorine : 20%	8,760
				Albminoid-N 250	Albminoid-N : 20%	8,760
High Pressure Steam Type Sterilizer	3	220	4,400	General Bacteria 250	General Bacteria : 47.5%	2,090
				Coliform Bacteria 250	Coliform Bacteria : 47.5%	2,090
				Nitrate Nitrogen	Nitrate Nitrogen : 5%	220
Spectrophotometer	1	550	11,000	Nitrate Nitrogen 250	Nitrate Nitrogen : 11%	1,210
				Fluorine 250	Fluorine : 11%	1,210
				Phenols 250	Phenols : 11%	1,210
				MBAS 250	MBAS : 11%	1,210
				Hexavalent Chromium 250	Hexavalent Chromium : 11%	1,210
				Arsenic 250	Arsenic : 11%	1,210
				Sulfate Ion 250	Sulfate Ion : 11%	1,210
				Phosphate Ion 250	Phosphate Ion : 11%	1,210
				Silicic Acid 250	Silicic Acid : 11%	1,210
				Cyanides 250	Cyanides : 11%	1,210
				Organic Phosphorus 250	Organic Phosphorus : 11%	1,210
pH Meter	0.1	55	1,100	pH Value 5,000	pH Value : 100%	1,100

Shaker	0.2	55	1,100	Mercury	250	Mercury	: 12.5%	137
				organic Mercury	250	organic Mercury	: 12.5%	137
				Copper	250	Copper	: 12.5%	137
				Lead	250	Lead	: 12.5%	137
				Zinc	250	Zinc	: 12.5%	137
				Cadmium	250	Cadmium	: 12.5%	137
				PCB	250	PCB	: 12.5%	137
				Organic Phosphorus	250	Organic Phosphorus	: 12.5%	137
Refrigerator	0.2	880	17,600			All Items	: 2.5% Each	440
Flame Photometer	1	37	740	Potassium	250	Potassium	: 50%	370
				Sodium	250	Sodium	: 50%	370
Incubator (For BOD)	0.5	4,380	87,600	BOD	250	BOD	: 100%	87,600
Incubator (For General Bacteria)	0.5	4,380	87,600	General Bacteria	250	General Bacteria	: 50%	43,800
				Coliform Bacteria	250	Coliform Bacteria	: 50%	43,800
ECD Type Gas Chromatographic Apparatus	1.5	550	11,000	PCB	250	PCB	: 50%	5,500
				Organic Mercury	250	Organic Mercury	: 50%	5,500
Atomic Absorption Flame Spectrophotometer	1.5	550	11,000	Mercury	250	Mercury	: 20%	2,200
				Copper	250	Copper	: 20%	2,200
				Lead	250	Lead	: 20%	2,200
				Zinc	250	Zinc	: 20%	2,200
				Cadmium	250	Cadmium	: 20%	2,200
Electronic Calculator	Battery 24 pcs.		960			All Items	: 2.5% Each	24
Water Charge		15,000				All Items	: 2.5% Each	375

5. Costs of Laboratory Supplies

Water Quality Item	Name of Apparatus to be Used	Specifications	Number of Samples	*1 Life	Unit Price	Cost Per Sample	Cost of Laboratory Supplies Per Sample for Each Analysis
Turbidity	Cell	50 mm	5,000 samples per year	1 Y	10,000	2.00	
	Cell	30 mm	-	1 Y	10,000	2.00	
	Cell	10 mm		1 Y	10,000	2.00	
	Beaker	500 ml	12 times per year	10 T	240	0.06	
	Stoppered Measuring Cylinder	1000 ml	12 times per year	30 T	17,000	1.36	
	Siphon		12 times per year	10 T	300	0.08	
	Evaporation Dish		60 times per year	10 T	100	0.12	
	Agato Mortar	10 cm ϕ	12 times per year	10 T	50,000	1.00	
	Wide-mouthed Bottle	200 ml		2 Y	670	0.07	
	Measuring Flask	1000	12 times per year	20 T	2,600	0.31	
	Medical Spoon	Stainless Steel		10 Y	300	0.01	
	Desiccator	30 cm ϕ		10 Y	23,900	0.50	9.51
Colourity	Measuring Flask	1000 ml	1 time per year	20 T	2,600	0.83	
	Colorimetric Tube	100	5,000 samples per year	50 T	1,800	36.00	
	Colorimetric Tube Stand	10-pieces type		5 Y	5,000	0.20	
	Measuring Pipet	1 ml	12 times per year	10 T	300	0.07	
	Stoppered Reagent Bottle	100 ml	12 times per year	2 Y	1,400	0.14	36.44
pH Value (Electrode Method)	Beaker	50 ml	5,000 samples per year	50 T	115	1.15	
	Washing Bottle (Polyethylene)	500 ml		5 Y	500	0.02	
	Filter Paper	First Class	1 sheet per analysis		200	2.00	
	Watch Glass	5 cm ϕ		2 M	100	0.12	3.29
pH Value (Colorimetric Method)	pH Colorimetric Tube	10 ml	5,000 samples per year	50 T	500	10.00	
	Komagome Pipet	0.5 ml		50 T	350	7.00	
	Reagent Bottle	50 ml		2 Y	1,300	0.13	17.13
Residual Chlorine *2	Reagent Bottle - Brown with Stopper	500 ml	5,000 samples per year*3	2 Y	2,200	1.10	
	Dropping Bottle - Brown	100 ml	5,000 samples per year*4	2 Y	630	0.19	1.29
Residual Chlorine (Colorimetric Method)	Desiccator	30 cm ϕ	5,000 samples per year	10 Y	23,900	0.48	
	Funnel	10 cm ϕ	12 times per year	10 T	1,000	0.24	
	Colorimetric Bottle	50 ml	20 Bottles *5	100 T	1,100	11.00	
	Komagome Pipet	5 ml	60 days per year	10 T	350	0.42	
	Measuring Flask	1000 ml	12 times per year	10 T	2,600	0.62	
	Reagent Bottle - Narrow-mouthed with Stopper	1000 ml	5 Bottles *5	2 Y	3,100	1.55	
	Reagent Bottle - Narrow-mouthed with Stopper	500 ml	2 Bottles *5	2 Y	1,900	0.38	
	Reagent Bottle - Narrow-mouthed with Stopper	120 ml	5 Bottles *5	2 Y	1,180	0.59	
	Flat Bottom Flask	3000 ml	12 times per year	10 T	3,000	0.72	
	Glass Bar	20 cm=l	12 times per year	10 T		0.07	
	Filter Paper	5-A 100 sheets	12 sheets per year		500	0.01	16.08
Odor	Reagent Bottle	5000 ml	5,000 samples per year	5 Y	8,000	0.32	
	Glass Tube	ϕ 5mm × 2m		1 Y	500	0.10	
	Rubber Stopper	5 cm ϕ		2 Y	200	0.02	
	Glass Wool	500 g		1 Y	500	0.10	
	Measuring Cylinder	200 ml		1 Y	1,800	0.36	
	Stoppered Erlenmeyer Flask	300 ml		10 T	1,000	100.00	
	Glass Pot	For Chromic Acid Mixture		2 Y	2,800	0.28	
	Measuring Pipet	10 ml		50 T	500	10.00	
	Reagent Bottle	120 ml		2 Y	1,180	0.12	111.30
Taste	Measuring Cylinder	200 ml	5,000 samples per year	1 Y	1,800	0.36	
	Stoppered Erlenmeyer Flask	300 ml		50 T	1,000	20.00	
	Measuring Pipet	10 ml		50 T	500	10.00	30.36
Alkalinity	Mesuring Cylinder	100 ml	5,000 samples per year	1 Y	1,260	0.25	

	Porcelain Dish	300 ml		1 Y	100	0.02	
	Dropping Bottle	120 ml		2 Y	630	0.06	
	Glass Bar	20 cm·l		1 Y	300	0.06	
	Automatic Buret - 1 set			3 Y	31,000	2.07	
	Reagent Bottle	1000 ml		2 Y	3,100	0.31	
	Reagent Bottle	500 ml		2 Y	1,900	0.19	
	Reagent Bottle	250 ml		2 Y	1,700	0.17	
	Reagent Bottle	120 ml		2 Y	1,180	0.12	
	Measuring Pipet	5 ml	12 times per year	10 T	500	0.12	
	Trasfer Pipet	25 ml	12 times per year	10 T	670	0.16	
	Measuring Flask	1000 ml	12 times per year	20 T	2,600	0.62	
	Buret (For Standardization)	50 ml		3 Y	31,000	2.07	
	Trasfer Pipet	100 ml	12 times per year	10 T	1,600	0.38	
	Medical Spoon	Stailess Steel	12 times per year	10 Y	300	0.01	
	Cartridge Paper		24 sheets per year		200		6.61
Ammonium Nitrogen	Colorimetric Tube	50 ml	250 samples per year	50 T	1,800	36.00	
	Komagome Pipet	5 ml		10 T	350	35.00	
	Watch	For 60 Minutes		5 Y	5,000	4.00	
	Measuring Pipet	1 ml		10 T	300	30.00	
	Colorimetric Tube Stand	10-pieces type		5 Y	5,000	4.00	
	Measuring Flask	1000 ml	12 times per year	30 T	2,600	12.48	
	Measuring Cylinder	1000 ml	12 times per year	30 T	4,620	7.39	
	Reagent Bottle - Brown, Narrow-mouthed	1000 ml	12 times per year	2 Y	3,600	7.20	
	Cartridge Paper	100 Sheets	24 sheets per year		200	0.19	
	Medical Spoon	Stailess Steel	12 times per year	10 Y	300	0.12	136.38
Nitrous Nitrogen	Wide-mouthed Bottle	200 ml	250 samples per year	2 Y	8,000	16.00	
	Colorimetric Tube	50 ml		10 T	1,800	180.00	
	Colorimetric Tube Stand	10-pieces type		5 Y	5,000	4.00	
	Medical Spoon	Stailess Steel		10 Y	300	0.12	
	Cartridge Paper	100 Sheets	24 sheets per year		200	0.19	
	Measuring Flask	1000 ml	12 times per year	10 T	2,600	12.48	
	Trasfer Pipet	25 ml	12 times per year	10 T	670	3.22	
	Washing Bottle (Polyethylene)	500 ml		5 Y	500	0.40	
	Komagome Pipet	1 ml		10 T	350	0.14	
	Reagent Bottle	1000 ml		2 Y	3,100	6.20	222.75
Chlorine Ion	Measuring Cylinder	100 ml	250 samples per year	1 Y	1,260	5.04	
	Porcelain Dish	300 ml		1 Y	100	0.40	
	Dropping Bottle	120 ml		2 Y	630	1.26	
	Glass Bar	20 cm·l		1 Y	300	1.20	
	Automatic Buret - 1 set	50 ml×2		3 Y	62,000	82.67	
	Reagent Bottle - Brown with a Stopper	1000 ml		2 Y	3,600	7.20	
	Reagent Bottle - Brown with a Stopper	120 ml		2 Y	1,400	2.80	100.57
Potassium Permanganate Consumption	Erlenmeyer Flask	300 ml	250 samples per year	20 T	240	12.00	
	Automatic Buret - 1 set	50 ml×2		3 Y	62,000	82.67	
	Dropping Bottle	120 ml		2 Y	630	1.26	
	Reagent Bottle	1000 ml×2		2 Y	6,200	12.40	
	Reagent Bottle	500 ml		2 Y	1,900	3.80	
	Flat Bottm Flask	2000 ml	12 times per year	10 T	1,350	6.48	
	Glass Filter	4G-3	12 times per year	2 T	900	21.60	140.21
Chorine Demand	Buret	50 ml		2 Y	6,400	12.80	
	Erlenmeyer Flask	200 ml		10 T	200	20.00	
	Dropping Bottle	120 ml		2 Y	630	1.26	
	Reagent Bottle	1000 ml		2 Y	3,100	6.20	

	Reagent Bottle	500 ml		2 Y	1,900	3.80	
	Reagent Bottle	120 ml		2 Y	1,180	2.36	46.42
Nitrate Nitrogen							
							226.00
Total Micro-organisms	Slide Glass	With Concavity	250 samples per year	50 T	800	16.00	
	Slide Glass	Without Concavity		1 T	13	13.00	
	Cover Glass	18 × 18	500 pieces are necessary	1 T	9	18.00	
	Measuring Cylinder	100 ml		1 Y	1,260	5.04	
	Measuring Pipet	500 ml		1 Y	2,860	11.44	
	Measuring Cylinder	1000 ml		1 Y	4,620	18.48	
	Measuring Pipet	0.1 ml		10 T	900	90.00	
	Measuring Pipet	1 ml		10 T	300	30.00	
	Measuring Pipet	10 ml		10 T	500	50.00	
	Preservation Bottle	50 ml		10 T	50	5.00	
	Komagome Pipet	2 ml		10 T	180	18.00	
	Water Tank	54 l		3 Y	3,000	4.00	
	Fishnet			20 T	200	10.00	
	Centrifugation Column	10 ml		10 T	930	93.00	
	Centrifugation Column	30 ml		10 T	600	60.00	441.96
General Bacteria and Coliform Bacteria	Pipet	300 ml	250 samples per year	10 T	300	30.00	
	Test Tube	50 ml		10 T	450	45.00	
	Test Tube	10 ml		10 T	41	4.10	
	Daram Tube			10 T	20	2.00	
	Pipet Case			10 Y	8,500	3.40	
	Test Tube Stand	50 ml		5 Y	2,000	1.60	
	Test Tube Stand	10 ml		5 Y	2,000	1.60	
	Desiccator	30 cmφ		10 Y	23,900	9.56	
	Beaker	2000 ml		10 T	1,270	127.00	
	Beaker	1000 ml		10 T	510	51.00	
	Beaker	200 ml		10 T	140	14.00	
	Reagent Bottle, etc.			1 Y	10,000	40.00	329.26
Cyanides	Distillation Flask	1000 ml	250 samples per year	5 T	2,250	450.00	
	Dropping Bottle	120 ml		2 Y	630	1.26	
	Komagome Pipet	10 ml	5 times per sample	10 T	350	175.00	
	Measuring Cylinder	100 ml		1 Y	1,260	5.04	
	Measuring Flask	250 ml	12 times per year	10 T	2,600	12.48	
	Funnel	10 cmφ		1 Y	1,000	4.00	
	Colorimetric Column	50 ml		10 T	1,100	4.40	
	Colorimetric Column Stand	10-piece Type		5 Y	5,000	4.00	
	Transfer Pipet	25 ml	12 times per year	10 T	670	3.22	
	Measuring Pipet	1 ml		10 T	300	30.00	
	Cell	10 mm		1 Y	10,000	40.00	729.40
P C B	KD Condensation Kettle		250 samples per year	2 M	36,000	164.00	
	Receiving Tube			2 M	1,800	43.20	
	Separating Funnel	300 ml Special		2 M	6,300	131.20	
	Separating Funnel	1000 ml Special		2 M	7,200	192.80	
	Chromatographic Tube			2 M	6,000	144.00	
	Flask (Eggplant-Shaped)	300 ml		2 M	1,500	33.60	
	Flask (Eggplant-Shaped)	200 ml		2 M	1,400	144.00	
	Cooling Tube			2 M	6,000	74.40	
	Round Bottom Flask	2000 ml		2 M	3,100	480.00	
	Fractionatine Coluen			2 M	20,000	115.20	
	Fractionatine Head			2 M	4,800	86.40	

	Thermometer			2 M	3,600	181.20	
	Glass Column for Gas Chromatography			2 M	6,300	33.60	
	Stoppered Erlenmeyer Flask	300 ml		2 M	1,400	38.40	
	Stoppered Erlenmeyer Flask	500 ml		2 M	1,600		2,568.00
Organic Phosphorus	Separating Funnel	300 ml	250 samples per year	20 T	5,300	265.00	
	Separating Funnel Supporter			5 Y	5,000	4.00	
	Bellows			1 Y	750	3.00	
	Komagome Pipet			10 T	350	35.00	
	Reflux Condenser			3 Y	7,900	10.53	
	Evaporating Dish			10 T	100	10.00	
	Colorimetric Tube			10 T	1,100	110.00	
	Chromatographic Column			20 T	5,500	275.00	
	Stand			10 Y	3,500	1.40	
	Cramp			10 Y	2,000	0.80	
	Erlenmeyer Flask			10 T	240	24.00	
	Measuring Flask	100 ml		1 Y	1,260	5.04	
	Measuring Flask	50 ml		1 Y	1,100	4.40	
	Measuring Flask	25 ml		1 Y	950	3.80	
	Reagent Bottle	1000 ml		2 Y	3,100	6.20	
	Reagent Bottle	500 ml		2 Y	1,900	3.80	
	Reagent Bottle	250 ml		2 Y	1,700	3.40	
	Reagent Bottle	120 ml		2 Y	1,180	2.36	
	Beaker	300 ml		10 T	150	15.00	
	Beaker	100 ml		10 T	115	11.50	
	Measuring Pipet	5 ml		10 T	350	35.00	
	Funnel	10 cmφ		1 Y	1,030	4.00	
	Filter Paper	100 Sheets	2 sheets per analysis		500	10.00	
	Cell	10 mm		1 Y	10,000	40.00	884.23
Fluorine	Long Thermometer	0～100℃	250 samples per year	3 Y	3,800	5.07	
	Distillation Flask	1000 ml		5 T	2,250	450.00	
	Measuring Cylinder	200 ml		1 Y	14,750	5.80	
	Porcelain Dish	300 ml		1 Y	100	0.40	
	Stopper Measuring Cylinder	200 ml		1 Y	3,300	13.20	
	Measuring Flask	50 ml		10 T	2,200	220.00	
	Komagome Pipet	5 ml		10 T	350	35.00	
	Measurign Pipet	10 ml		10 T	500	50.00	
	Reagent Bottle	1000 ml		2 Y	3,100	6.20	
	Reagent Bottle	500 ml		2 Y	1,900	3.80	
	Reagent Bottle	250 ml		2 Y	1,700	3.40	
	Reagent Bottle	120 ml		2 Y	1,180	2.36	
	Dopping Bottle	120 ml		2 Y	630	1.26	
	Transfer Pipet	25 ml		10 T	670	67.00	
	Cell	10 mm		1 Y	10,000	40.00	903.49
Hexavalent Chromium	Measuring Pipet	10 ml	250 samples per year	10 T	500	50.00	
	Measuring Cylinder	50 ml		1 Y	1,100	4.40	
	Colorimetric Tube	50 ml		10 T	1,100	110.00	
	Komagome Pipet	5 ml		10 T	350	35.00	
	Beaker	300 ml		10 T	160	16.00	
	Transfer Pipet	25 ml		10 T	670	67.00	
	Cell	10 mm		1 Y	10,000	40.00	322.40
Phenols	Komagome Pipet	5 ml	250 samples per year	10 T	350	35.00	
	Dropping Bottle	120 ml		2 Y	630	1.26	
	Measuring Cylinder	100 ml		1 Y	1,260	5.04	
	Separate Funnel	300 ml		20 T	5,300	265.00	

	Separate Funnel Supporter			5 Y	5,000	4.00	
	Beaker	500 ml		10 T	240	24.00	
	Beaker	200 ml		10 T	130	13.00	
	Filter Paper	Class 3, 100 Sheets	2 sheets per analysis		500	10.00	
	Funnel	10 cmϕ		1 Y	1,000	4.00	
	Tranfer Pipet	25 ml		10 T	670	67.00	
	Measuring Pipet	10 ml		10 T	500	50.00	
	Stoppered Erlenmeyer Flask	200 ml		10 T	850	85.00	
	Reagent Bottle	1000 ml		2 Y	3,100	6.20	
	Reagent Bottle	500 ml		2 Y	1,900	3.80	
	Reagent Bottle	250 ml		2 Y	1,700	3.40	
	Reagent Bottle	120 ml		2 Y	1,180	2.36	
	Distillation Flask	1000 ml		5 T	2,250	450.00	
	Cell	10 mm		1 Y	10,000	40.00	1,069.06
M B A S	Measuring Cylinder	200 ml	250 samples per year	1 Y	1,450	5.80	
	Separate Funnel	300 ml		20 T	5,300	265.00	
	Separate Funnel Supporter			5 Y	5,000	4.00	
	Dropping Bottle	120 ml		2 Y	630	1.26	
	Komagome Pipet	10 ml		10 T	350	35.00	
	Measuring Cylinder	50 ml		1 Y	1,100	4.40	
	Absorbent Cotton	500 g		1 Y	500	0.02	
	Funnel	10 cmϕ		1 Y	1,000	4.00	
	Measuring Flask	50 ml		10 T	2,100	210.00	
	Reagent Bottle	1000 ml		2 Y	3,100	6.20	
	Reagent Bottle	500 ml		2 Y	1,900	3.80	
	Reagent Bottle	250 ml		2 Y	1,700	3.40	
	Reagent Bottle	120 ml		2 Y	1,180	2.36	
	Cell	10 mm		1 Y	10,000	40.00	585.24
Arsenic	Measurign Cylinder	200 ml	250 samples per year	1 Y	1,450	5.80	
	Evaporating Dish	300 ml		10 T	100	10.00	
	Komagome Pipet	5 ml		10 T	350	35.00	
	Arsenic Test Kit			20 T	5,000	250.00	
	Dropping Bottle	120 ml		2 Y	630	1.26	
	Measuring Flask	1000 ml		10 T	2,600	260.00	
	Water Distilling Apparatus, Demineralizer			2 Y	5,500	11.00	
	Beaker	100 ml		10 T	115	11.50	
	Reagent Bottle	1000 ml		2 Y	3,100	6.20	
	Reagent Bottle	500 ml		2 Y	1,900	3.80	
	Reagent Bottle	250 ml		2 Y	1,700	3.40	
	Reagent Bottle	120 ml		2 Y	1,180	2.36	
	Absorbent Cotton	200 g		1 Y	200	0.80	
	Cell	10 mm		1 Y	10,000	40.00	641.12
Hardness	Measuring Cylinder	100 ml	250 samples per year	1 Y	1,260	5.04	
	Erlenmeyer Flask	300 ml		10 T	240	24.00	
	Dropping Bottle	120 ml		2 Y	630	1.26	
	Reagent Bottle	1000 ml		2 Y	3,100	6.20	
	Reagent Bottle	120 ml		2 Y	1,180	2.36	
	Komagome Pipet	5 ml		10 T	350	35.00	
	Automatic Buret - 1 set	50 ml		3 Y	31,000	41.33	
	Beaker	300 ml		10 T	160	16.00	
	Measuring Flask	1000 ml		10 T	2,600	260.00	
	Transfer Pipet	25 ml		10 T	670	67.00	
	Glass Bar	20 cm×1		1 Y	1,000	4.00	462.19
Albminoid	Distillation Flask	1000 ml	250 samples per year	5 T	2,250	450.00	

Nitrogen	Measuring Cylinder	500 ml		1 Y	2,860	11.44	
	Measuring Cylinder	100 ml		1 Y	1,260	5.04	
	Stoppered Measuring Cylinder	250 ml		1 Y	3,300	13.20	
	Colorimetric Tube	50 ml		10 T	1,100	110.00	
	Reagent Bottle	1000 ml		2 Y	3,100	6.20	
	Reagent Bottle	500 ml		2 Y	1,900	3.80	
	Komagome Pipet	5 ml		10 T	350	35.00	
	Colorimetric Tube Stand			5 Y	5,000	4.00	
	Measuring Pipet	5 ml		10 T	500	50.00	698.68
Total Residues	Nickel Dish	200 ml	250 samples per year	5 Y	1,500	1.20	
							1.20
Sulfate Ion	Glass Filter	1G-4	250 samples per year	5 T	900	180.00	
	Wide-mouthed Bottle	200 ml		2 Y	670	1.38	
	Suction Filter Apparatus			5 Y	10,000	8.00	
	Reagent Bottle	1000 ml		2 Y	3,100	6.20	
	Reagent Bottle	500 ml		2 Y	1,900	3.80	
	Reagent Bottle	250 ml		2 Y	1,700	3.40	
	Reagent Bottle	120 ml		2 Y	1,180	2.36	
	Water Distilling Apparatus, Demineralizer			2 Y	5,500	11.00	216.14
Phosphate Ion	Measuring Flask	1000 ml	250 samples per year	10 T	2,600	260.00	
	Beaker	500 ml		10 T	240	24.00	
	Transfer Pipet	100 ml		10 T	1,600	160.00	
	Measuring Cylinder	100 ml		1 Y	1,260	5.04	
	Colorimetric Tube	50 ml		10 T	1,100	110.00	
	Colorimetric Tube Stand			5 Y	5,000	4.00	
	Measuring Pipet	1 ml		10 T	300	30.00	
	Reagent Bottle	1000 ml		2 Y	3,100	6.20	
	Reagent Bottle	500 ml		2 Y	1,900	3.80	
	Reagent Bottle	120 ml		2 Y	1,180	2.36	605.40
Silicic Acid	Colorimetric Tube	50 ml	250 samples per year	10 T	1,100	110.00	
	Colorimetric Tube Stand			5 Y	5,000	4.00	
	Komagome Pipet	5 ml		10 T	350	35.00	
	Transfer Pipet	10 ml		10 T	440	44.00	
	Reagent Bottle	1000 ml		2 Y	3,100	6.20	
	Reagent Bottle	500 ml		2 Y	1,900	3.80	
	Reagent Bottle	250 ml		2 Y	1,700	3.40	
	Reagent Bottle	120 ml		2 Y	1,180	2.36	
	Reagent Bottle (Polyethylene)	1000 ml		5 Y	300	0.24	209.09
Sodium and Potassium	Beaker	300 ml	250 samples per year	10 T	160	16.00	
	Measuring Flask	1000 ml		10 T	2,600	260.00	
	Reagent Bottle	1000 ml		2 Y	3,100	6.20	
	Reagent Bottle	500 ml		2 Y	1,900	3.80	
	Reagent Bottle	250 ml		2 Y	1,700	3.40	
	Reagent Bottle	120 ml		2 Y	1,180	2.36	
	Transfer Pipet	25 ml		10 T	670	67.00	358.76
B O D	Oxygen Bottle	300 ml	250 samples per year	5 T	1,970	394.00	
	Reagent Bottle	1000 ml		2 Y	3,100	6.20	
	Reagent Bottle	500 ml		2 Y	1,900	3.80	
	Reagent Bottle	250 ml		2 Y	1,700	3.40	
	Reagent Bottle	120 ml		2 Y	1,180	2.36	
	Komagome Pipet	5 ml		10 T	350	35.00	
	Buret	50 ml		3 Y	6,400	8.53	
	Dopping Bottle	120 ml		2 Y	630	1.26	

	Transfer Pipet	50 ml		10 T	990	99.00	
	Erlenmeyer Flask	200 ml		10 T	200	20.00	
	Siphon			1 Y	300	1.20	574.75
Suspended Solids	Membrane Filters		250 samples per year	1 T	90	90.00	
	Filter Folder & Base			5 Y	10,000	8.00	98.00
Organic Mercury	Separating Funnel	1000 ml	250 samples per year	30 T	7,200	240.00	
	Separating Funnel Supporter			5 Y	5,000	4.00	
	Beaker	100 ml		10 T	115	11.50	
	Beaker	200 ml		10 T	130	13.00	
	Beaker	500 ml		10 T	240	24.00	
	Small Size Test Tube	10 ml		10 T	1,000	100.00	
	Reagent Bottle	1000 ml		2 Y	3,100	6.20	
	Reagent Bottle	500 ml		2 Y	1,900	3.80	
	Reagent Bottle	250 ml		2 Y	1,700	3.40	
	Reagent Bottle	120 ml		2 Y	1,180	2.36	
	Komagome Pipet	5 ml		10 T	350	35.00	
	Transfer Pipet	10 ml		10 T	440	44.00	
	Measuring Flask	1000 ml		10 T	2,600	260.00	
	Measuring Pipet	1 ml		10 T	300	30.00	777.26
Mercury, Copper, Lead, Zinc, and Cadmium	Beaker	500 ml	250 samples per year	10 T	240	24.00	
	Beaker	100 ml		10 T	115	11.50	1,984.21
	Measuring Flask	1000 ml		10 T	2,600	260.00	
	Measuring Flask	100 ml		10 T	2,300	230.00	1,433.54

	Separating Funnel	300 ml		20 T	5,300	265.00	
	Separating Funnel Supporter			5 Y	5,000	4.00	1,457.54
	Measuring Cylinder	100 ml		1 Y	1,260	5.04	1,433.54
	Stoppered Test Tube	10 ml		10 T	2,000	200.00	
	Transfer Pipet	5 ml		10 T	500	50.00	
	Transfer Pipet	10 ml		10 T	670	67.00	
	Transfer Pipet	20 ml		10 T	670	67.00	
	Measuring Pipet	1 ml		10 T	300	30.00	
	Measuring Pipet	5 ml		10 T	500	50.00	
	Measuring Pipet	10 ml		10 T	500	50.00	
	Lamp	For Hg		1 Y	64,000	256.00	
	Lamp	For Zn		1 Y	30,000	120.00	
	Lamp	For Cu		1 Y	30,000	120.00	
	Lamp	For Pb		1 Y	36,000	144.00	
	Lamp	For Cd		1 Y	36,000	144.00	
	Quartz Cell	(For only Mercury)		3 Y	32,000	42.67	
	Mercury-Reducing Vaporization Apparatus	(For only Mercury)		5 Y	55,000	44.00	
	Mercury Decomposition Apparatus	(For only Mercury)		5 Y	410,000	328.00	1,437.54

NOTE : *1) T : Times, M : Month, Y : Year
*2) Amerometri Titration Method
*3) 5 Bottles are necessary at the same time.
*4) 3 bottles are necessary at the same time.
*5) To be necessary at the same time.

6. Expenses for Sampling Apparatuses

Name of Apparatus	Specifications	Unit Price	Nescessary Amount Per year	Amount Necessary for Damage (2% Annual Amounts)	Expenses	Remark
Sampling Bottle (For Physico-Chemical analysis)	Stopped Narrow-Mouthed Bottle 1,000ml	1,500	2,000 ~8,000 Bottles	40~160 Bottles	¥60,000 ~240,000	
Sampling Bottle (For Biological Analysis)	Polyethylene 1,000ml	200	164 ~268	4~ 6 Bottles	¥ 800 ~1,200	
Sampling Bottle For Bacteria Test	120ml	500	〃 (82~134)	2~ 3 Bottles	¥ 1,000 ~1,500	
Hyroth-type Sampling Bottle	120ml	300	〃 (〃)	2~ 3 Bottles	¥ 600 ~900	

7. Expenses for Sampling and Transportation of Samples

Source of Samples	Transportation Distance	*1	Expenses of Venicle	Sampling Frequency	Annual Cost	Remark
Water Source	30 km in Average (One Way Trip)	¥18 Per km	¥20 Per km	Once A Month 12 Times A Year	¥27,360	
Water Treatment Plant Raw Water Treated Water Filtered Water Water in Reservoir	1 km in Average (One Way Trip)	* Estimated under the assumption that each vehicle runs 8km per 1lit. which costs ¥140.	* Estimated under the assumption that each vehicle at the cost of ¥2,000,000 runs 20,000 km per year for 5 years.	Once A Month 365 Times A Year	¥27,740	
Hydrant in City	3km in case of 1 site. 10km in case of 16 site. (One Way Trip)			Once | 16 Times A Day	Once A Day ¥83,220 | 16 Times A Day ¥277,400	
Environment	2 km in Average (One Way Trip)			Once a Month	¥1,824	
Sampling Expenses		2,000 Samples per Year		¥ 140,144	Unit Cost Per Samples ¥70	
		8,000 Samples per Year		¥ 334,324	Unit Cost Per Samples ¥42	

NOTE : *1) Transportation Cost (Unit Price Per 1km) Fuel Cost EXcluding Personnel

8 Number of peopel Required for Each Water Quality Analysis Calculated by Ttaking the Analysis Time Necessary into Consideration

		Time Required for Analysis		Time Required for Preparation of Chemicals and Analysis		The Number of People Requireed for Analysis in Total	
		In case of 1 sample (minites)	In case of 10 samples (minites)	In case of 1 sample (minites)	In case of 10 samples (minites)	In case of 1 sample (persons)	In case of 10 samples (persons)
A	Turbidity	1	5	6	10		
	Colourity	1	5	6	10	0.093	0.167
	pH Value	1	5	6	10	(0.077)	
	Residual Chlorine	5	15	10	20		
B	Nitrous Nitrogen	15	30	35	50		
	Ammonium Nitrogen	15	30	35	50		
	Nitrate Nitrogen	90	240	110	260	1.29	2.43
	Potassium Permanganate Consumption	15	30	35	50	(1.075)	(2.03)
	Chlorine ion	2	20	22	40		
	Iron	90	120	110	140		
	Manganese	90	120	110	140		
C	General bacteria	30	60	45	75	0.65	2.08
	Coliform Bacteria	60	90	75	105	(0.54)	(1.74)
	Total Microorganisms	60	430	75	445		
D	Total Hardness	2	20	32	50		
	Evapolation Residue	300	320	330	350		
	Copper	90	180	120	210		
	Lead	120	240	150	270		
	Zinc	90	180	120	210		
	Fluorine	300	700	330	730	7.34	14.97
	Cyanogen	120	240	150	270	(6.14)	(12.47)
	Phenol	180	540	210	570		
	Mercury	180	540	210	570		
	Anikyl Mercury	120	480	150	510		
	Hexavalent Chromium	20	60	50	90		
	Arsenic	180	360	210	390		
	Cadmium	120	240	150	270		
		2,135	5,300	2,892	5,895	9.403 (7.332)	19.647 (16.378)

The number of persons required for each group of tests shown in the last columns are calbulated by diving the total time required for preparation of chemicals and analysis for all items of tsets in the froup by the substautial work hours in aday. The number shown on the top is the number of persons required under the assumption that the substantial work hours in aday is 5 hours and the number on the bottom in the parenthese, 6 hours.

9. Number of Samples for Analysis and Laboratory Facilities (Plan)

Area / Served Population	Physico-chemical Lab.			Biological Lab.		Bacteria Lab.		No. of Samples	Furniture for Laboratory						
	Ordinary Lab.	Lab. for Close Analysis	Other Facilities	Pre. Room	Lab.	Pre. Room	Lab.	A:Turbidity, Etc. B:Ammonium C:Biology D:Heavy Metal, Etc.	*1	*2	Shelf	Draft	Desk	Level	Others
101 ～ 5,000	40sqm							A:2,190	1	2	3	1		2	
5,001 ～ 50,000	40sqm							A:2,190 ～3,650	1	3	5	1		3	
50,001 ～ 100,000	50sqm		Chemical and Apparatus Storehouse					A:3,650 ～5,110	2	3	6	1		4	
100,001 ～ 250,000	50sqm	30sqm	*3	20sqm	20sqm	20sqm	20sqm	A:5,110 ～6,570 B:168 ～216 C: Ditto	6	3	7	2	4	10	
250,001 ～ 500,000	70sqm	70sqm	*4	25sqm	25sqm	25sqm	25sqm	A:6,570 ～8,030 B:216～264 C: Ditto D:25～29	7	3	12	2	4	12	
500,000 ～	100sqm	100sqm	*4	30sqm	30sqm	30sqm	30sqm	A:8,030～ B:264～ C:264～ D:29～	1	4	15	3	4	14	

NOTE : *1) Large Experiment Table
*2) Small Experiment Table
*3) Chemical and Apparatus storehouse, Balance Room, Data Room, Conference Room, Darkroom
*4) Chemical and Apparatus storehouse, Balance Room, (Construction) Work Room, Data Room, Conference Room, Darkroom

WORLD HEALTH ORGANIZATION

WESTERN PACIFIC REGION

ORGANISATION MONDIALE DE LA SANTE

REGION DU PACIFIQUE OCCIDENTAL

REGIONAL CENTRE FOR THE PROMOTION OF
ENVIRONMENTAL PLANNING AND APPLIED STUDIES (PEPAS)

REGIONAL WORKSHOP ON DRINKING WATER
QUALITY MONITORING AND SURVEILLANCE

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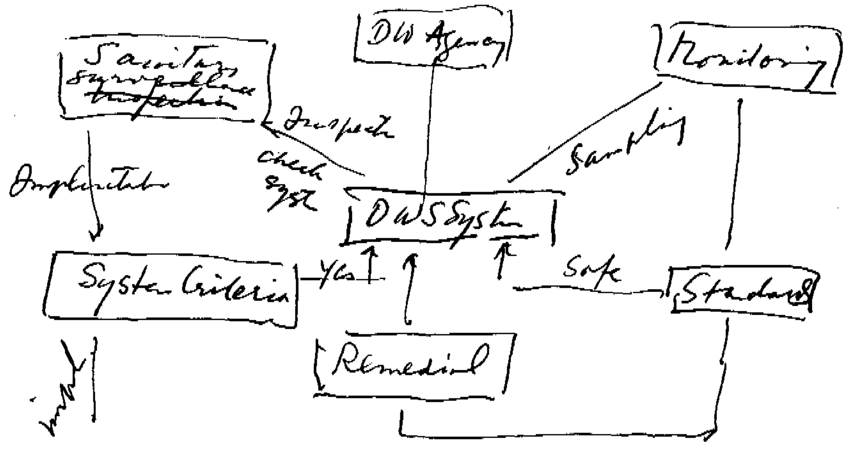
PRINCIPLES OF DRINKING-WATER QUALITY MONITORING AND SURVEILLANCE

by

Dr Y. Magara



1. Introduction

In the modern society, water is used for a variety of purposes, providing an important base to support the social activities of citizens. We can find an economic logic in the attempt to utilize the benefit of water service to a maximum extent by incorporating the system of water supply into the social system. The beneficialness of water supply is lying in the aspect that people can freely utilize the "dissolving power, heat capacity and continuity of water" at the point of use. Its original benefit is, however, still lying in the fact that people can ensure at their will the necessary water to maintain their life.

Regarding to the structure of demand for city water, the quantity of water being used for maintenance of human life and health accounts for merely about 20% of the total quantity of water or 30 to 40lcpd. The other uses are overwhelmingly large in share.

Even within the scope of those people who are drinking community water, various people are using it. They range from the infants who rely on community water for the water with which their milk is prepared, such people as sick persons and the aged who are highly sensitive, to healthy people like adults. In particular the progress towards the aging society and the advance of medical treatment techniques are no doubt enhancing the increase in the population which has weak resistance to environmental pollutants. It is a matter of course that the objective of managing water service and other base facilities for health in life, which are deeply related with the movement of environmental pollutants, is to ensure the health and safety of the citizens, but the question would involve the contents of such health and safety. Referring to the concept of health, in addition, the view of health in terms is going to change due to the effects of society, economy and culture. As a consequence, we have to stand on the premise that the level of the control target of water service will also change.

Water supply is essential to every form of life in every communities, however the water supply system is differed from each community because each water supply is strongly linked with each local condition. The demand for water differs greatly according to climate, structure of houses, life of style and living standard. Furthermore, the condition of water sources also differ, due to unequal distribution of water source. Thus, the water supply system differ according to local condition, and therefore the monitoring and surveillance of drinking water quality should be designed and implemented by taking into account the type and the level of the water supply system which is affected by the local condition of the community.

2. Characteristics and Management of Water Supply System

People get water for the purpose of drinking, domestic, industrial and commercial activities from the community water supply system which is operated by either public or private waterworks or from their individual water sources. Water itself is also classified into piped or unpiped, treated or untreated, derived from any suitable sources such as rivers, ponds, wells , run-off etc.. If water in each of them above mentioned is contaminated, it becomes a dreadful vector to spread a communnical disease and to decrease a potential of activities of the communities. Therefore water in each of them should be assured its quality and quantity so as to meet the target of public health condition of the community.

Under the International Drinking Water Supply and Sanitation Decade, most of WHO member countries have established the national program of water supply and environmental sanitation. It is usually provided the regulatory design standards or manuals in which show the compliance level of quality and quantity of supplied water by the government. Water is an indispensable necessary for daily living and greatly implicated in the life and health of people, and water supply effects the inhabitants of a whole local community such as public hygiene,fire protection, etc., deeply concerned with the local administration. Water supply can be specified as the case with material service, the payment in consideration of those benefits above mentioned shall be paid by the beneficity at the rate of which receives the benefit, that is the payment on beneficence - born basis.

The aims of water supply enterprise are to supply water it meets the quantitative and qualitative demands of the consumers, therefore water supply enterprise should implement their activities according to their self regulations in principle in order to anticipate the water charge from the consumers. On the other hands because the water supply contribute to secure public hygiene, and especially to prevent epidemic disease, water supply should be excluded commercialisms and thus the principle of water works being laid and managed by autonomous agent was preferred by the public in many countries.

Even in water supply enterprise play a key role to provide water to the community under the public management that means the voluntary control and the supervision of the communities, they often can not satisfy the demands of the community because of the shortage of human resource, water source and insufficient capability of consumers to burden water charge. In order to cope these situation , it is desirable that the government should support water supplier under general affairs or health registration.

The registration concerning to water supply should include

(1) the specification of the scope of water supply enterprise,
(2) the delegation of powers to administer the registration on law to a specified agency or agencies,
(3) provision for the establishment and amendment of regulations for

the development, production, maintenance, and distribution of safe drinking water and
(4) provision of enforcement.

The specification of the scope of water supply enterprise should shows the necessary provisions who can be the water supplier, in such as local public nonprofitable authority, private profittable enterprise and so on.

The water supply enterprise or authority has two faces of their activities such as the construction of water supply facilities and the production-distribution of water to the community. In many developing country the level of safe water supply is still low, therefore the construction as well as the expansion work should accelerate to meet the national target of the IDWSSD program. But the human resources as well as financial potential in the local community are limited, therefore the construction work should be implemented or suported intensively by the government in developing countries. Because the water supply facilities development are closely related with water resource and other social infrastructure management, the construction work is usually implemented by the construction and/or public works agency in many countries. On the other hand, the management of water supply authority such as finance, man-power management, production and distribution are closely related with the local administration as well as public health, therefore the management of water supply is implemented by water supply authorities supported by the local community under the supervision of the home affairs agency and/or public health agency in many countries.

Either the water supply development sector or the water supply management sector have the responsibility for the quantity and quality of water it provides, however it is sometimes difficult to assess their activities and to take the counter measures,if necessary, by theirselves because the conflict among the political, administrative, economical, technological and health aspects. Therefore the delegation of powers to administer the registration or law to specified agency(ies) is essentials to wholesome of drinking water supply. It is an ideal that the sole agency in national level is established to administer every aspects of water supply. Since water is closely related with health, the public health authorities has to play a key role to establish the agency.

Even in the sole agency has established, it should note that the agency still has two functions which are the support and supervisor to water supply authority. Those two functions are complementary each other to fulfill the object of drinking water supply. The drinking water quality standard should become the basis of the management of each sector. Practically the following activities are implemented by the agency according to the guidelines or manuals of which are developed considering the social, economical, technological and other conditions of the country so as to meet the drinking water quality standard.

(1) Approval of water sources,
(2) watershed protection,
(3) approval of the construction and operating procedures of water authority,
(4) monitoring of water quality and quantity,
(5) sanitary survey,
(6) financial arrangement,
(7) human resources development,
(8) public relations,
(9) research and development and so on.

Since the drinking water quality standard is the basis of every activities of it concerns, it should be established through the deepest consultation not only within the public health sector but also among the sectors related with drinking water supply in the country.

3. Drinking Water Quality Standard

3-1 Principles of Drinking Water Quality Standard

At present, the quality of community water in Japan is prescribed by the water quality standards subject to the Water Works Law. The operator of water service should carry out test on the supplied water, judge whether it is proper or not to supply water based on the test results in the light of the water quality standards, and suspend water supply as occasion demands. That is to say, the water quality standards have an absolute significance to the water works authority and in turn the user, and it is important to keep understanding the policy for establishment of the said standards.

The standards of water quality subject to the Water Works Law were studied and formulated in the light of such three principles as
(1) safety and acceptability in use,
(2) appropriateness in selection of items and
(3) the propriety of the test method.
Referring to the "safety and acceptability in use," it can interprets that "safety" and "acceptability" mean that the effects as indicated by , disease and change in physiological functions in no way occur and that any trouble (e.g., coloration of laundry) is not caused in general use, respectively. "Appropriateness in selection of items" means the appropriateness of obliging all the water works authority to perform tests, and "the propriety of the test method" would mean the scientific appropriateness of the test method as shown by the water quality standards, and its feasibility. That is to say, the water quality standards should represent the level of community water management that it should maintain its absolutely safe level against chemical substances and microorganisms within a feasible scope in the framework of water service from the nationwide standpoint. Namely, the water quality standards as established in this way possess the nature that they should be complied with in any areas the country over

and under any conditions.

In community water, however, the view of the establishment of the target level is changing as in the case of bother environmental media. Namely, it is pointed out that a view of controlling and managing "health risk" at a certain level is being introduced for the purpose of ensuring the absolute "safety." This is exactly the fact that the view of the so-called risk assessment/risk management has been taking root particularly in controlling and managing carcinogenic chemical substances.

3-2. Water Quality and Management Target Level

City water is utilized for various purposes, and there are various impurities contained in community water, so that it is important to keep understanding correctly the relationship between the purposes of using water and the characteristics of water quality. The WHO drinking water quality guideline established in 1984 indicates the respective guideline values, dividing the water quality into four categories, such as microbiological property, health related inorganic substances and organic chemicals and aesthetic and organoleptic properties. Under the Safe Drinking Water Act (as partly amended in 1986) of the U. S., in addition, there are primary drinking water regulation and secondary drinking water regulation, the former being the standard aiming to protect human health and the latter to reduce disorders caused by the use of community water, provided, however, that water supply enterprise are obliged to comply with primary drinking water , but not with secondary drinking water regulation. Although it remains open to study whether this sort of system, which establishes the standards of water quality in accordance with the use characteristic and water quality characteristic of community water, will adapt itself to the system in other country. In Japan it is considered that the manuals of the maintenance and operation of water supply facilities and the tentative guidelines and target values issued by way of various notices have already been of nature close to the aforementioned system, so that the said system could be indicating one direction on how the water quality standards should be in the situation that the people's needs for community water will be increasingly diversified in the future.

The WHO several chemicals drinking water quality guideline established in 1984 and the Safe Drinking Water Act of the U. S. are characterized by the point that the respective guideline values or standard values have been prescribed for carcinogenic substances by the different methods from the erstwhile system of formulating the standards. This is also depicting realistically a change in the view of the water quality standards of drinking water. It is widely known that the sciences related to carcinoma are far from mature, showing a steady progress. It is considered unacceptable, however, that the control and management of carcinogenic substances in drinking water does not have to be carried out because the maturity of those sciences is at a low level, so long as there is the very truth that the carcinogenic substances in the environment are one of the causes of carcinoma. The stand of public health/sanitary engineering to maintain and enhance human health, with awareness of the low maturity of the sciences related to carcinoma, evaluated the effects of environmental carcinogenic substances on the health, thus addressing the standards to control and manage them. As will be shown later, however, the guideline or standard values of the carcinogenic substances are those of such nature that they should be always reviewed to meet the progress of the sciences and be revised from time to time as occasion demands.

For the standard value of water quality, heretofore, a maximum threshold value has been obtained from the results of chronic toxicity test and then multiplied by safety factor (uncertainty factor), thus leading to the calculation of allowable daily intake. Further, the intake from drinking water has been determined in view of the percentage intake from drinking water out of the total exposure to the subject substance, and the allowable concentration, that is, the

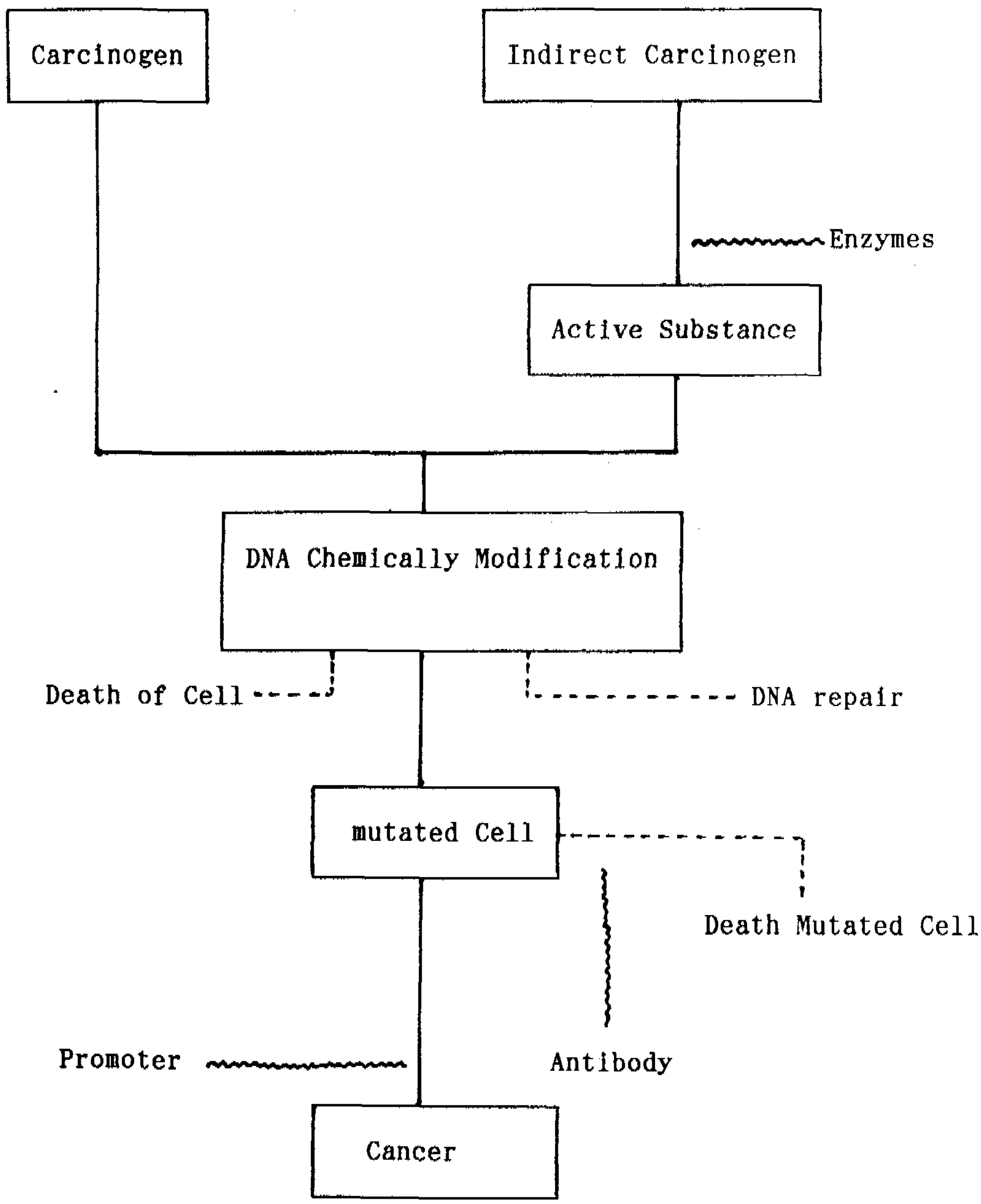


Figure 1 Mechanism of Carcinogenecity Caused by Chemical Substances

standard value of water quality has been determined assuming that the daily water intake of an adult is 2 L. That is to say, any intake not more than the foregoing standard value has been defined as the absolutely safe level that causes no effect on health. In other words, the presence of a threshold or critical value has been addressed for an impurity in drinking water.

On the other hand, the method of establishing a guideline value or standard value for a carcinogenic substance is entirely different from the above mentioned one for the chronically toxic substance. The carcinogenic mechanism has been considered to be explained by the channels as illustrated in Figure 1. In the formulating work of the WHO guideline in 1984, those channels shown by the real line out of the aforesaid carcinogenic mechanism were taken into consideration for determination of the guideline values for the carcinogenic substances.

It is conceived that carcinoma might be initiated as the monomolecules of a chemical substance develop direct action on DNA in somatic cells or induce mutation in DNA. Even though the chemical substance itself has no Carcinogenecity, in addition, a chemical substance taken into a living body might be activated in the process of metabolism and then become a substance which induces mutation in DNA or a substance which possesses Carcinogenecity. In any case, the cells suffering the mutation of their DNA's would occur due to a single chemical substance, and the proliferation of such mutated cells could cause the progress of carcinoma. As a consequence, whether carcinoma is generated would be dictated by whether a person is exposed to the concerned chemical substance. That is to say, there is no threshold or critical value, unlike in the case of the chronic toxic substance. Using the relationship between the dose and the response amount obtained from an animal test conducted under the conditions of high exposure to a chemical substance based on the foregoing view, the probabilities of cancer development at the level of the presence of the chemical substance (equal to extremely low exposure) in the environment are obtained by a statistical technique. An allowable exposure value, when a certain carcinogenic risk is made the level of management, can be obtained in the same way as a carcinogenic probability (risk) at the time of a certain exposure can be gained by the above mentioned method.

While many models are suggested in the extrapolation that pursues the carcinogenic risk under a low exposure condition, a linear non-threshold value models on the safest side are used in the WHO guideline. The guideline values when sufficiently reliable data were acquired on tow or more kinds of animals, when there was, if possible, a finding to support such animal test data as the results of mutagenicity test, etc. and when the carcinogenic risk was set at 10-5 targeting at those chemical substances on which epidemiologic information was available, were obtained by use of the above mentioned the linear non-threshold value models and were then shown by WHO.

As showed in Figure 1, however, many views have been accumulated since the time when the WHO guideline values were established in 1984, for example, the presence of a mechanism in which even though DNA's are chemically modified, the concerned cells die, the DNA's are repaired to be restored to the normal cells, or the mutated cells are inhibited from proliferation or die, or the presence of not only those substances that cause DNA mutation which might trigger carcinoma but also those that promote carcinoma. Furthermore, there have also been accumulated those views of the species difference between human and animal, the difference in the sensitivity to Carcinogenecity developed among the lines of test animal species, the interpretation of malignant and benign tumors, etc. These matters indicate that it is not necessarily scientific to obtain risks to humans from the results of animal test only by means of the non-threshold value models of the linear system in relation to all of the carcinogenic chemical substances. They also imply, in addition, that it is necessary to review the animal test data that were used in establishing the guideline values in the WHO guideline. As a result of these things, the science has made progress to the stage in which the scientists examine also the data related to Carcinogenecity on human or animal from the aforesaid viewpoints, etc. and take into consideration the carcinogenic substances also in terms of the priority setting or the risk assessment techniques related to the establishment of the management standards of the carcinogenic substances, etc. by means of the classification as indicated in Table 1.

Table 1 Illustrative Classification of Evidences Based on Human and Animal Data

Evidence in Epidemiological Studies	Evidence in Animal Studies				
	Sufficient	Limited	Limited or equivocal	Inadequate	No evidence
Sufficient	A	A	A	A	A
Limited	B1	B1	B1	B1	B1
Limited or equivocal	B2	C	D	D	D
Inadequate	B2	C	D	D	E
No evidence	B2	C	D	D	E

3-3. Plan for Revision of WHO Guideline of Water Quality of Drinking Water

Although the WHO guideline of the water quality of drinking water was published in 1984 as already described, its formulating work had been completed in 1980. That is, the current WHO guideline is one that was formulated based upon the scientific views in 1980. Hence, there was no sufficient data available on toxicity, therefore leaving the chemical substances, such as trichloroethylene for which the tentative guideline value was merely suggested, or those chemical substances for which no guideline value could be suggested despite foreseen problems in terms of public health. On the other hand, there has occurred the necessity for review of the existing toxicity data due to the progress of the sciences related to carcinoma as mentioned above, and it has become obvious that many chemical substances have problems in terms of public health as plenty of toxicity data have been accumulated.

As a description that "the contents of the guideline should be reviewed on a periodical basis" is also contained in the current WHO guideline, with an aim to revise it in 1991 WHO has scheduled to hold meetings in 1987 and 1988 to start out the said work, determining the following policies:

<Nature and Objectives of Guideline>

The philosophy of the guideline is appropriate, so that there is no need for any particular revision thereof. WHO will further clarify the information and preconditions underlying the guideline recommended values and thus make it possible to accomplish the intention to desire the WHO member nations to make most use of the current guideline. The preconditions established to develop the current guideline into a new one should be made better-grounded, in addition, and the modification of these preconditions should enable people to learn how the water quality requirements and their effects on health will be changed. The criteria on individual substances shall describe the procedure for the establishment of guideline values and what figures have been rounded off as well as contain the results prior to the rounding-off of the figures for reference.

<Toxicological Viewpoint>

We should select The toxicity data based on animal test should be evaluated by fully taking into consideration the species differences in metabolism, pharmakinetic and sensitivity in order to assure the conclusions to apply to human. For the purpose of selecting the uncertainty factor to be used in formulating ADI, in addition, it is necessary to pay attention to not only the species differences but also the certainty of data, and to a highly sensitive human group as well. In verifying the data on Carcinogenecity, it should pay attention to the certainty of the data including epidemiology, animal test and genetic toxicity and clarify the appropriateness of the application of low-exposure extrapolated models. This signifies the directions in which the low-exposure extrapolated models are acquired and presented for the carcinogenic substances classified into IARC1, 2A and 2B in the IARC classification of carcinogenic substances and in which the guideline values are gained by threshold value models and presented for those other than the above ones, as has been made a principle in gaining the U.S. MCLG (Maximum contamination level goal) which is shown in Table 2.

<Items to be Studied>

Still another policy is to study the guideline in relation to the chemical substances as specified in Table 3 in the light of the principles: there is evidence that the chemical substances have effect on health; they have such effects at their concentrations in the drinking water; they are frequently found in the drinking water; they can be measured with GC or abbreviated GC/MS level analytical equipment; and they can be managed and controlled by means of the water service.

Table 2 Principles of Establishing Maximum Contaminant Level Goals for Carcinogenic Chemical Substances in U.S. EPA Drinking Water Safety Act

class	Evidence	classification	MCLG
class 1	Sufficient	EPA A,B IARC 1,2A,2	0
class 2	limited equivocal	EPA C IARC 3	RFD/ $10^{-5}10^{-6}$
class 3	none or inadequate	EPA D,E IARC 3	RFD

In parallel to the above, further, work is also to be developed on their microbiological properties and those properties affecting the inorganic substances, which have effect on health, aesthetic and organoleptic.

4. Monitoring and Surveillance

Surveillance means that the keeping of a careful watch at all times over the safety and acceptability of drinking water supplies. Surveillance requires a continuous and systematic program of survey , carried out at different points of the water distribution system. Surveillance program aimed at ensuring a consistently acceptable level of drinking water quality, if it is to be fully effective, may also require legislation supported by regulatory standards and code of practice.

Table 3 List of Items to Be Studied for Revision of WHO Guidelines

ORGANIC

(i) Chlorinated organic

a. Chlorinated alkanes

carbon tetrachloride
1,2-dichloroethane
1,1,1-trichloroethane
dichloromethane
1,1-dichloroethane

b. Chlorinated ethenes

1,1-dichloroethene
1,2-dichloroethene
trichloroethene
tetrachloroethene
Vinyl chloride

c. Chlorinated benzenes

(ii) Disinfecation by-products, including trihalomethanes

a. Trihalomethanes

chloroform
bromoform
dichlorobromomethane

b. Formaldehyde

c. Chlorophenols

2,4,6-trichlorophenol

d. Other chlorination reaction products

(iv) Pesticides

aldrin/dieldrin
chlordane
2,4-D
DDT
HCH(lindane)
heptachlor and heptachlor epoxide
hexachlorobenzene
methoxychlor
atrazine
simazine
alachlor
bentazon
MCPA
metalachlor
molinate
pendimethalin
propanil
pyridate
trifluralin
pyrethroids
ethylene dibromide (incl.automobile exhaust)
1,2-dibromo-3-chloropropane
1,3-dichloropropane
1,2-dichloropropane
1,3-dichloropropene
aldicarb
carbofuran
chlortoluron
isoproturon
other chlorophenoxies

(iii) Aromatic hvdrocarbons

a. Benzene,lower alkyl benzenes and vinyl benzene

styrene
xylene
benzene
toluene
ethyl benzene

b. Polynuclear aromatic hydrocarbons

(v) Miscellaneous organics
products

acrylamide
plasticizers:
- diethlhexyladipate
- diethlhexyladipate
organotin
hexachlorobutadiene
epichlorohydrine
EDTA
NTA

• INORGANICS

(i) Health-related inorganics and aesthetic/organoleptic aspects

aluminium
ammonia
antimony
arsenic
asbestos
barium
beryllium
boron
bromate
cadmium
chloride
chromium
colour
copper
cyanide
fluoride
hardness
hydrogen sulfide
iodine
iron
lead
manganese
mercury
molybdenum
nickel
nitrate and nitrite
oxygen,dissolved
pH level
selenium
silver
sodium
sulfate
taste and odour
temperature
tin
total dissolved solids
turbidity
uranium
zinc

(ii) Disinfectants

residual chlorine
chlorine dioxide,incl.
chlorite and chlorate
chloramines(mono-,di-)

MICROBIOLOGY/BIOLOGY

RADIOACTIVE MATERIALS

The organizational arrangement at ensuring compliance with the requirement of legislation, standards, or codes of practice of drinking water quality must provide for surveillance to be shared between the water supply sector and a separate, and preferably independent, surveillance agency. The surveillance agency should ideally established with national support and operate at central, regional and local levels, usually the the health authority. It should be concerned with the public health aspects of drinking water supplies, and have overall responsibility for ensuring the all such supplies under its jurisdiction are free from health hazards.

Some important aspects of the surveillance program are as follows:
(1) The agency should have the sole responsibility within the health authority for providing surveillance services to protect the public from waterborne diseases and other hazards associated with the water supply.
(2) Water quality surveillance should be integrated with other environmental health measures, especially sanitation.
(3) Surveillance requires specialized knowledge and the agency should thus include personnel specially trained in matters such as sanitary engineering, community health, epidemiology, chemistry, biology, etc., additional support should be provided by medical profession, particularly during an outbreak of enteric diseases.
(4) Health authorities should posses centralized laboratories and other service which can be advantageously used for the conduct of program of surveillance of water supplies.
(5) Periodic reports to the government regarding the public health situation of the country's water supplies are essential.

If the operational standards of water supply agencies are high, the duties of the surveillance agency can be reduced to a minimum. In these circumstances, the surveillance agency, while still retaining the ultimate responsibility for ensuring the safety of all public water supplies, should be able to give greater attention to the supply systems having water of the poorest quality.

Since the program and the level of surveillance should be established by taking account the conditions of water supply such as the type of water supply system, available equipment and human resources, the economical condition of the community, etc., an inventory of the existing and proposed water supply system should be prepared and should include details of the water source, size and type of water treatment process, the distribution system, population served, number and type of employees, the records of operation, the records of routine water quality tests. etc. From an analysis of all the information in the inventory, the workload for the surveillance activities can be assessed and the cost of surveillance calculated, this is essential if a realistic program is to be undertaken.

In the case of water quality testing carried out by the local surveillance agency, the lines of communication normally pass through a regional surveillance agency. Where the regional surveillance agency decided that the results of the water analyses are unsatisfactory and that immediate remedial action is required, that decision together with the appropriate instructions must be conveyed both to the local surveillance agency and to the responsible water supply agency at local level. The water supply agency responsible at the local level should implement the remedial measures such as high level disinfection, suspending water supply and/or flushing distribution systems, etc.,. In addition the water supply agency or surveillance agency should also alert the population to the situation and advise them to boil all their drinking water.

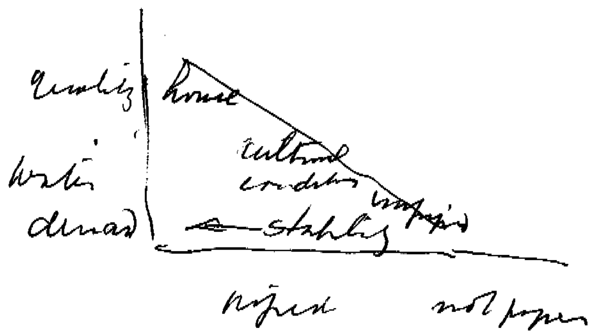
In some countries, many regions have qualified staff to carry out surveillance but, in others, such staff will be available only at the central level. To avoid difficulties in communication, every effort should be made to ensure the transmission of information is as direct and simple as possible. It is most important the the bodies responsible for surveillance ensure that any instruction they issue, whether written or verbal, are clearly understood, This should help to avoid any misunderstanding and conflict between the different activities of the various bodies concerned with drinking water supply. Cooperation and collaboration among the different bodies is of great importance and should be fostered so as to ensure a good working relationship.

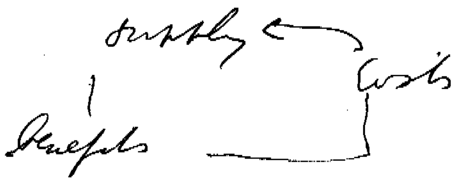
5. Conclusion

The level of the management and control of chemical substances and microorganisms in the community water is featured by the fact that such management and control has been carried out targeting at those phenomena that occur at extremely low probabilities. The typical case is concerned with carcinogenic substances in drinking water. While the goal of drinking water quality management should be aiming to reduce any risks due to the carcinogenic substances to zero, we must manage the social system named community water while allowing certain risks. As U.S. EPA, for example, has made it a principle that the water quality of the treated water available when the Best Available Technology is applied should be determined as MCL (Maximum Contaminant Level) that is the standard, it is also the rule of WHO that the guideline values should be determined by adding engineering judgment to toxicological views.

WHO recently reported that the cost per person of providing water and sanitation is about US$180 by the late of 1980. In southeast Asia, the per capita costs of providing safe drinking water in rural area has fallen to as little as US$15, improved water and sanitation together can cost as little as US$30. If these system are developed by using ground water, fortunately deep ground water, we can develop the surveillance program which needs the least cost. But, it is said the population of urban areas in developing countries is continuing to increase and then the number of cities whose population is more than

10millions becomes more than 65 in the year of 2025. Water supply system should be established to use surface water for their water source on that time. Considering the treatment cost as well as the surveillance cost for that type of water supply system, we should make more effort to develop the best appropriate and available technology for the safe water supply.





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PROCEDURES FOR MONITORING OF DRINKING WATER QUALITY - ANALYTICAL QUALITY CONTROL, SAMPLING FREQUENCY, TECHNIQUES AND PROCEDURES

by

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Procedures for Monitoring of Drinking Water Quality

-- Analytical Quality Control, Sampling frequency,

Techniques and Procedures ---

Y.Magara

1. Introduction

Monitoring of drinking water without intensive studies on the subjects of 1) its purpose and contents, 2) locations and the number of water taps to be monitored and 3) sampling and analytical methods would not be able to provide really working data for effective management of drinking water quality. In fact, monitoring without such systematic approach could not possibly bring on any significant data conducive to efficient drinking water quality control and management.

The contents of monitoring varies with its purpose, whether to monitor chemical substances which may directly hazard human health such as mercury, cadmium, etc. or specific properties of water which may deter the effective utilization of tap water, such as turbidity, colour, etc.. Where contaminants which tend to accumulate into human body such as heavy metals are to be monitored, the matter of primary importance is to identify the concentration and characteristic properties of these contaminants in tap water supplied to the monitored area and acquire the data which helps us judge whether their concentrations are on the level of hazards to human health. Besides, if water contamination and its progress is monitored over an extended period of time for the purpose of determining the peculiar change of these contaminants, it should possible to take effective countermeasures before they pose menace to human health.

Since it is assumed that the concentration of contaminants in tap water supplied to the monitored area changes at random in any locations or at any time and that their distribution is in normal distribution, the characteristics of their concentration can be represented by average annual concentration and standard deviation. Requirements for monitoring vary with the magnitude of the accuracy (on specific significant level) of the annual mean concentration.

In other words, if the required significant level and accuracy are low, correspondingly less sampling frequency will suffice, and so sampling and analytical processes can proportionately be less precise. Accordingly, prior to monitoring, it is invariably necessary to predefine the requisite degree of accuracy of information or data to be provided by the monitoring.

Hereafter, the examples of the designing of monitoring programme for heavy metals and organic chlorides in tap water are presented in order to make clear the matter concerned on the monitoring.

2. Accuracy of monitoring data

The accuracy of monitoring data can be determined by the selection of maximum tolerable error of annual mean concentration and/or the smallest concentration (hereafter describes as CL) of which does not implies the error. When monitoring any contaminants potentially hazardous to human health, it would be appropriate to set one-tenth (1/10) of the standard value of water as CL in view of their characteristic properties. Besides, it should be noted that the maximum tolerable error of the annual mean value obtained changes in proportion to the magnitude of the value itself. Therefore, it is a common that the maximum tolerable error is selected to 20% of the CL if it is greater than CL or 10% of the CL it is smaller than CL, and to estimate the mean value within the said tolerance in terms of a 95% of confidence level. Based on the CL and the maximum tolerable error, the accuracy of analytical method and the number of samples required shall be decided.

Errors arised by sampling and analysis are classified in the "systematic error" and the "random error." Of these, sampling error is for the most part classified as the systematic error, which can be practically zeroed by collection of samples in standardized way which maximizes elimination of potentials for errors. In fact, this approach would dispense with needs for consideration of the negative impact of sampling on errors to the mean annual value.

Since the error in the analytical work is ascribed to diverse factors, specific consideration to these factors will be required in order to hold the error within the maximum tolerable error. As a common practice, the accuracy of a selected analytical method is indicated in terms of the limits of detection of target contaminant, and the standard deviation and bias. In this instance, the limits of detection stand below the limits of concentration where data obtained contains no error, namely CL.

Of the errors to measurements, bias due to systematic error, namely measurement errors from laboratory to laboratory, must be less than half the maximum tolerance of the annual mean value. Accordingly, the bias of the analytical results should be held to within 0.50 C_L, or within 10% of the measured value, whichever greater.

The accuracy required of the analytical method adopted by some laboratories must also be less than half the tolerance allowed for estimation of the annual mean value. In order for any measurements to stay within the specified tolerance in terms of the 95% confidence level, the standard deviation of a given measured value is 5% of the measured concentration or 0.20 C_L. This standard deviation is determined by the standard deviation of within and between batch, respectively.

Suppose two blank tests are conducted on a single batch analysis, arrange of blank values obtained is zero, where the standard deviation is to be $\sqrt{2}\sigma_B$ (σ_B : standard deviation of the blank values). Also, since the standard deviation of the concentration similar to the blank value, namely concentration close to the limits of detection, nearly equals the standard deviation of the blank value, the standard deviation of the measurement value of samples whose concentration is close to the limit of detection also assumes the value of $\sqrt{2}\sigma_B$. Consequently, on assumption that the confidence level of these measurements is 95%, the limit of detection must be $2\sqrt{2}\sigma_B$. When defining the safety factor as 2, considering that it represents routine test performance, the final limit of detection becomes 5 σ_B. In other words, the standard deviation for measurements of samples with concentration close to the limits of detection becomes 0.20 CL.

After relevant test conditions have been established as above, it is necessary to determine sampling and analytical methods satisfying these preconditions and the locations and the number of water taps to be monitored,according to the steps as shown in Figure 1.

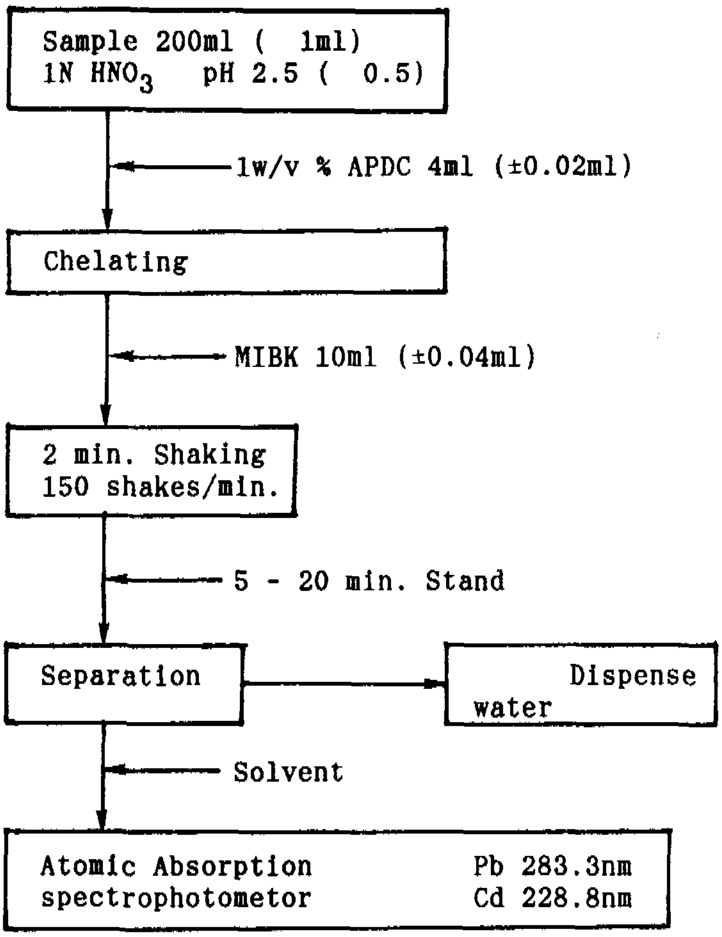

Figure-1 Flow chart of Pb, Cd Analysis

3. Design of Monitoring Programme of Pb.

3-1. Selection of Analytical Method and Accuracy Control

The WHO drinking water quality guideline of Pb is 0.05 mg/l, therefore the accuracy required of Pb analysis is shown in Table 1.

Table-1. The required precision for analytical method of Pb.

Limit of detection	0.005 mg/l
Standard deviation	0.001 mg/l or 5% of concentration
Bias	0.0025 mg/l or 10% of concentration

3-1-1 Preparatory Tests

Analytical errors are classified in the systematic and the random errors. The former relates more closely to the magnitude of bias. Accordingly, upon comparison of values measured by different laboratories, error calibration is particularly important. This error relates to 1) the question of whether or not to measure total Pb content irrespective of the form of lead contained in samples, 2) influence of co-existing substances in samples, 3) accuracy of calibration curves and 4) accuracy of blank tests conducted.

1) Verification of Calibration Curves

After preparation of a standard Pb concentration series in the order of 0, 0.02, 0.04, 0.06, 0.08 and 0.10 mg/l, analysis was made once a day for three consecutive days (three times in all) in accordance with the procedures set forth in Figure 2. Peak height were used for determining the accuracy of the calibration curves.

Table 2 presents the results of measurement and calibration, evidencing the achievement of satisfactory results in terms of the accuracy of the calibration curves.

2) Pretreatment of Samples

The analytical procedures in Fig.1 employs the direct APDC-MIBK

Table-2 Assess of Linearity of Pb Calibration Curve

1. Data

Concentration mg/l	0.00	0.02	0.04	0.06	0.08	0.10
			peak height mm			
No. 1	1	20	40	62	81	102
No. 2	1	21	40	62	81	102
No. 3	1	21	41	64	82	103

2. Covariance Analysis

Item	S	D.F.	V	F0	F	F
Variance of regression	S_R 21644.8	1	$V_R=S_R/1$ 21644.8	V_r/V_W	4:12:	4:12:
variance of residue	Sr 5.97	K-2 4	Vr=Sr/(K-2) 1.4476	2.37	3.26	6.41
Between batch	S_B 21650.67	K-1 5	$V_B=S_B/(K-1)$ 4330.13	V_B/V_W	5:12:	5:12:
Within batch	S_W 7.33	N-K 12	$V_W=S_W/(N-K)$ 0.61	7085.8	3.11	5.06

Variance of between batch 7085.80>5.41
Residues 2.37 <3.26

3. Assessment of Linearity

Item	S	D.F.	V	F0	F	F
Variance of regression	S_R 21644.8	1	$V_R=S_R/1$ 21644.8	V_R/Vyx	1:16:	1:16:
Variance of residue	Syx 13.12	N-2 16	Vyx=Syx/(n-2) 0.82	26389.75	4.49	8.53

F_0, F 9473.10>8.53 (the linearity of the calibration curve has approved)

Procedure	Briefs of Job
Selection of Analytical Method	.APDC-MIBK Extraction, AAS Method
Preliminary check	.Blank test .Linearity of Caribration Curve Covariance Analysis 95% C.L. .Feasibility of Direct Extraction .Sample → D.Extraction / HNO_3, Heat Extraction → Comparison
Within Lab. Precision Test	.Sample (Blank Std. 0.05mg/l, Std. 0.1mg/l, Tap Water, Spiked Tap Water) Duplicate analysis, 5days .Data Analysis Total accuracy .0.001 mg/l or Within batch accuracy 5% of concentration Between batch accuracy .95% of C.L. Recovery
Between Lab. Precision Test	.Sample (Blank, Std Sol, Distribt Std Sol.) 10 analysis
Stand Sol. Precision	Data Analysis, t analysis. 95% C.L.
Unknown Sample	.Sample (Blank, Hard Water Sample Soft Water Sample, Distribt Std. Sol) 5 days analysis Data Analysis, t analysis 95% C.L.
Control chart	.Sample Std. Sol. 0.05 mg/l x-R Control Chart

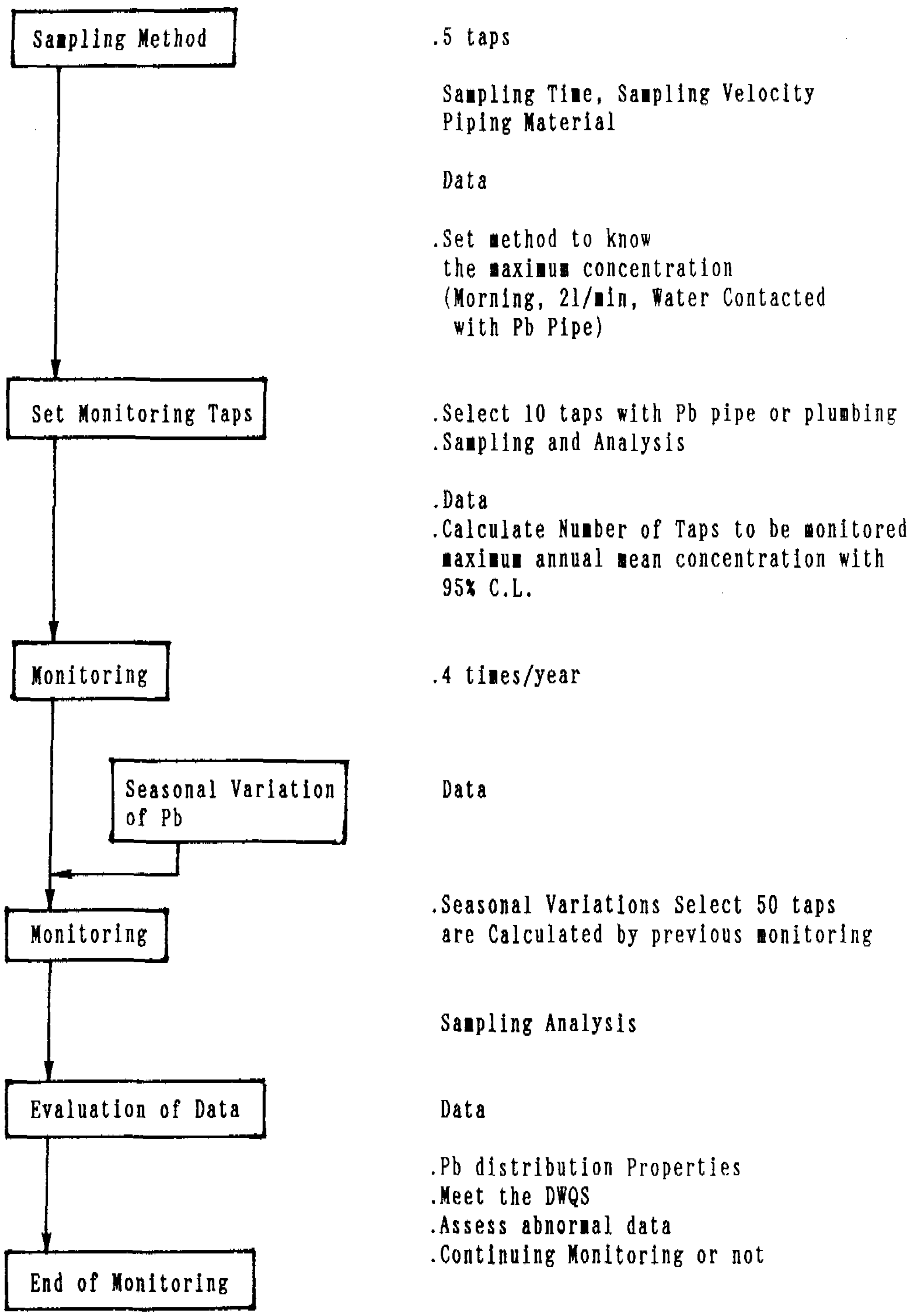

Figure-2. Flow Chart of Pb Monitoring

extraction format to condense Pb and Cd in samples, but if the sample contains Pb as metallic salt which resists the APDC-MIBK extraction, its thorough extraction may possibly be impossible. Therefore, the results obtained by indirect APDC-MIBK extraction after processing sample-contained Pb with nitric acid were compared with those obtained by direct APDC-MIBK extraction to determine if sample pretreatment is required.

Fig.3 shows a sample pretreatment process for tap water-contained ADPC and Pb reactivation. Samples (200 ml each) were prepared for a couple of subjects as follows.

a) Same sample as that used for the direct extraction process

b) Sample (a) + 1.0 (plus or minus 0.1) ml HNO_3

c) De-ionized water+ HNO_3 [in quantities enough to obtain same pH as for sample (a)]

d) Sample (c) + 1.0 (0.1)ml HNO_3

e)Sample (d) + 2 ml standard solution (1 ml=5 g Pb)

Measurements were made for these pretreated samples, blanks, 0.1 mg/l standard solution. Also, the direct extraction process was applied to sample (a), blanks and 0.1mg/l standard solution.

Based on these results, the recovery rates using Eq.(1) came up with a 96% recovery, which assures the propriety of the pretreatment process used.

$$\text{Recovery rate} = \frac{C_1+C_2}{2} - \frac{d_1+d_2}{2} \times \frac{100}{0.050} \quad \ldots\ldots (1)$$

Accordingly, the results of samples a and b, and also the results of sample a tested by direct extraction were compared in respect of measurements to determine needs for pretreatment.

Table 3 shows the results obtained, which also shows those acquired by the other laboratories which take part in the Monitoring Program. Here, the authors belong to Laboratory No.8. No particular pretreatment is required for analysis of tap water based on findings as shown in Table 3, therefore the direct APDC-MIBK extraction method was employed.

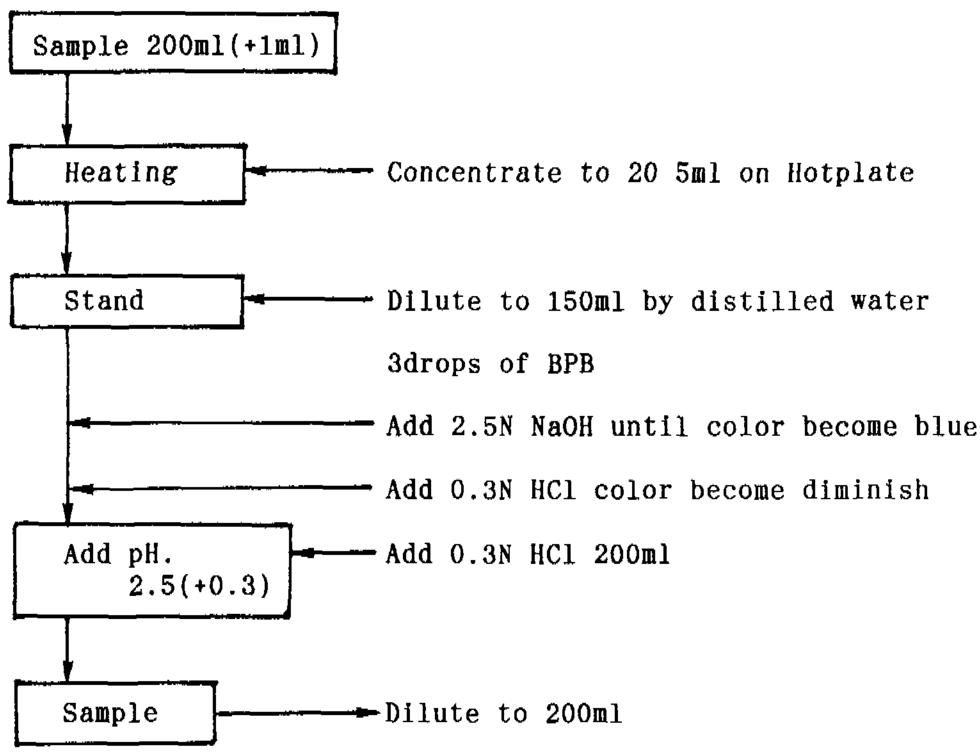

Figure-3 Pretreatment procedures for Pb analysis

Table-3 Test in the necessity of pretreatment method of sample

Labs.	Pb Concentration			Cd Concentration		
	Direct	Heating	HNO_3 + Heating	Direct	Heating	HNO_3 + Heating
1	12	13	12	-0.2	0.0	-0.1
2	90	-	86	3.3	3.3	2.4
4	38	39	39	5.1	5.5	5.7
5	64	-	62	5.5	-	5.6
6(1)	7.6	7.6	9.7	0.5	0.4	0.0
(2)	200	210	220	-0.1	-0.2	0.0
(3)	110	110	120	-	-	-
7	32	27	24	7.5	6.5	5.8
8	68	67	70	6.8	6.7	7.0

3-1-2 Identification of Within Laboratory Accuracy

Two samples each were collected from distilled water, 0.05 mg Pb/1, tap water and tap water+0.05 mg Pb/1 in a random sequence for five straight days on end (once a day) to determine if results meeting the criteria in parallel accuracy, repeating accuracy and recovery rates can be obtained, where the flowchart in Fig.4 was used for assessment of the results.

In accordance with the definition, an between-batch mean square (M_1) and within-batch mean square (M_0) are calculated by the measurement values. If M_1 is larger than M_0 after their comparison, it implies that between-batch variance is significant. The ratio F obtained by dividing M_1 with M_0 is compared with $F_{0.05}$ and $F_{0.01}$. If F is greater than F 0.01, it implies the presence of an between-batch variance, namely the presence of substantial between-batch errors between the batch. Accordingly, the analytical method needs to be checked for propriety.

In the case of $F_{0.01} > F > F_{0.05}$, it is assumable that there is no between-batch variance. In case F is greater than $F_{0.05}$, the between-

a. Blank
b. 0.05mg/l
c. Sample
d. Sample + 0.05mg/l

Between batch mean square M_1

Within batch mean square M_0

Step 1. to check between batch variation

$M_1 > M_0$

$F = M_1/M_0$ $\quad$ $F = M_0/M_1$

Step2. to check between batch variation

$F > 0.01$

$F > 0.05$

Between batch variance

$S_b^2 = (M_1 - M_0)/2$

Total variance

$S_t^2 = (M_1 + M_0)/2$ $\quad$ $S_t^2 = S_w^2 + S_b2$

Step1. to check total precision

$S_t > Z^*$

S_t^2 degree of freedom

$f = 20(M_1 + M_0)^2/(5M_1^2 + 4M_0)^2$

Step to check total precision

$F_{0.05}(f, \infty) > S_t^2/Z^2$

To check recovery

$R = d - c$

R standard deviation : S_R

$t^{(4\ ,\ 0.05)}$

$R < 0.95D^* - S_R t/\ 5$

$R > 1.05D + S_R t/\ 5$

END

Z : Target of accuracy
D : - 0.05mg/l

Figure-4. Flow chart of within laboratory precision test batch variance is assumably related as follows:

$$S_b^2=(M_1-M_0)/2 \ldots\ldots\ldots (1)$$

Total variance forms the following relation.

$$St^2=Sw^2 + Sb^2 \ldots\ldots\ldots\ldots (2)$$

If F is smaller than $F_{0.05}$, Sb^2 is zeroed and the total variance is given by the following equation.

$$St^2= (M_1 + M_0)/2 \ldots\ldots\ldots (3)$$

Provided the between-batch mean square M_1 is smaller than the within-batch mean square M_0, the variance F is defined as a value obtained by dividing M_0 with M_1 and verified as above.

If F is greater than $F_{0.05}$, the measurement method used can be defective, and probable causes thereof should be traced.

The above methods will be used to determine between- and within-batch and total standard deviations to verify if the targeted accuracy has been achieved.

The number of degree of freedom for each mean square S_t can be obtained from;

$$f= \frac{20(M_1+M_0)^2}{5M_1^2 + 4\ Mo^2} \ldots\ldots\ldots\ldots (4)$$

The value of $F_{0.05}$ (f'_{∞}) of an integer f' closest to this f value is determined by the F distribution table. Since total standard deviations of the standard solution and the tap water + standard solution assumes the value of 5% of the concentration or 0.001 mg Pb/1, whichever greater, the F0.05(f'_{∞}) of each sample to be determined by the following equation must not exceed $St^2/\chi^2(\chi$ =

targeted accuracy).

These processes practically complete the confirmation of laboratory analytical accuracy, but in addition, the rate of recovery by laboratory will be examined based on the result of analysis of tap water and tapwater plus standard solution in order to determine the recovery rate of the laboratory involved and ascertain the accuracy of the analytical method as a whole.

Average amount of recovery will be calculated based on the differentials to determine the standard deviation of the average recovery value obtained after repeating measurement five times.

When determining the t value when the degree of freedom is " n-1 " from the Student's Distribution (95% confidence level), an average recovery value R must stay within the following range.

$$0.95 - St/\sqrt{5} < R < 1.05d + St/\sqrt{5} \quad \ldots\ldots\ldots (5)$$

Table 4 presents the results on verification of analytical accuracy in this manner.

Analytical accuracy must be below the standard deviation (1 μg Pb/l) or 5% of measurements, whichever greater. With regard to the standard sample (50 μg Pb/l) and the sample (50 μg Pb/l) added to tap water, each test group has come up with satisfactory results. However, regarding tap water, groups 1, 3, 5 and 6 slightly exceeded this values, but results as a whole were satisfactory.

Besides, regarding the rate of recovery, relatively satisfactory results were achieved. Judging from this outcome, it may be concluded that the required analytical accuracy, including that of Laboratory No.8 as presented in Table 1, can be secured.

3-1-3 Verification of Analytical Accuracy by Laboratory

To compare given measurements obtained by some laboratory with those of other laboratories in terms of the standard level of accuracy, it is necessary to determine the specific analytical accuracy of each laboratory.

Table-4 Within laboratory Precision Test of Recovery

[( ) mean value]

Labs	Standard (g/l)				
	Blank	Standard Pb (50 g/l)	Tapwater	Tapwater+ 50 gPb/l	Recovery %
1	0.5	2.9 (50)	2.8 (2.7)	4.1 (56)	107+6
2	0.1	2.0 (-)	0.6 (9.8)	3.6 (72)	99+8
3	1.0	1.8 (49)	2.6 (0.7)	1.8 (49)	98+3
4	0.3	0.9 (52)	0.5 (0.4)	1.8 (52)	103+3
5	1.3	2.4 (49)	2.2 (5.7)	3.0 (59)	107+8
6	0.9	1.4 (50)	2.1 (9.0)	2.5 (57)	96+3
7	0.2	1.0 (51)	0.7 (6.4)	1.4 (57)	101+2
8	0.6	2.4 (49)	1.4 (24)	2.4 (75)	98+1

The assessment of between laboratory analytical accuracy can be achieved by 1) analyzing identical common samples used by all the laboratories, 2) determining the bias of actual measurements from the standard values and 3) by examining if deviations stay within the prescribed range of accuracy.

The bias is ascribed to a laboratory-to-laboratory variance in concentration of standard solution prepared and used on their own and to the presence of other systematic errors. As circumstances stand, verification of "between-laboratory" analytical accuracy was conducted on the standard and common solutions in two different stages.

(1) Calibration of standard solution

Standard solution and modified standard solution produced by heating and dissolving metallic lead in the nitric acid in the laboratory were diluted to the equal concentration.

These diluted samples (10 each for two groups) were analyzed by the atomic absorption method in a random sequence to compare peak values (heights) of samples in each group. As a result, no significant difference was observed between these different types of standard solution in any laboratories including the authors' as shown in Table-5.

Table-5 Standard Solution Comparison

Labs	Deviation of Two Standards %	
	Pb	Cd
1	+0.1 (+1.4)	-0.4 (+1.4)
2	+0.2 (+0.4)	+0.7 (+0.7)
3	0.0 (+0.7)	0.0 (+0.8)
4	+0.4 (+0.4)	-0.3 (+0.6)
5	+0.3 (+0.5)	+0.6 (+0.1)
6	+1.4 (+0.4)	-0.5 (+0.9)
7	+0.9 (+1.0)	-0.2 (+1.0)
8	0.0 (+1.2)	+1.0 (+0.7)

(2) Unknown test samples

Four different types of samples including de-ionized water, hard water, soft water, standard solution supplied to various laboratories by the centre of this program, recurrent analysis for 5 days on end. Table 6 presents findings.

The analytical accuracy to be achieved by each of these laboratories must be below plus or minus of 10% of the samples involved in terms of bias from the real value or 2.5 g Pb/l (blank test), whichever greater. It is deemed that each of the laboratories concerned virtually meet the specified criteria. However, Laboratory 1 tends to show somewhat larger value, and Laboratory 8, somewhat smaller value. The error can be attributed to a difference in the way of modifying the standard solution, but it should be no major issue since the cause of this error can easily be remedied. In any cases, however, it was found that each of the laboratories involved practically meet the requirements and that measurements obtained by them can be compared on an equitable basis.

Table-6 Unknown Sample List

Labs	Mean Concentration g/l				Average bias from expected value %
	Std.Sol.	Hard Water	Soft Water	Deionized Water	
1	52+4	61+6	88+4	0+0	+10
2	-	-	-	-	-
3	45+3	56+3	81+2	0+0	- 1
4	47+2	57+4	86+2	-1+1	+ 3
5	44+1	56+2	82+1	1+1	- 2
6	43+1	52+1	80+2	3+1	- 5
7	46+1	58+1	87+2	0+0	+ 3
8	40+3	48+3	77+2	0+0	- 1
Expected Value	45	55	85	0	

3-2-4 Analytical Accuracy Control

As a result of accuracy verification on the within- and the between-laboratory level, it was found that the measure-ments of the authors' laboratory meet the prescribed criteria in this respect.

Nevertheless, it is necessary to verify if the required accuracy can really be achieved in the process of monitoring.

Accordingly, standard solution with a concentration of 0.05 mg Pb/l was added to the samples each time analysis was made to calibrate the accuracy of the analytical method based on the measurements of concentration of the standard solution. Figure 5 chronologically plots the measurements of the standard solution. Assuming the average value of past total, measurements as "x" and the standard deviation as " ," verification was made to ascertain if measurements at a given time had exceeded the warning limit ("x $\pm 2\sigma$") or the action limit.

Should the action limit be exceeded, relevant results would not adopted as working data based on the conception that the required accuracy remained unsatisfied. Concurrently, efforts should be made to trace and remedy the cause of such error.

On the other hand, should the warning limit be exceeded, the cause of the error should be traced and reformed to hold the error to within the specified tolerance.

The control chart in the laboratory (Fig.5) indicates that the laboratory keeps operating accuracy within the control limit.

It means that tap water quality (results of measurement obtained in the monitoring process) was analyzed in accordance with the criteria of accuracy as set forth in Table 1.

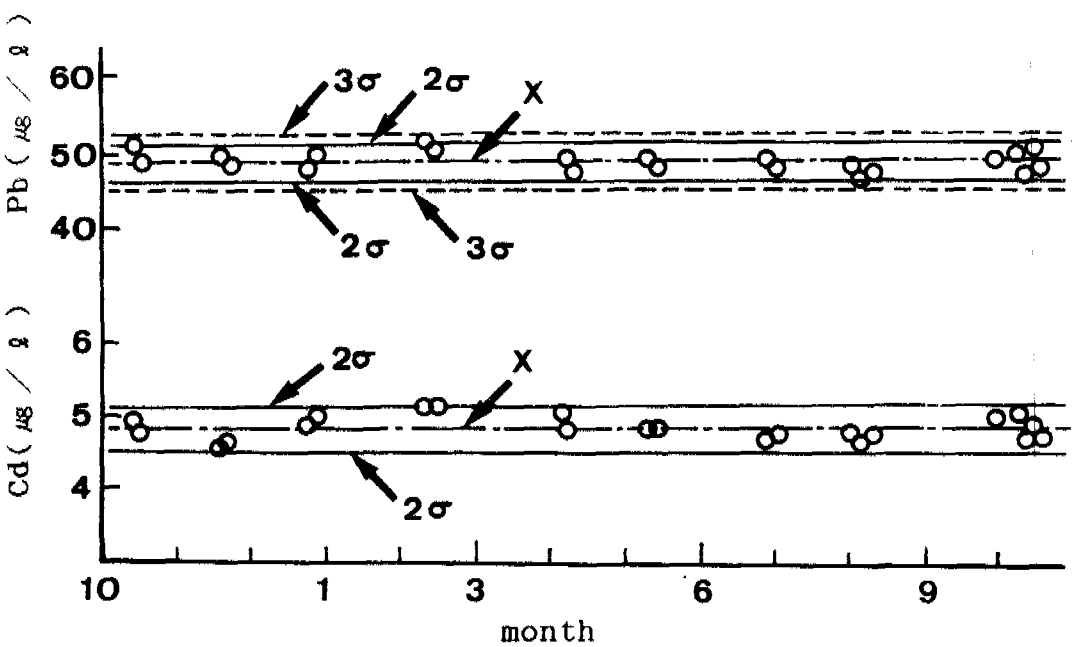

Figure - 5 Control chart of Analytical Quality

3-2. Sampling Method

It is assumed that the quality of tap water to be monitored varies with the material and length of pipes and with the velocity of water flow at the time sampling. Accordingly, sample water was collected from five cooking water taps under varying conditions to determine Pb concentration in the samples taken. Based on the findings, we followed an approach to sample tap water possibly with the highest Pb concentration.

Relative procedures are presented in details using the flowchart (Fig.2).

3-2-1 Method and Results of Investigation

In order to assess the potential effect of water distribution system and the material of pipes used, five taps (Table 7) were selected. From the five cooking water taps, we collected the following eight samples.

Table-7 Properties of Tap

No.	Pipe	Desd Water Volume	Distribution Area	Sevice Year
1	GP 20 5m LP 16 25m	71	B	1926
2	GP 20 5m CP 13 2.5m LP 13 1m	21	A	1954
3	GP 20 15m GP 13 6m LP 13 1m	21	A	1970
4	GP 20 15m LP 13 0.5m	51	B	1964
5	GP 18	<101	A	1973

Specifically, we opened taps to permit 1 liter/min flow rate early in the morning, and sampled 500 ml of water in two stages, one immediately after opening the tap, the other 10 minutes after flushing the tap. Also, before cooking was kicked off in the evening, a couple of samples were taken in the like manner as in the morning.

Besides, on the following day, the tap was opened to permit 2 l/min velocity before four samples were collected in the same manner as for the previous day.

As sample containers, we used polyethylene bottles after immersing them in 10%HNO_3 solution and cleansing them thoroughly with water. These polyethylene bottles were pre-filled with a specified amount of INHNO_3 solution to assure that sample pH shows 2.5   0.3.

Table 8 shows measurements attained by the above method, where Pb and Cd concentrations in the samples collected early in the morning are shown higher than those collected in the evening.

Since the purpose of the monitoring is to determine their maximum concentrations, samples must be taken early in the morning, it was found. Their concentrations in tap water varies little with flow velocity upon sampling. Accordingly, it turned out that if the velocity stays within this range of values, it does not exert much influence on actual measurements.

Also, it was observed that Pb concentration tends to be higher if lead pipe are used. Besides, the higher the amount of residual water in the pipe, the higher the Pb and Cd content, it was learned as a common trend.

Consequently, sample must be collected in consideration of the material of feed pipe used and the amount of residual water. As Pb and Cd concentrations in water sampled 10 minutes immediately after opening the tap (initial discharge) are higher than those in water sampled 10 minutes after opening the tap, it is necessary to sample initial discharge. However, it was found that when collecting samples which no longer affect the quality of water collected in the feed pipe, namely, samples immune to the influence of residual water in the feed pipe, a tap must be kept flushed for 20 minutes or longer prior

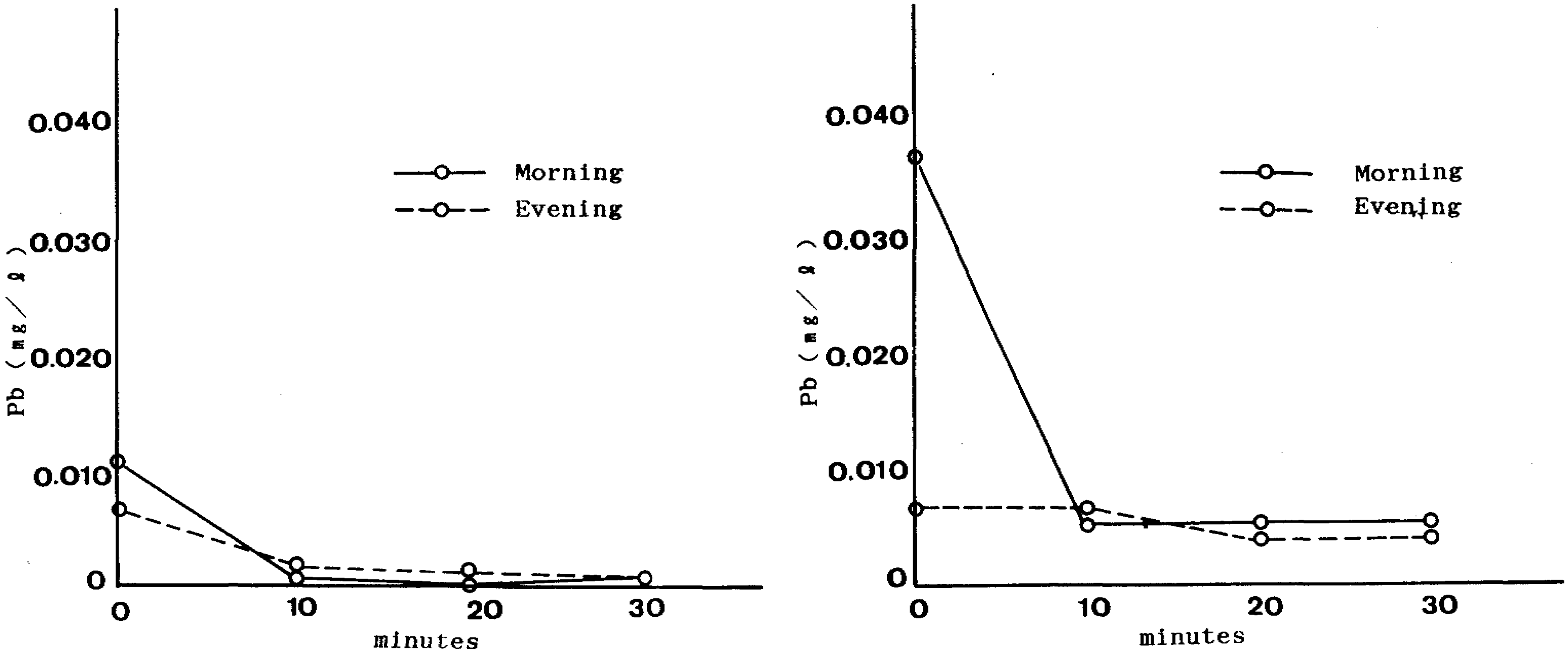

Figure - 6 Pb Concentration and flushing time

Table-8 Tap Water Quality

Pb(mg/l)		No. 1		No. 2		No. 3		No. 4		No. 5	
		first flush	10min flush	first flush	10min flush	first flush	10min flush	first flush	10min flush	first flush	10min flush
1l/min.	Morning	0.026	0.008	0.006	0.000	0.015	0.008	0.006	0.000	0.003	0.001
	Evening	0.026	0.005	0.002	0.000	0.004	0.000	0.000	0.000	0.002	0.000
2l/min.	Morning	0.019	0.005	0.005	0.000	0.016	0.010	0.003	0.010	0.000	0.000
	Evening	0.004	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cd(mg/l)											
1l/min.	Morning	0.0004	0.0001	0.0001	0.0000	0.0002	0.0003	0.0001	0.0000	0.0000	0.0000
	Evening	0.0004	0.0001	0.0001	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
2l/min.	Morning	0.0005	0.0001	0.0003	0.0000	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000
	Evening	0.0003	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

to sampling.

In the water of distributing reservoirs of the water purification plant, Pb and Cd concentrations were found lower than the limit of detection at the time monitored, as shown in Table 9.

Table-9 Pb and Cd of Water Distribution Reservoir Water

Pb(mg/l)	A			B	
	No.1	No.2	No.3	No.1	No.2
1l/min.	0.000	0.000	0.000	0.000	0.000
2l/min.	0.000	0.000	0.000	0.000	0.000
Cd(mg/l)					
1l/min.	0.0000	0.0000	0.0000	0.0000	0.0000
2l/min.	0.0000	0.0000	0.0000	0.0000	0.0000

In the next process, the variance analyses were conducted to confirm the validity of these matters, specifically on the following four factors.

A: Material of feed pipes (on leaded and non-leaded)

B: Sampling stages (immediately and 10 minutes after opening hydrant)

C: Flow velocity (1 liter/min, 2 liters/min)

D: Sampling time of the day(early in the morning and in the evening)

As a result, it was possible to statistically confirm that the material of feed pipes used, sampling stages and the sampling time of the day relate to Pb concentration of the samples tested as shown in Table-10.

Table-10 Variance Analysis Table

Item	S		V	F	F	F	F0.01
A	7.37×10^{-4}	4	1.84×10^{-4}	22.61	37.72**	2.87	4.43
B	2.70×10^{-4}	1	2.70×10^{-4}	33.13	55.27**	4.35	8.10
C	2.89×10^{-5}	1	2.89×10^{-5}	3.55	5.92 *	4.35	8.10
D	2.12×10^{-4}	1	2.12×10^{-4}	26.01	43.40**	4.35	8.10
AxB	1.47×10^{-4}	4	3.68×10^{-5}	4.51	7.52**	2.87	4.43
AxC	9.56×10^{-4}	4	2.39×10^{-5}	2.93	4.89**	2.87	4.43
AxD	1.16×10^{-4}	4	2.90×10^{-6}	0.356			
BxC	2.60×10^{-5}	1	2.69×10^{-5}	3.19	5.32 *	4.35	8.10
BxD	6.25×10^{-5}	1	6.25×10^{-5}	7.67	12.79**	4.35	8.10
CxD	1.41×10^{-5}	1	1.41×10^{-5}	1.73	2.89	4.35	8.10
AxBxC	7.50×10^{-5}	4	1.88×10^{-5}	2.30	3.84 *	2.87	4.43
AxBxD	1.00×10^{-6}	4	2.50×10^{-7}	0.031			
AxCxD	1.99×10^{-5}	4	4.58×10^{-6}	0.510			
BxCxD	2.24×10^{-5}	1	2.24×10^{-5}	2.75	4.59 *	4.35	8.10
AxBxCxD	3.26×10^{-5}	4	8.15×10^{-6}	1.00			
SE	3.26×10^{-5}	4	8.15×10^{-6}				
Covariance table by (L8)							
Item	S		V	F	F	F	F(5,20:0.01)
B	4.17×10^{-4}	5	8.34×10^{-5}	6.05*	2.71	4.10	
C	0.12×10^{-4}	5	2.49×10^{-5}	1.81			
D	3.28×10^{-4}	5	6.56×10^{-5}	4.77**			
Sc	2.75×10^{-4}	20					

* 95% ** 99%

3-2-2 Sampling Method to Monitor Pb Concentration

Other laboratories also conducted the same survey as we did and found that Pb concentration in tap water could vary with the material of feed pipes used and how water is collected in the pipe. Accordingly, based on the findings of the survey, a sampling procedure for application to monitoring Pb concentrations were established.

1) Classification of tap

Water tap to be monitored are classified in three classes depending on the kind of materials used.

Class 1: Where no lead is used for feed pipes or their connections

Class 2: Where it is impossible to identify if lead is used for feed pipes or their connections

Class 3: Where lead is used for feed pipes and their connections

Class 3a: Where lead are used for all components other than tapping and water meters

Class 3b: Where lead is used for part of feed pipes or their connections

2) Sampling method

Prior to using tap water early in the morning, collect two samples from each tap in accordance with the following procedures.

Where tap is classified in class a and class 3a:

Sample 1: Take a sample of 500 ml immediately after flushing the tap at a 2 liters/min rate.

Sample 2: After collection of sample 1, open the tap to a full and flush 20 liters and choke the flow rate to 2 liters/min, and then, sample 500 ml.

Where tap is classified in class 2 and class 3b:

Sample 1: Same as the above sample 1 procedure

Sample 2: Pb concentration is the highest in water in contact with lead. Therefore, after collection of sample 1, take a 500 ml sample after discharging residual water collected in the water supply system (tap through lead pipe) without changing flow rate.

Compliance with this method would enable collection of samples required to determine the characteristics of the maximum lead concentration in tap water, the purpose of monitoring.

3-3. Monitoring of Pb, Cd and Zn Concentrations in Tap Water

Compared to the preceding section focused on ways for controlling analytical accuracy and collecting samples which need prestudies prior to monitoring, this section deals with the results of monitoring on Pb, Cd and Zn concentrations in tap water.

The reason why we selected cadmium for monitoring other than lead is that cadmium is also extractable into ADPC-MIBK solution while in extraction of lead and easily analyze by means of atomic absorption method. Another reason is that we considered it potentially hazardous to human health.

Unlike lead and cadmium, zinc does not pose hazards to human health. It just slightly deters efficient utilization of tap water. Nevertheless, since it is considerably susceptible to the effect of water pipes and shows a behavior similar to that of cadmium in the natural environment, this substance was additionally selected as the target of monitoring.

It is to be noted that the current monitoring program is primarily designed to analyze Pb concentration. Cd and Zn concentrations were investigated for the reason mentioned in the preceding section, but not as major targets of this program.

3-3-1 Method of Investigation

Lead and cadmium concentrations were examined by the ADPC-MIBK extracted, atomic absorption method (See preceding section.) and zinc concentration by APDC-butyl acetate extracted, atomic absorption method.

Samples were collected with the method specified in section 3-2, where information pertaining to the material, diameter and length of feed pipes connected to the tap from which the samples were collected were obtained from the water service installation register.

Based on this information, the volume of residual water throughout the pipes leading to the tap and other statistical data required upon sampling were calculated.

3-3-2 Determination of number of tap to be monitored

The purpose of monitoring is to estimate the mean value of maximum Pb concentrations in tap water supplied to the area monitored. It is assumed that the maximum concentration in tap water supplied to this area fluctuate at random and varies with tap. Accordingly, it is difficult to determine the optimal number of tap to be monitored in a decisive manner.

Therefore, there is no alternative but to determine the number of samples to be collected continuously over an extended period of one year in ways that an error (standard deviations) to the estimated mean value determinable as the mean value of Pb concentrations in samples collected may be held to within a specified range.

Assuming that samples collected from a given number of tap are analyzed and the standard deviation s for a given number of analytical values is obtained, then reliability limit for these average values can be expressed by Eq.(6).

$$t(n-1,2)s/n \quad \ldots\ldots\ldots\ldots \quad (6)$$

Where,

t(n-1,); Assuming that the degree of freedom in the t distribution table is n-1, hazardous ratio value , $n > 20$, $= 0.05$, then $t(n-1,2) = 2.0$

Consequently, assuming that the error of this estimated mean value is below 20% of the annual mean value or 10% of the water quality standard, whichever greater, in terms of the 95% confidence level, the number of samples required can be determined as follows:

$$n>(2.0 \times s/0.2c)^2=(10\ s/c)^2 \quad \ldots\ldots\ldots \quad (7)$$

if the average concentration (c) of a given substance monitored exceeds 50% of the reference value of tap water, or

$$n>(2.0 \times s/0.1 \times U)^2 = (0.4s)^2 \quad \ldots\ldots\ldots \quad (8)$$

if it is not more than 50%.

Here, U: Reference value of tap water (50 g/l) Accordingly, 10 taps using lead feed pipes, even partially, were selected from Table 11 and samples were collected. Table 11 shows findings, specifically average concentration (22.9 g/l) and standard deviation (22.9 g/l). We substituted these values for Eq.(8) and obtained the value of "47" as annual sampling frequency.

Allowing for these results and a given degree of safety margin, we sampled tap water from taps in 51 locations in four times a year. With regard to 10 taps selected for the above preliminary survey, we decided to recurrently sample 8 times a year in order to determine factors affecting tap water quality, such as seasonal fluctuations, etc..

Since the preliminary survey had revealed that Pb concentration in tap water sampled from a tap which does not use lead feed pipes were close to the limit of detection, 10 taps of this type were selected for sampling 9 times a year.

3-3-3 Results and considerations

With the method mentioned above, we sampled initial discharge (tap water sampled immediately after opening the hydrant) and interim discharge (tap water sampled sometime after opening the hydrant) from 71 taps in the monitored area, and assayed lead, cadmium and zinc concentrations. The following paragraph presents findings.

The monitoring of 10 taps selected for the preliminary survey conducted for a year disclosed the followings. Figures 7 through 9 give typical examples.

Comparison of the initial with the interim discharge in terms of Pb, Cd and Zn concentrations indicates that the initial discharge often shows higher concentration, except when the latter casually shows higher value, depending on the condition of service pipes used.

Table-11 Preliminary Monitoring Tap

No.	Pipe	Dead Volume	Distribution	Sevice in	Pb (g/l) Sample1	Sample2
1	LP 13 15m	21	B	1930	48.3	55.5
2	GP 20 5m LP 16 25m	7	A	1926	50.9	6.0
3	GP 20 5.0m GP 13 2.5m LP 13 1.0m	2	B	1954	4.8	2.6
4	GP 20 3.0m GP 13 6.0m LP 13 1.0m	2	B	1969	16.9	13.3
5	GP 20 15m LP 13 1.0m	5	A	1964	6.9	3.6
6	LP 20 15m GP 20 18.5m LP 13 1.0m	6	A	1969	31.9	15.7
7	VP 25 8.1m LP 13 1.5m GP 20 3.1m	42	A	1959	14.5	4.8
8	LP 20 1.0m VLGP 20 10.8m	4	B	1975	7.7	18.1
9	LP 20 1.0m GP 20 19.2m LP 13 1.0m	6	B	1973	23.2	9.6
10	LP 13 10m	1	B	19	6.0	1.7

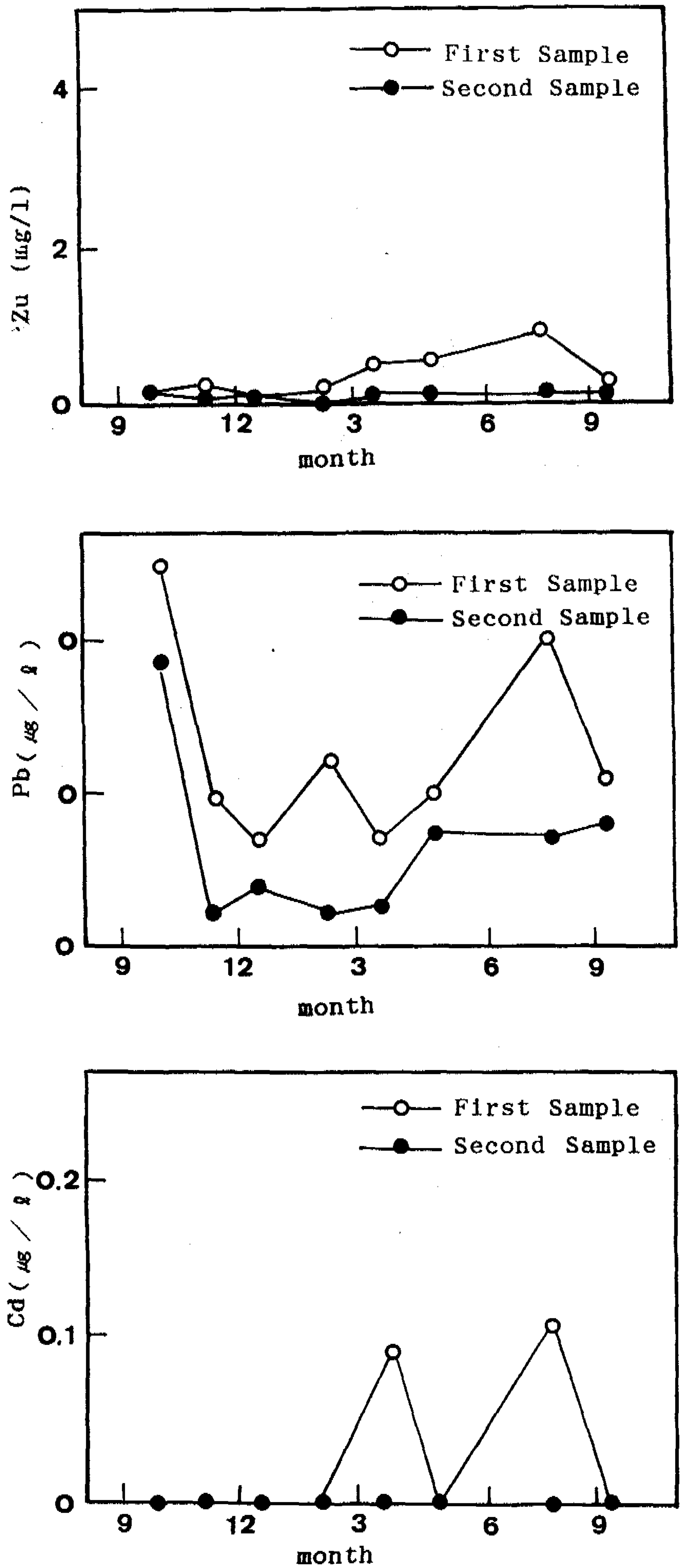

Figure - 7 Monthly variation of Zu,Pb and Cd of Top 1

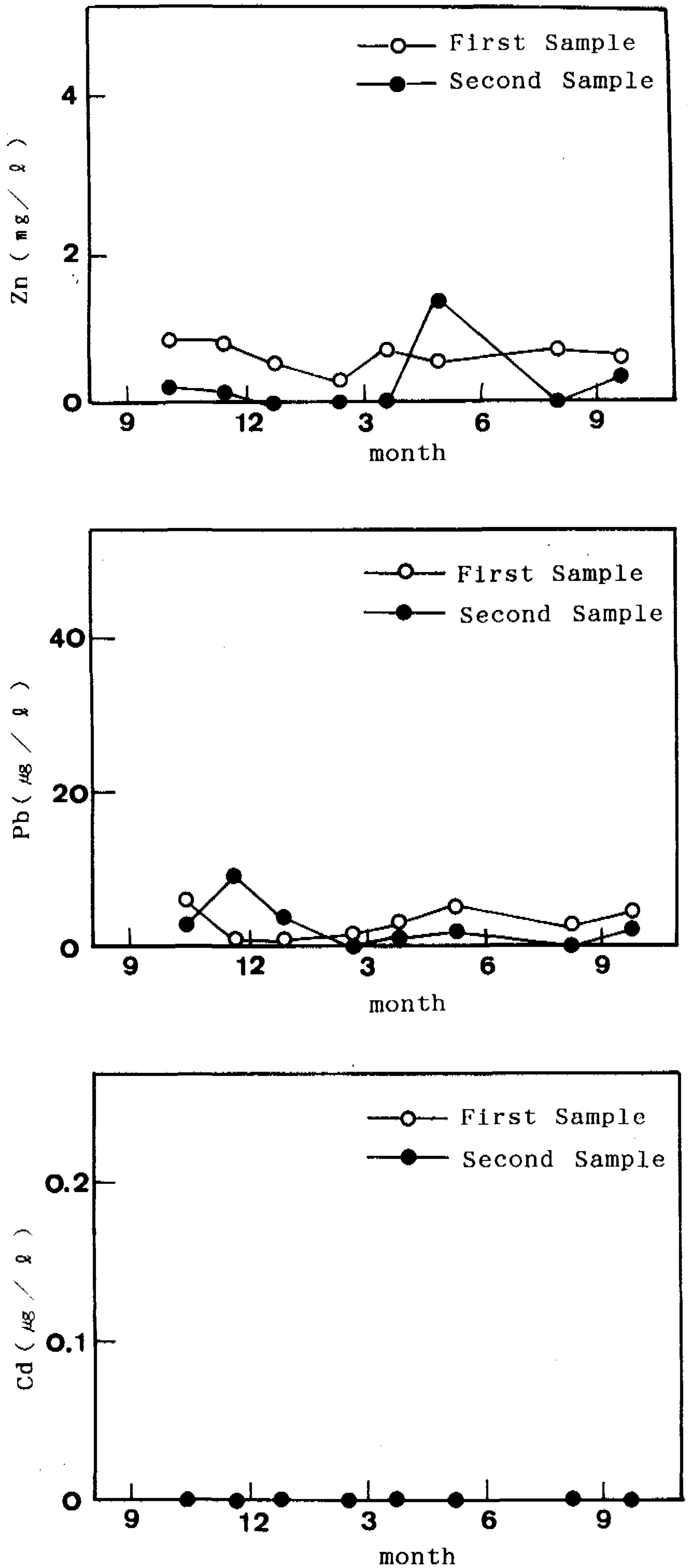

Figure - 8 Monthly variation of Zu,Pb and Cd of Top 5

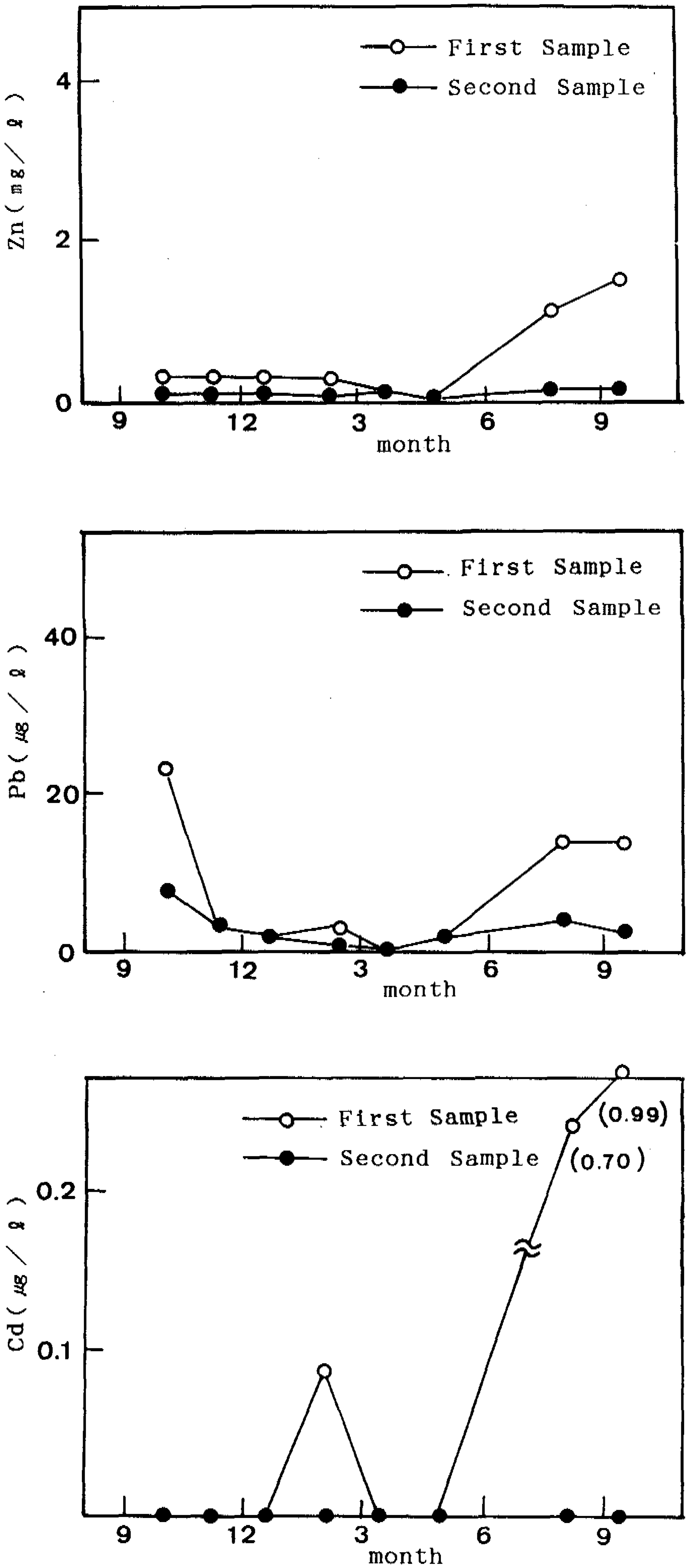

Figure - 9 Monthly variation of Zu,Pb and Cd of Top 9

As the major purpose of monitoring is to determine the maximum concentrations, samples with higher concentration, out of the initial and interim discharges, were selected for analysis.

Table 12 shows the average values of maximum concentrations scored on each measurement and standard deviations regarding all samples tested, while Fig.10 presents average concentrations alone.

Table-12 Pb, Cd, Zn of first flush water

	Monitoring St. No.	Pb;		Cd;		Zn;	
76 6 10	1 - 10	22.2	16.7	0.14	0.17	1.10	1.19
76 11 16	1 - 10	9.8	7.9	0.02	0.07	1.30	1.32
76 12 23	1 - 10	7.7	7.5	0.00	0.00	1.37	1.69
77 2 7	1 - 10	6.9	8.4	0.06	0.14	1.15	1.37
77 3 23	1 - 10	10.4	13.3	0.15	0.12	1.35	1.47
77 4 30	1 - 10	16.7	15.6	0.18	0.18	1.81	1.99
77 8 4	1 - 10	22.5	19.4	0.32	0.29	1.67	1.28
77 9 19	1 - 10	16.8	14.0	0.29	0.32	1.57	1.20
77 6 23	21 - 31	11.6	12.2	0.32	0.40	0.94	0.71
77 8 4	32 - 43	23.0	37.8	0.17	0.27	0.70	0.88
77 9 19	44 - 62	24.0	33.2	0.27	0.40	1.07	1.13
-	11 - 20	4.9	4.6	0.23	0.44	0.80	0.98

Table 13 shows the average water quality of tap water in the water distribution reservoirs. Of the tap water sampled, it turned out that Pb, Cd and Zn concentrations in tap water with the most deteriorated quality are, respectively, 16.3 21.1 g/l, 0.19 0.29 g/l and 1.21 1.28 mg/l respectively. These values are significantly higher than those of water in the distributing reservoir. It may be ascribed to the fact that water can possibly dissolve heavy metals from pipes in the process of flowing down to the tap from the distributing reservoir.

In view of the fact that the initial discharge shows higher concentration than the interim discharge, it became obvious that elution of heavy metals from feed pipes is responsible for the high concentration.

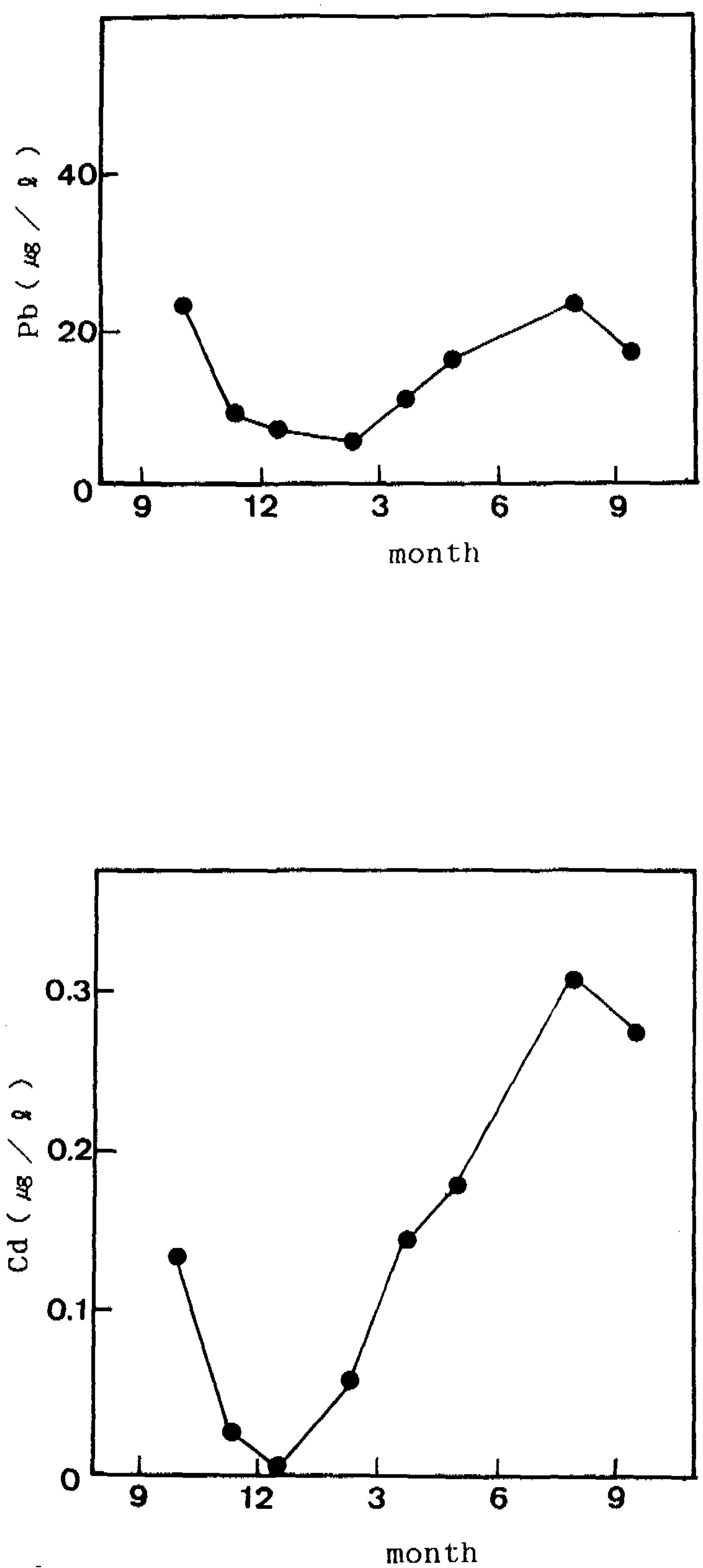

Figure - 10 Monthly variation of Pb and Cd

Table-13 Water Quality of Reservoirs

A		A	B
Water Temperture	^{0}C	14.4 + 6.0	15.7 +5.8
pH		6.6 + 0.07	6.9 +0.08
Electric Conductivity	s/cm	182.6 +22.4	121.8 +8.4
Aeralinity	mg/l	36.4 + 4.5	33.3 +3.4
Hadness	mg/l	45.9 + 7.6	33.3 +7.1
Total hardness	mg/l	62.3 + 9.9	45.9 +4.6
$KMnO_4$ Consumption	mg/l	1.36 + 0.63	0.86 +0.49
Pb	g/l	0.32 + 0.65	1.23 +1.89
Cd	g/l	0.04 + 0.07	0.001+0.05
Zn	mg/l	0.004+ 0.002	0.1 +0.01

The average value of concentration upon each analysis in different periods indicates the presence of seasonal fluctuations, especially in the case of lead and cadmium.

Ascribing it to the effect of water temperature, the differences between the some of reservoir and concentration upon sampling were examined.

Fig. 11 plots their relationships, which implies that the higher the water temperature, the high the Pb and Cd concentrations in tap water.

Thus, since heavy metals elute from the pipe into tap water, its concentration depends on the condition of these pipes and water quality. Therefore, in order to trace probable causes, variance analysis was implemented to verify if there is any significant difference in the average value of heavy metal concentrations by probable factors for high concentration i.e., material of feed pipes used, the year water service was commenced, volume of tap water collected in pipes from water meter to tap, water temperature, distribution system, etc.

Table 14 shows the overall results of variance analysis. Besides, regarding factors determined significant as a result of analysis, Table 15 shows respective values by classification.

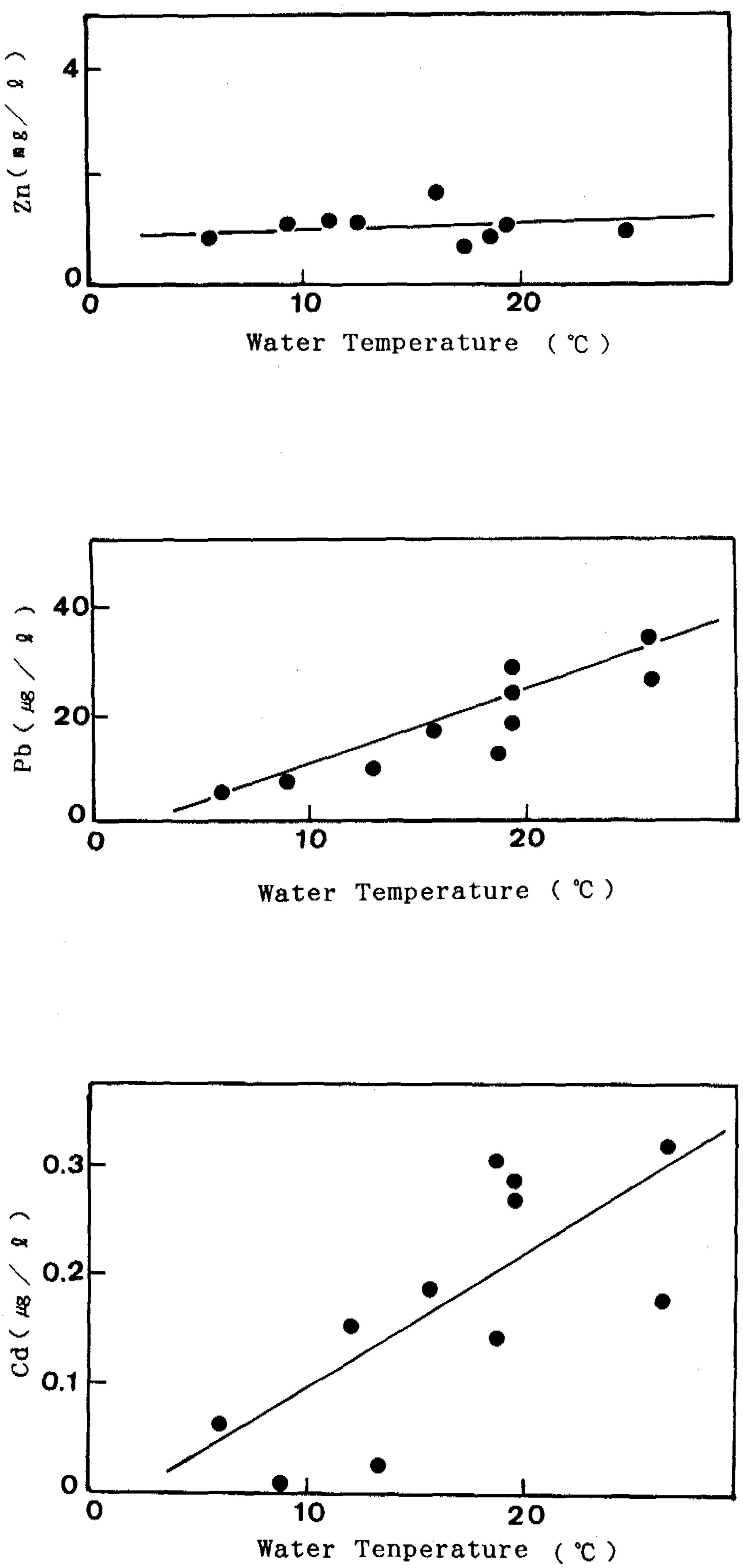

Figure - 11 Relationship between Water Temperature and Zu,Pb,Cd

Table-14 Variance Table

F(0.05)		F (0.05)				F (0.05)				F (0.05)		
		Pb	Cd	Zn		Pb	Cd	Zn		Pb	Cd	Zn
Pb; 22.7*	1960 1961-1970 1970	0.32	1.47	15.2*	5 1 5-10 1 10 1	1.97	0.52	1.66	10^{o}C 10-15^{o}C 10-20^{o}C 20^{o}C	4.77*	4.28*	0.83
Pb; 1.83		F(0.05)										
		Pb	Cd	Zn								
Zn; 6.19*		6.10*	1.59	29.3*								

Table-15 Relationship between pipe and heavy metal

	Pb	16.38 + 23.31 g/l n=95 4.86 + 4.57 g/l n=10		
GP GP	Zn	1.67 + 1.35mg/l n=90 0.42 + 0.63mg/l n=40		
1960 1961-1970 1970	Zn	1.39 + 1.28mg/l n=47 1.75 + 1.38mg/l n=44 0.40 + 0.57mg/l n=40		
$10^{o}C$ $10-15^{o}C$ $15-20^{o}C$ $20^{o}C$	Pb	5.97 + 6.90 g/l 9.58 + 10.26 g/l 18.00 + 21.57 g/l 26.80 + 29.60 g/l	Cd	0.06 + 0.15 g/l n=13 0.07 + 0.10 g/l n=26 0.24 + 0.32 g/l n=63 0.28 + 0.36 g/l n=24
A B	Pb	22.14 + 24.00 g/l 12.80 + 18.62 g/l	Zn	1.92 + 1.49mg/l n=49 0.79 + 0.89mg/l n=82

It turned out from tables 14 and 15 that if a tap uses lead for any part of its feed pipes, if water temperature is high or if any tap for Distribution System A is used, lead concentration in tap water was high.

It was also made clear that in the case of cadmium, water temperature was the exclusive factor responsible for high concentration in water. In the case of zinc, it was found that its concentration was high where galvanized steel pipes are used or taps of Distribution System A was involved. Besides, the high concentration was observed in pipes started to service during the period of 1961 through 1970. As a result of the preliminary survey, no significant difference in Pb and Cd concentrations between tap for the distribution systems A and B. However, the corrosibity. Langeria indices for the both distributions systems fell short of -2, but especially, pH of tap water through Distribution System A is lower than that of Distribution System B and can better dissolve metals in the feed pipe. Accordingly, the number of samples tested were increased in this preliminary survey. Table 15 shows findings.

Substituting the results of monitoring over a year for Eq.(8) to determine the number of samples required to estimate the maximum Pb concentration in tap water supplied to the monitored area in terms of the 95% confidence level, it was found that 130-135 tap were required. In addition, it turned out that analysis of cadmium concentration would require sampling a hydrant in one location, while zinc, those in 110 locations.

Nevertheless, since Japanese standard value of Pb concentration is 100 g/l, a total number of hydrants to be tested would aggregate somewhere in a range of 33 to 35 units.

On the other hand, analysis of cadmium concentration would require 10 locations from a statistical point of view.

Such results will be utilized as useul information to formulate the monitoring program.

4. Design of Monitoring Programme

4-1. Introduction

The presence of a wide range of organic carcinogens in the environment has been a matter of concern in recent years. The risk associated with organic carcinogens should be assessed and managed by considering the total or integrated intake and exposure from air, food, and water. In order to develop techniques and procedures for measuring and assessing human exposure to environmental pollutants, the WHO/UNEP HEALs (Human Exposure Assessment Location) project was started in 1985. The preliminary data obtained from a pilot study in Japan showed that the total daily intake of chloroform (68.5 g/day) comes from : 23.2 g in food, 10.8 g in air, and 34.5 g in drinking water. As shown by the above data, drinking water is one of the sources of exposure to chloroform.

The management level of total exposure is estimated by an arbitrarily selected risk level and a dose-response relationship based on the results of animal tests. Ideally the management level of each media should be decided by its proportional contribution to the total human exposure. However, what is usually considered is the feasibility or cost of action need to manage each media so that its maxmum-limit concentration will not be exceeded. Eitherway, it is most essential to grasp the exposure level through each media as precisely as we can. Thus, the role of monitoring organic carcinogens in each media is significant in efforts to manage them.

It is well known that trihaliomethanes (THMs) and other halogenated organic compounds in tap water are formed during the chlorination process, by reactions between chlorine and organic substances. Since chloroform (one of the THMs) is a carcinogen, WHO drinking water quality guidelines (set at the level of 30 g/l) and those of Japan, USA, and other countries refer to total THMs.

The mutagenecity of chlorinated water is higher than non-chlorinated drinking water. Therefore, total organic halides (TOX), chloral hydrate (chloral), trichloroacetic acid (TCAA), dichloroacetic acid (DCAA), and other organic halides,as well as THMs, have been researched by many authors. Because halogenated organic compounds are formed by reactions between chlorine and organic substances, their concentration in tap water is affected by : the raw water quality; the water treatment method; and the distribution service system. Therefore, a monitoring program should be established that takes into account variations attributable to these three factors.

The reliability of monitoring data is not only affected by sampling method, frequency of sampling, and /or number of samples, but also by the accuracy of analysis. Therefore, it is necessary to adopt a cost-effective analytical method that provides the requisite accuracy and reliability, and to implement systematic quality control of the analysis.

This paper discusses the accuracy and reliability of analytical methods, the succession of halogenated organic compounds in chlorinated water, and the distribution of halogenated organic compounds in the distribution system, in order to provide basic information for establishing a reasonable monitoring program.

4-2. Methods for analyzing halogenated organic substances, and their accuracy.

The head space method (for determining THMs), the adsorption-pyrolysis-titrimetric method (for determining TOX) and the solvent extraction-gas chromatographic method (for determining chloral, DCAA, and TCAA) have been developed and/or evaluated under the following necessary conditions. The maximum tolerable error should be less than 20% of the measured value or the limit of detection, whichever is smaller. The limit of detection should be less than 10% of the drinking water quality standard value or 3 times the concentration obtained for a blank solution, whichever is smaller.

(1) Head space method for determining THMs

The water sample is gently poured into a vial that has previously received sodium sulfate solution to remove its residual chlorine. It is then sealed by an aluminum cap with a silicone septum. After the vial is shaken to diminish the residual chlorine, phosphoric acid (for adjusting the pH below 1.0) is injected into it using a syringe through the silicone septum. The vial is then incubated in a 25 C water bath for one hour. A portion of the head space gas (500 l) in the vial is injected into a gas chromatograph to determine the level of THMs.

The analysis was conducted on a Shimazu Model 7A gas chromatograph with an electron capture detector. A glass column (3mm x 2m)packed with 20% silicone DC-550 on a Chromosorb-W (100-120mesh) was used for separating the compounds. The column was operated at 100 C, and the carrier nitrogen gas flow-rate was 70ml/min.

Table-16 shows the retention time and concentration that give 1cm of chromatogram peak height for the four kinds of THMs. If we can define the limit of detection as the concentration that gives 1cm of peak height, the limits of detection by the head space method become: 0.5 g/l of chloroform; 0.25 g/l of bromodichloromethane; 1.0 g/l of dibromochloromethane; and 5.0 g/l of bromoform.

Table-16 Retention time and limit of detection

	Retention time (min)	Limit of detection (g/l)
Chloroform	1.0	0.5
Bromodichloromethane	2.0	0.25
Dibromochloromethane	4.0	1.0
Bromoform	7.9	5.0

Table-17 shows the mean and standard deviation of peak height for 8 samples, which contained 10 g/l of chloroform, 2 g/l of bromodichloromethane, 5 g/l of dibromochloromethane, and 10 g/l of bromoform. As shown in Table-2, the accuracy of the head space method for analyzing THMs is within about 5%.

Table-17 Accuracy of the Head Space Method

	n	mean+s.d	C.V.(%)
Chloroform	8	5.1+0.13	2.6
Bromochloromethane	8	6.1+0.14	2.3
Dibromochloromethane	8	2.2+0.04	1.8
Bromoform	8	1.5+0.08	5.2

The procedures of the head space method are simpler than those of the solvent extraction method or purge trap method, which are adopted in the standard methods. Therefore, this method is widely adopted for the routine analysis of THMs and other volatile chlorinated organic compounds in tap water in Japan.

(2) Adsorption-pyrolysis-titrimetric method for determining TOX

The adsorption pyrolysis titrimetric method that is adopted in the standard methods for determining TOX levels is performed by following procedure. A water sample (100ml) is passed through a granular activated carbon (GAC) column. Then, a nitrate solution is passed to remove inorganic halogens from the GAC column. After concentrating the GAC sample and removing its inorganic halogens by nitrate washing, the contents of the GAC column are pyrolyzed at 250-680 C. The halogen gas thus generated is determined as a chlorine-equivalent by microcoulometric titration.

Table-18 shows the calculations of the precision expressed as the standard deviation of a blank sample and a 2,4,6-trichlorophenol standard sample. If one wants to select the detection limit conservatively (i.e., equal to 5 times the mean concentration of a blank solution), the detection limit of the adsorption-pyrolysis-titrimetric method for determining TOX becomes 10 g/l. The accuracy of this method is within about 6% of the observed value, as shown in Table-18.

We also measured the accuracy of this method by inter-laboratory precision test (analyzing a sample of prepared chlorinating humic acid under the same specified conditions at 5 laboratories). The data thus obtained are shown in Table-18. The accuracy of those 5 data was also within our target. Thus, we conclude that this method can be adopted as a routine method for determining TOX level in tap water.

Table-18 Accuracy of the adsorption-pyrolysis-titration method

	n	mean+s.d.	C.V.(%)
Blank solution	57	2.12+0.32	-
Standard solution	57	102.0+5.97	5.8
Sample	5	523 +59	11.2

(3) Solvent extraction-gas chromatographic method for determining chloral, DCAA, and TCAA

Figure-1 shows the procedure for the solvent extraction-gas chromatographic method we developed. Chloral, DCAA, and TCAA are hydrophilic halogenated organic substances. So, we first use hexane to to extract the hydrophobic halogenated compounds (such as THMs) from the water sample into an n-hexane layer. Next the pH of the water layer is adjusted to about 7.0, and either is added. After sufficient shaking the sample is separated into an either layer (containing choral) and a water layer (containing DCAA and TCAA). After the water is removed from the ether layer, the ether is removed by distillation at room temperature. Then diazomethane is added to methylate chloral, and the portion of this solution is analyzed by gas chromatography.

The other water portion has its pH adjusted to about 0.5 by hydrochloric acid befor ether is added. The ether layer and water layer are then separated after sufficient shaking. The ether layer is treated by the same procedures mentioned above ,and analyzed by gas chromatography. The gas chromatography conditions are the same as for determining THMs. The volume of sample injected into the gas chromatograph is 2 1.

Recovery of chloral, DCAA, and TCAA by this analytical method are shown in Table-19. The recovery ratio was 92.7% of chloral, 88.6% of DCAA, and 97.2% of TCAA. The levels of precision, calculated by duplicate analysis of samples having similar concentrations, are also shown in Table-19. This data shows that this analytical method has sufficient accuracy to determine the level of hydrophilic halogenated organic substnaces (HOX).

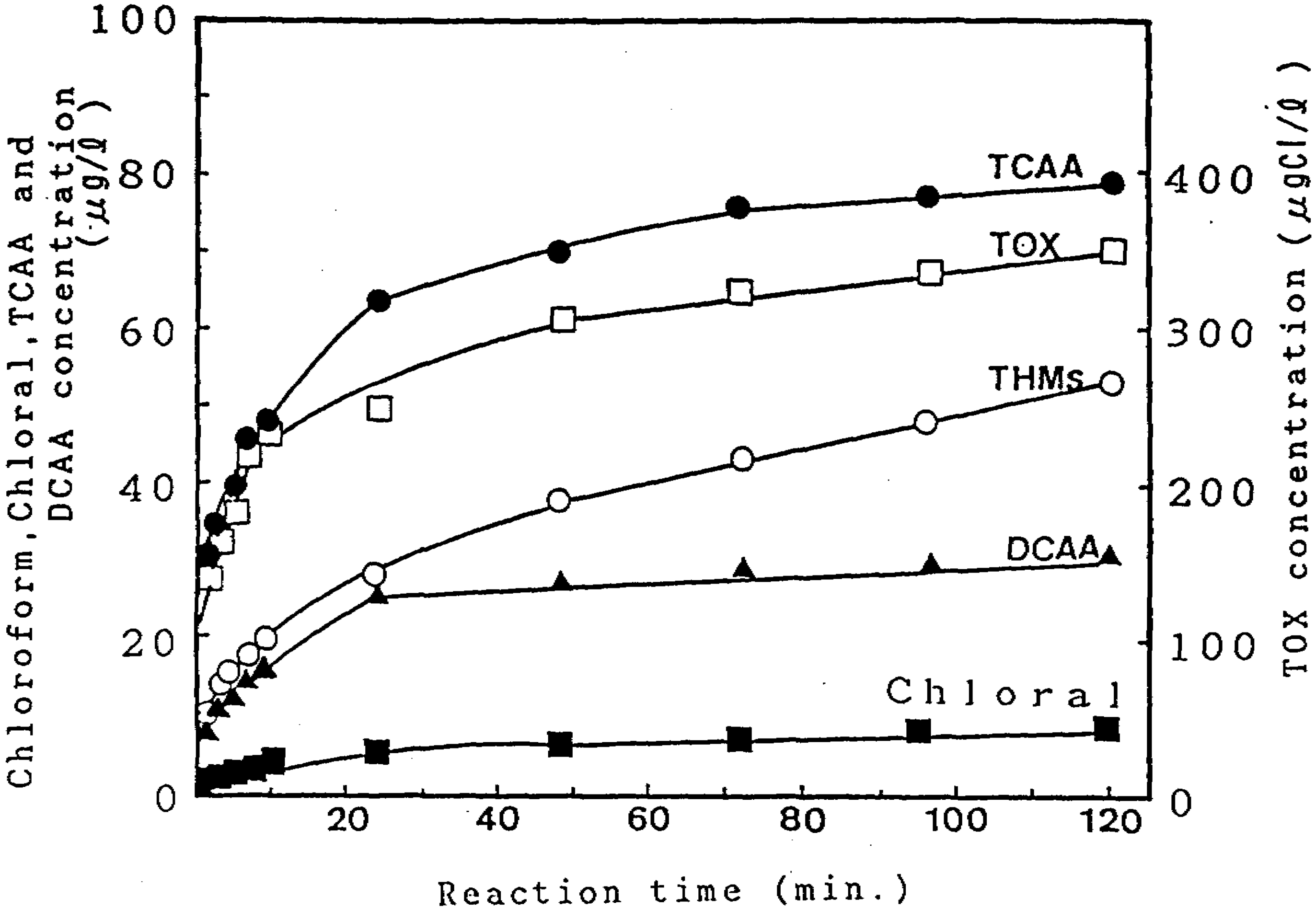

Figure - 12 Effect of Chlorine concact time on formation of THMs, Chloral, TCAA, DCAA and TOX
Conditions: initial humic acid 2mg/l
Chlorine 20mg/l, ph 7 and
temperature 20 C

Table-19 Accuracy of solvent extraction methods

	Recovery test			Duplicate analysis of samples	
	n	Recovery(%)	C.V.(%)	n	C.V.(%)
Chloral	5	92.7	2.0	60	5.5
DCAA	5	88.6	3.4	60	3.4
TCAA	5	97.2	3.6	60	8.5

4-3. Behavior of halogenated organic compounds in chlorinated water

It has been reported that the TOX and THMs concentrations in chlorinated water are affected by: the quality and quantity of precursor; the reaction conditions with chlorine (such as pH); temperature; and other factors. Because the presence of THOX (such as chloral, DCAA, and TCAA acid) has not been reported, the behavior of HOX in connection with THMs and TOX still remains obscure. The factors affecting chloral, DCAA, and TCAA formation, and their relationships with other halogenated compounds, were studied by applying chlorine to humic acid (selected as a model precursor) under various reaction conditions.

Figure-12 shows the time course formation of TOX, THMs, chloral, DCAA, and TCAA from humic acid treated with chlorine. The velocity of formation of these compounds was fast, generally within 24 hours. TCAA, DCAA, and chloral reached maximum and equilibrium concentration within 24 hours of reacting with chlorine. However, TOX and THMs increased gradually with reaction time. After 120 hours of reacting with chlorine, TCAA showed the largest concentration among these haloganated organic compounds, followed by THMs, DCAA, and chloral. The proportion of THMs and THOX (i.e., the sum total of chloral, DCAA, and TCAA) to TOX were about 13% and 21%, respectively.

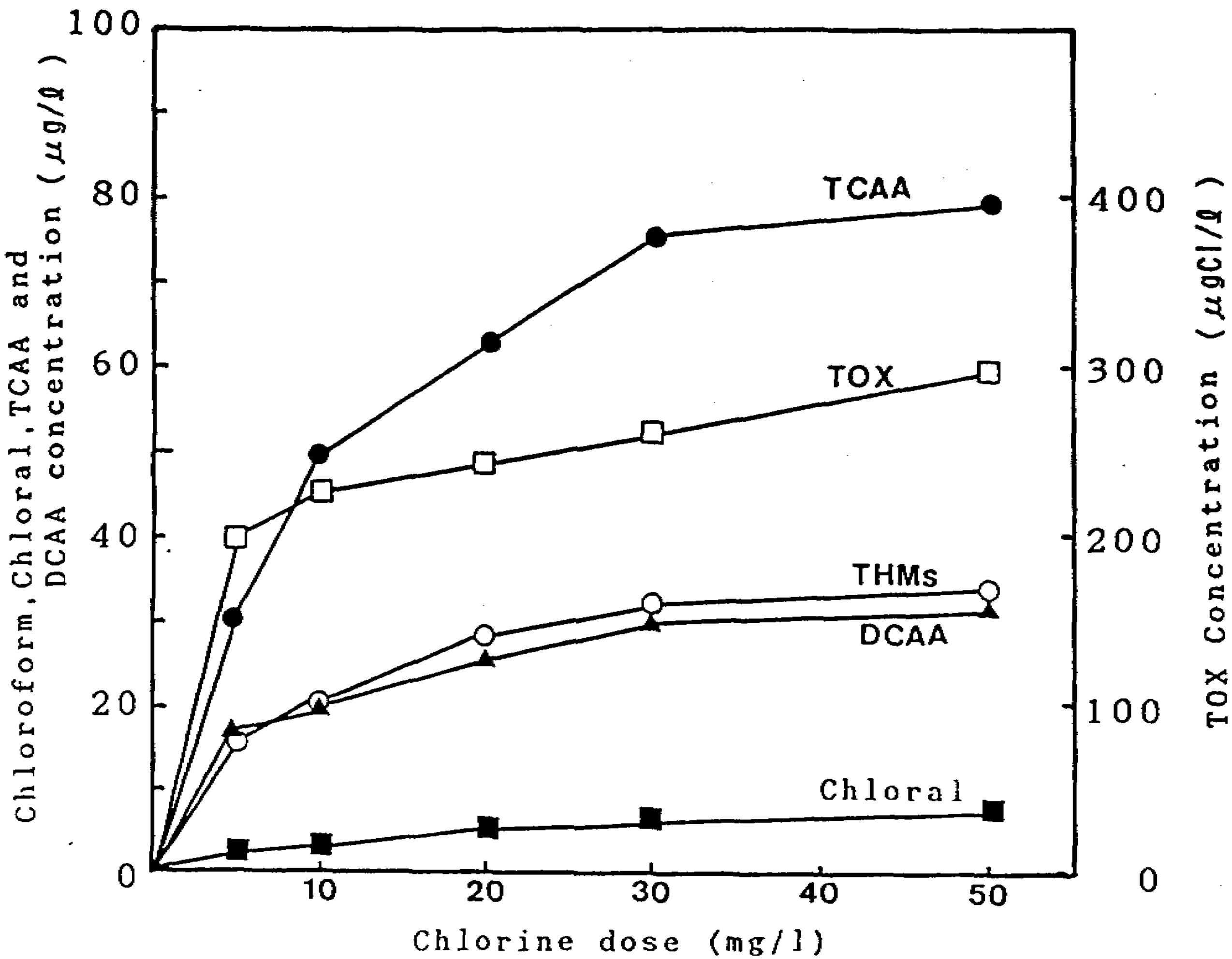

Figure - 13 Effect of Chlorine dose on formation of THMs, Chloral, TCAA, DCAA and TOX
Conditions: initial humic acid 2mg/l
reaction time 24hr, pH 7 and
temoerature 20 C

The formation of THOX, TOX, and THMs increased with higher chlorine dose, as shown in Figure-13. Among these halogenated organic compounds, TCAA was strongly affected by chlorine dose.

The formation of halogenated organic compounds was affected by pH, as shown in Figure-14. The formation of TOX, TCAA and DCAA showed maximum concentration at pH=4, decreasing with increasing pH. However, the amount of chloral decreased to nil concentration at pH=12. In contrast, the formation of THMs increased as pH increased, reached maximum concentration at pH=10, and then decreased as pH increased beyond that.

Chlorine is present in water as hypochlorous acid and /or hypochlorous ions. Since hypochlorous acid (which is dominantat in low pH) is more reactive than hypochlorous ions, the halogenation of a precursor becomes more promoted under an acidic condition than under an alkali condition (see Figure-4). Since THMs are formed by the hydrolysis of halogenated intermediates, THMs reach maximum concentration under high pH conditions.

The effect of reaction temperature is shown in Table-20. The formation of TOX was not strongly affected by reaction temperature. However, as the water temperature increased, the formation of THMs, chloral, DCAA, and TCAA increased. AS the water temperature increased from 4 C to 37 C, THMs increased by a factor of 3.5, while THOX increased by a factor of 2.0.

Table-20 Effect of reaction temperature on TOX, THMs, and THOX

Temperature	TOX(g/l)	THMs/TOX(%)	Chloral/TOX(%)	DCAA/TOX(%)	TCAA/TOX(%)
4 C	239.4	4.3	1.3	4.2	11.6
10	237.4	5.4	1.4	4.3	12.9
20	244.0	10.1	1.6	5.2	15.5
37	251.5	15.5	2.7	8.5	19.7

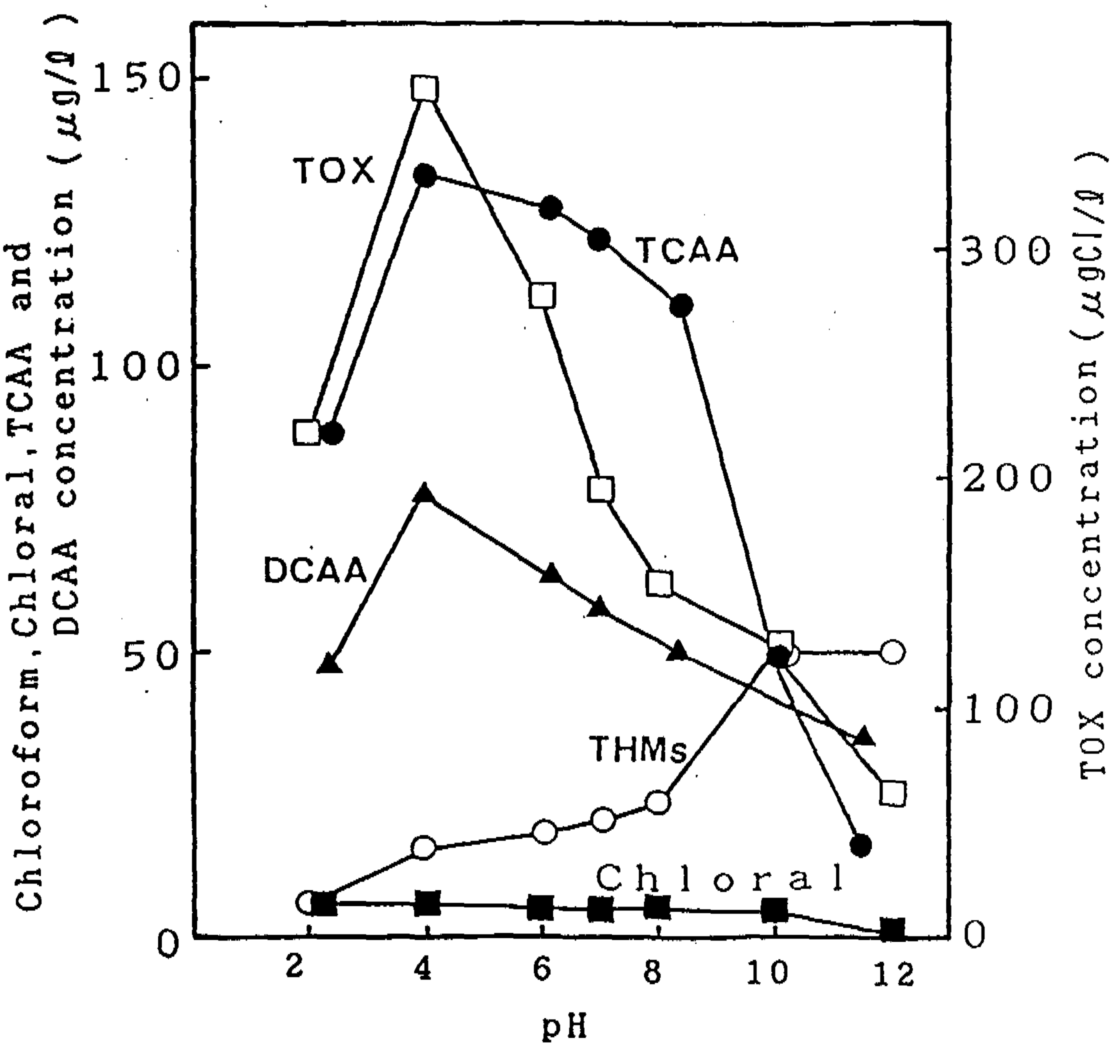

Figure - 14 Effect of pH on Chloroform,Chloral, TCAA,DCAA and TOX formation
Conditions: initial humic acid 2mg/l, Chlorine 20mg/l, Reaction time 24hr and temperture 20 C

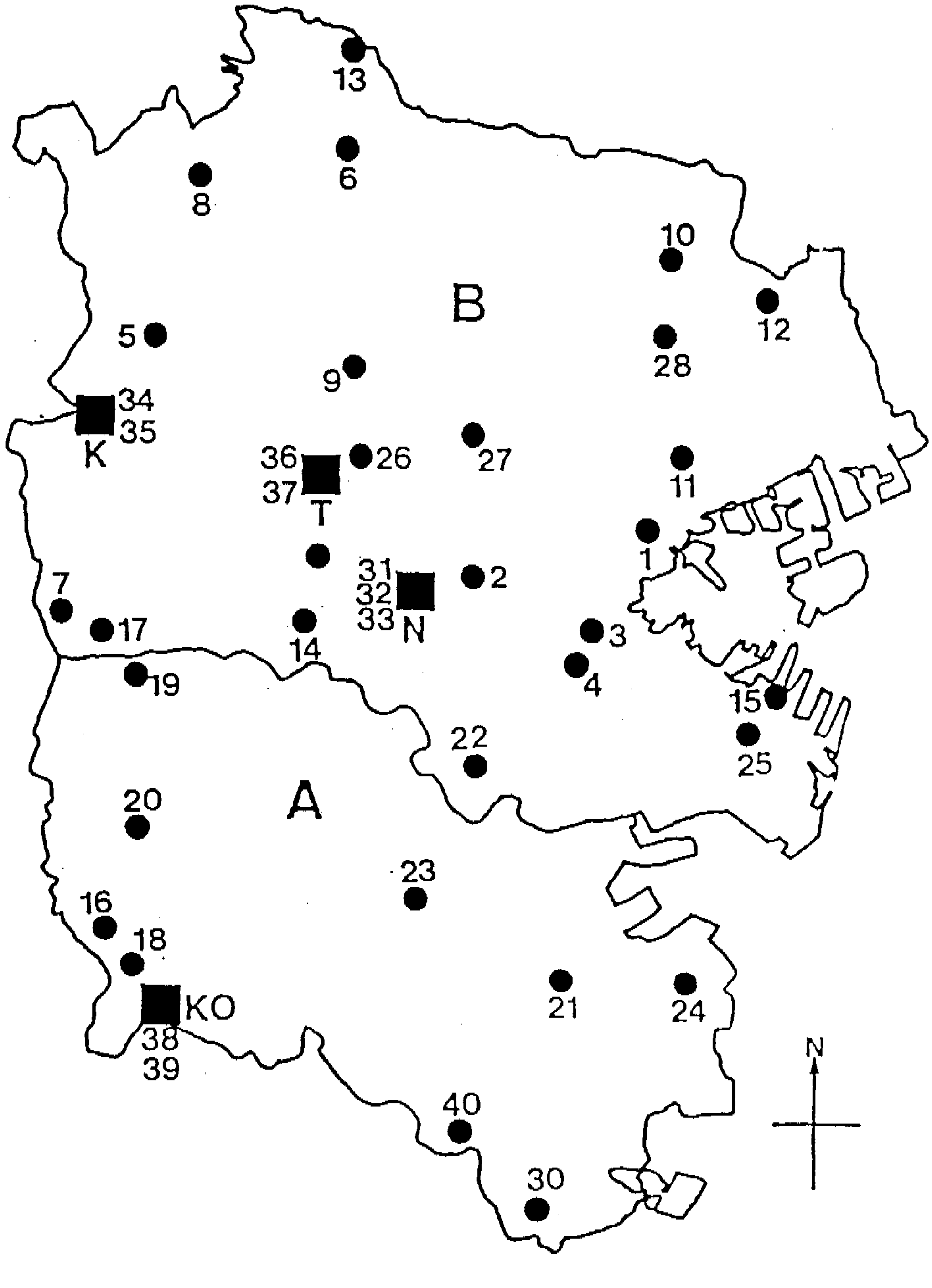

Figure - 15 Location of sampling stations

● sampling station

■ water purification plant

4-4. Levels of halogenated organic compounds in distribution system

A distribution area that is supplied city water from two main water sources (i .e., distribution area A that is served by one purification plant; and distribution area B that is served by three purification plants) was selected for observation. Figure-15 shouws 40 sampling points that were chosen by taking into account the distance from each water purification plant. The tap water from each sampling point was sampled by a conventional procedure.

Residual chlorine in each sample was removed immediately by adding sodium thiosulfate. TOX, THMs, chloral, DCAA, and TCAA were analyzed by the method described above. The accuracy of the analytical results was controlled by an R-chart derived from duplicate analysis of selected samples.

The mean concentrations of TOX and THMs in this distribution system were 84.1+ 29.6 g/l and 14.5+7.0 g/l, respectively, as shown in Table-21. However, there were variations between sampling periods. For example, TOX levels in summer and winter were 91.5+31.1 g/l and 74.4+27.0 g/l, respectively, while THMs in summer and winter were 19.4+5,9 g/l and 9.4+3.0 g/l, respectively.

Since there were also changes in TOC (such as 1.1+0.2 mg/l in summer and 0.6+0.2mg/l in winter), we concluded that the TOX and THMs levels depended not only on the water temperature but also on the levels of organic substances(i.e., precursors) in the water sample. Although the difference in TOC between distribution areas A and B was small (see Table-21), the differences in TOX, THMs, and THOX were large.

Table-21 Levels of halogenated organic substances in tap water

			TOX(g/l)	THMs(g/l)	THOX(g/l)	TOC(mg/l)	Temp.(C)
A	KO	Summer	103.4+26.9	24.8+2.9	20.3+6.3	1.3+0.2	24.6+0.6
		Winter	95.3+19.2	10.0+3.8	-	0.9+0.1	7.8+0.9
	N	Summer	85.8+20.2	17.3+6.3	18.5+7.9	1.1+0.2	
		Winter	75.5+26.7	10.1+1.1	-	0.6+0.2	
B	K	Summer	91.1+38.1	17.2+3.5	19.2+5.4	1.0+0.2	23.7+1.0
		Winter	57.2+28.5	8.5+2.7	-	0.5+0.3	7.4+1.2
	T	Summer	89.8+38.9	15.5+4.4	14.4+9.2	1.1+0.1	
		Winter	60.6+11.3	7.2+3.0	-	0.6+0.2	
Mean		Summer	91.5+31.1	19.4+5.9	18.4+7.5	1.1+0.2	
		Winter	74.0+27.0	9.4+3.0	-	0.6+0.2	

N, K, and T refer to the names of water purification plants

The concentration of halogenated organic compounds in tap water should naturally be affected by reaction time with chlorine. Therefore, the concentration should vary with the distance of the sample from the water purification plants. We plotted TOX, THMs, and THOX data against distance from the water purification plants, and obtained Figures-16, 17, and 18, respectively. We observed tendencies for the concentrations of halogenated organic compounds to increase with distance from the water purification plant. However, these tendencies were not significant according to statistical analysis.

The reasons for the unconfirmed relationship between halogenated compound concentrations and distance from the water purification plant are as follows. Since the distance of each sampling point from the

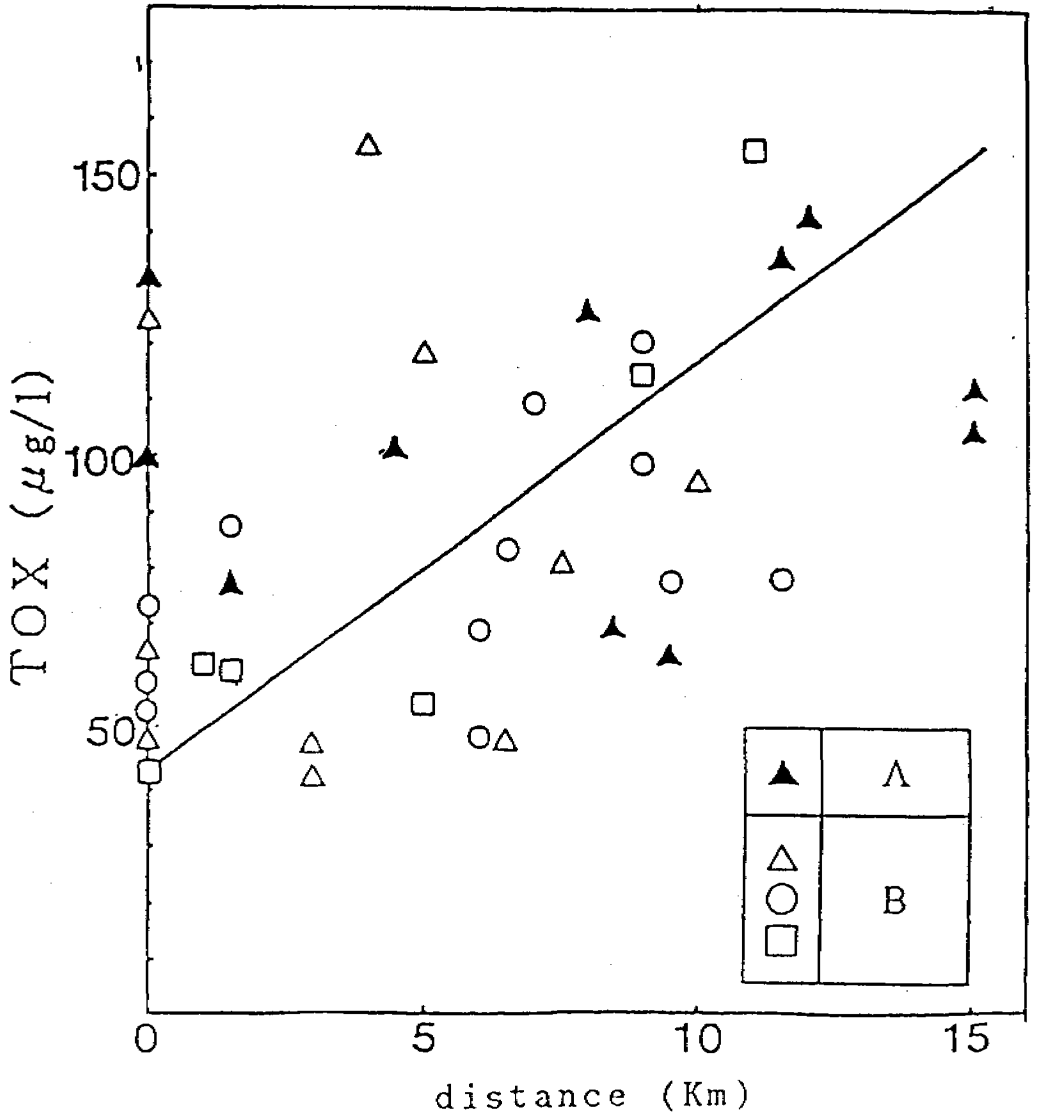

Figure - 16 The rerationship between TOX and distance from water purification plant

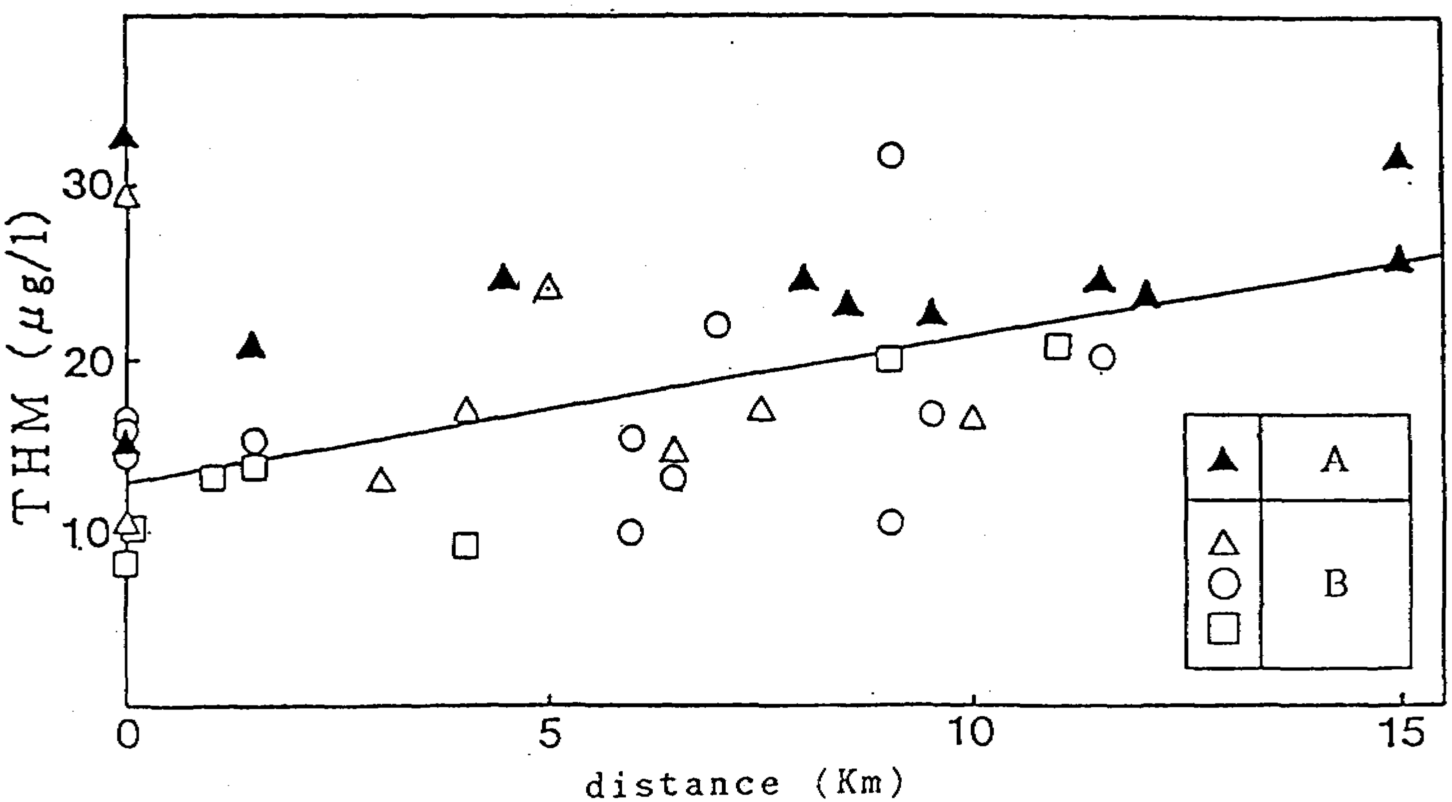

Figure - 17 The rerationship between THM and distance from water purification plant

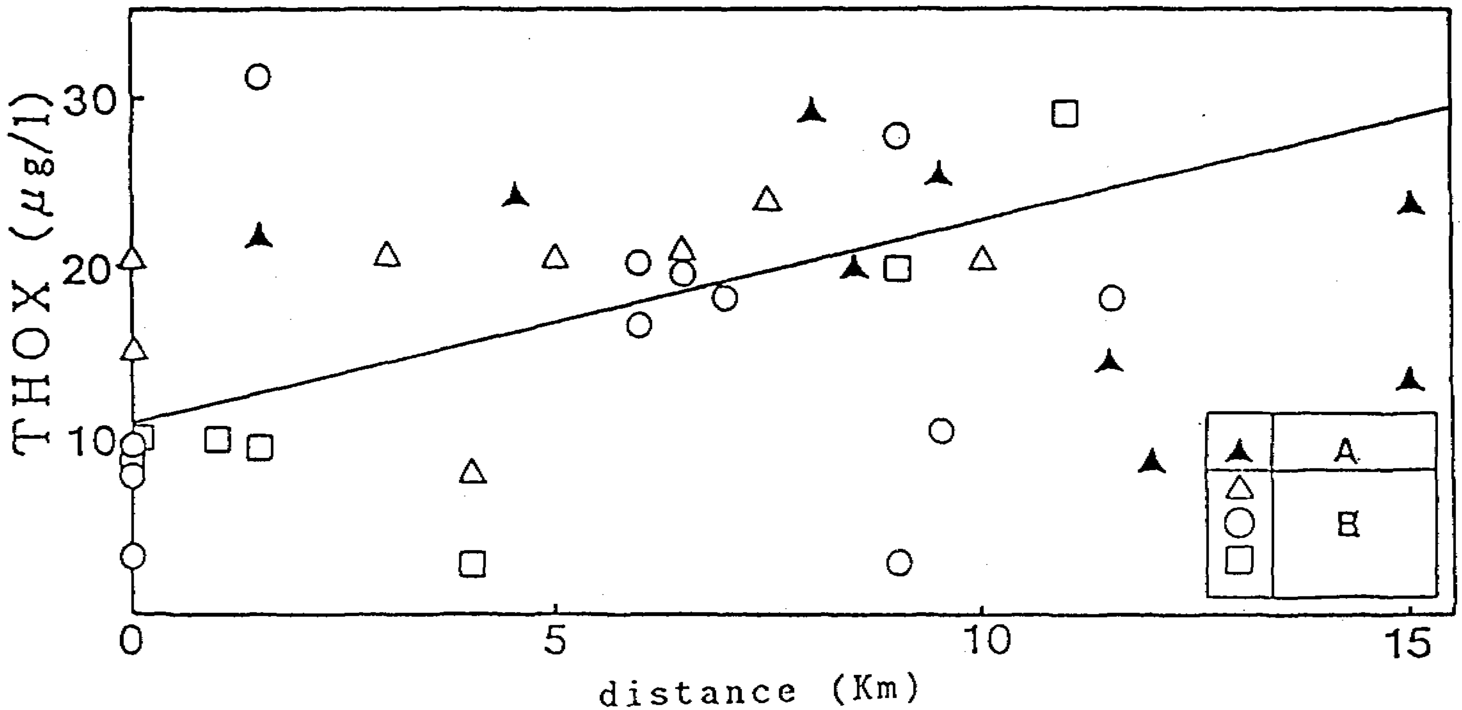

Figure -18 The rerationship between THOX and distance from water purification plant water purification plant was obtained by measuring on a map, it might differ from the actual distance. Moreover, the retention time (i.e., the reaction time with chlorine) is affected by the size of the distribution and service pipes and the rate of water consumption. Therefore, the distance might not be a true function of actual retention time.

From the above results, we considered that halogenated organic compounds were spread randomly throught out the distribution system. Therefore, it is practical to establish a monitoring program that can obtain the mean estimated concentration within a specified error of estimate at a specified confidence level. If we select 20% error of estimate and 95% confidence level, the number of samples needed to obtain the mean estimated concentration of halogeneted organic compounds in this model distribution area is given by the following equation:

$$n > (2.0 * s / 0.2 * c)^2$$

where:

n: number of samples

s: standard deviation obtained by pilot monitoring

c: mean concentration obtained by pilot monitoring

Since the halogenated organic compounds concentration is strongly affected by water temperature, we must take into account seasonal variations when using the above equations to estimate the requisite number of samples. The number of samples for monitoring the mean concentrations of TOX and THMs were estimated to be: 12 and 10 in summer; and 14 and 12 in winter; respectively, using the data shown in Table-20.

All of these numbers are less than 40. Therefore, we conclude that the monitoring program implemented in this study was sufficient for estimating the mean concentrations of TOX and THMs. The mean concentrations thus obtained could be used for estimating the mean exposure level of populations in the observed area from city drinking water.

4-5. Conclusions

The matters to be considered in establishing a reasonable program for monitoring halogenated organic compounds in drinking water have been discussed in this paper.

The head space method for determining THMs, the adsorption-pyrolysis-titrimetric method for determining TOX, and the solvent extraction-gas chromatographic method for determining hydrophilic halogenated organic substances have sufficient accuracy to measure the levels of organic halogenated compounds in tap water.

The formation of halogenated organic compounds was affected by reaction time, pH, amount of chlorine added, and temperature. TCAA showed the largest concentration among THMs and other HOX. The formation of TOX and THOX increased under a low pH condition. However, THMs increased under a high pH condition. The formation of TOX was not strongly affected by temperature. However, THMs and THOX increased as water temperature increased.

The level of organo halogenated substances in tap water is affected not only by water temperature, but also by distance from a water purification plant. However, for practical purposes, we can consider that these substances are distributed randomly through out any water distribution network.

The requisite number of samples for obtaining the mean estimated concentration of halogenated organic compounds in an observed distribution area can be obtained by simple statistical calculation.

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water borne disease
dies off by environment

Dr B. Lloyd

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THE RELATIONSHIP BETWEEN WATER-RELATED DISEASE AND WATER QUALITY WITH PARTICULAR REFERENCE TO URBAN WATER SUPPLY IN A DEVELOPING COUNTRY

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1. ABSTRACT

The problems of urban water supply and water related disease in the Americas are examined in the context of population growth and geographical features. The debate concerning the transmission of potentially water-borne pathogens is discussed. The factors affecting the quality of water supply services in a large metropolitan area (Lima) are described and the epidemiological characteristics of water-related disease summarised and compared with data from Africa (Lesotho).
A water quality additive index is proposed in order to identify the level of risk for each metropolitan district. This incorporates the presence of faecal coliforms and the absence of chlorine residual. A water-related disease product index (DPI) is also proposed which incorporates the incidence of typhoid, hepatitis and diarrhoea. The indices were matched for all districts, where adequate data were available, and a strong correlation was noted. The water quality index was divided into categories (A,B,C) and it was observed that these were generally dependent upon the water supply service levels. It is concluded that disinfection control is grossly deficient in most developing countries but essential for the control of water-borne disease.

1.1 KEYWORDS

Water-related disease transmission; disease product index (DPI); typhoid; hepatitis; diarrhoea; water quality index; faecal coliforms; chlorine residual.

2. THE PROBLEM OF WATER SUPPLY AND POPULATION GROWTH

The Decade Dossier for the International Drinking Water Supply and Sanitation Decade suggested that 40% of the population in developing countries had access to an adequate and safe water supply. However the efforts to improve this level of coverage during the last two decades are being overwhelmed in the urban sector by rapid population growth and poor maintenance. It has been estimated that about 100 million more people drink unsafe water now than in 1975 (World Water, 1981). In the low income developing countries population growth proceeded at an annual rate of 1.2 per centduring the 1970's while that for the middle income group was 2.4 per cent (World Development Report, 1982).

2.1 The urban sector

Many of the problems of urbanisation are typified by the South American region where overall population growth is proceeding at 2.4 per cent. However the growth rate in the urban population is 3.8 per cent (Inter-American Development Bank Report, 1982). Thus whilst the rural population of the region appears to be stabilising at around 116 million the urban sector is under increasing pressure to absorb almost all of the demographic growth.

There are 286 cities in Central and South America which have more than 100,000 inhabitants each. This accounts for 168 million (45 percent) of the population of 376 million in the region. Inevitably the rapid growth of the urban population has aggravated environmental and associated health problems. In particular water resources are becoming scarcer whilst demand is increasing. Traditional sources are becoming contaminated and new sources more costly to develop. Water supply is therefore not keeping pace with slum growth. Industrial wastewater and sewage are inadequately treated, or more usually not treated at all. There is little control of discharge and convenience has been the primary consideration. A quarter of the major cities are located in coastal and estuarine areas (Figure 1) and coastal outfalls have been an obvious means of wastewater disposal (Bartone and Salas, 1983). More seriously, in the arid zones, sewage reuse for irrigation has increased dramatically with little regulation or regard for the risk of crop contamination by pathogens and parasites.

The geographical distribution of these major urban centres (Figure 1) is associated with several features which contribute to the public health engineering problems. The great majority of the population inhabit tropical zones of high humidity which favour the transfer and growth of bacterial agents of diarrhoeal disease on moist foodstuffs. This is particularly true for much of continental Central America and tropical South America where the death rate in infancy and early childhood are highest (Table 1). The enteric and diarrhoeal disease group constitute the most severe health problem in the region and throughout the Third World. PAHO/WHO data (Table 2) show that this group continues to be the number one cause of mortality amongst small children who, according to Canadian data, consume more drinking water per kilogram of body weight than adults.

To what extent diarrhoeal disease and other enteric infections are directly attributable to water quality we shall attempt to assess with reference to available data. However from the above it is clear that the availability of reliable microbiological, and in particular faecal indicator data, assumes paramount importance in assessing the health risks attributed to water supplies.

2.2 Water supply and water related disease

The European and North American experience has demonstrated how a range of developments in social and allopathic medicine, public health engineering and a rise in general living standards have all but eliminated the major communicable disease problems of the nineteenth century. Today we are striving to solve the same basic problems in developing countries where the population is orders of magnitude greater and financial resources increasingly scarce. The temptation is therefore to attempt to find low cost intervention strategies or single interventions which have maximum health impact. Urban water supply however cannot be low cost but is so vital to basic living requirements and hygiene that it is expected, on its own, to have a profound influence on the incidence of a range of infectious diseases.

TABLE 1
INFANT MORTALITY DATA FOR THE AMERICAS, 1979*

Subregion	Death rate per thousand		Percentage of all deaths	
	Under 1 year	1-4 years	Under 1 year	1-4 years
Northern America	12.9	0.7	2.4	0.4
Caribbean	20.5	0.7	10.5	3.0
Continental Middle America	50.9	10.4	28.4	15.4
Temperate South America	32.5	1.5	11.5	1.9
Tropical South America	36.6	4.2	24.0	10.5

* PAHO "Health Conditions in the Americas, 1977-1980". PAHO Scientific Publication No. 427, Washington, D.C. (1982).

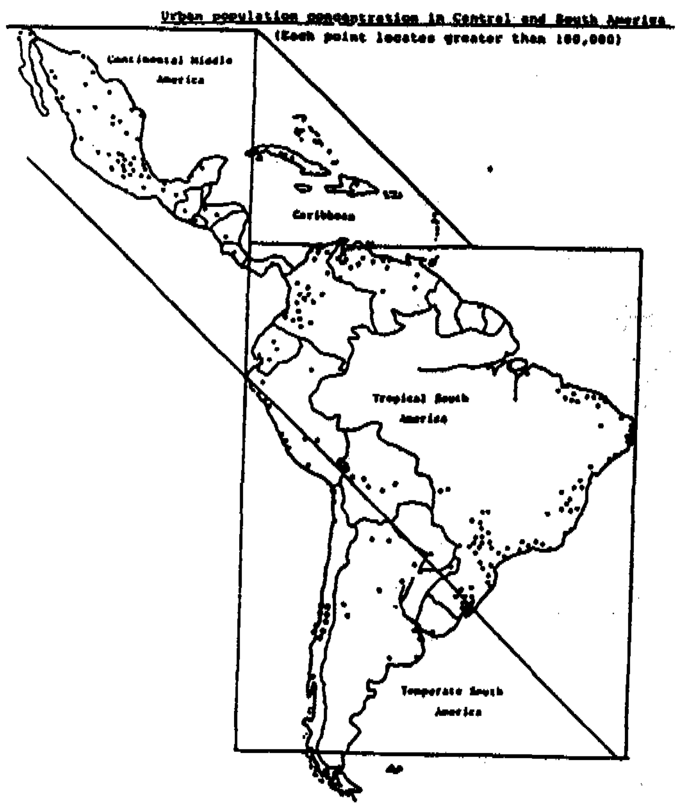

Fig. 1. Urban population concentration in Central & S.America

The importance of the enteric and diarrhoeal disease group has already been referred to and their association with water is sufficient for them to be classified as water-borne and water-washed (Feachem, 1977). However, some studies including that of Feachem et al., (1978) have shown a poor or negative correlation between diarrhoeal disease incidence and water supply improvement. In most cases other factors may have obviated the benefit of good water quality and in the case of some rural investigations the population under study may have been statistically insufficient. Thus for example in Egypt, the ratio of handpumps to population served was unfavourable (Weir et al., 1977). Rahman (1979) however demonstrated the importance of adequacy of supply, by showing an inverse relationship between volume of supply and shigellosis attack rates. There is a consensus that cholera transmission, in riverine and deltaic regions, is primarily water borne (Spira et al., 1980; Curlin et al., 1977; Hughes et al., 1977), but an understanding of the principal transmission routes of some of the more recently identified aetiological agents of diarrhoeal disease such as enterotoxigenic E. coli, rotaviruses and Norwalk virus are at present lacking.

A fundamental difference exists between the viruses and bacteria capable of infecting the mammalian intestine in as much as the latter group are capable of multiplying in moist food stuffs. The bacteria can therefore increase their inoculum potential outside the human host and the food-borne transmission route therefore becomes a most effective mechanism for this group of organisms. In contrast water and poor hygiene (hands) are relatively ineffective means of transmission of large inocula. Thus water, whilst serving as a highly effective dispersant for the spread of an inoculum throughout the environment, paradoxically also acts as an excellent diluent which reduces inoculum potential. Similarly inocula on hands are rapidly reduced in a dry environment, but effectively dispersed and sometimes directly transmitted (parent to child) or indirectly via food. Thus the three vehicles are so intimately associated, as indicated in Figure 5 , that it is often impossible to extricate the impact of water quality alone.

TABLE 2

NUMBER OF DEATHS FROM DIARRHOEAL DISEASES IN CHILDREN UNDER 5 YEARS OF AGE, WITH RATES PER 100,000 POPULATION, AND RANK ORDER AS LEADING CAUSE DEATH, SELECTED COUNTRIES: 1970 AND 1979.

Country	1970						1979					
	Under 1 year			1-4 years			Under 1 year			1-4 years		
	Number	Rate (a)	Rank order	Number	Rate	Rank order	Number	Rate (a)	Rank order	Number	Rate	Rank order
Argentina	4,561	880.5	3	722	38.5	3	2,641	463.3	2	420	20.0	2
Belize	39	823.6	1	15	86.7	1	45	762.7	1	9	41.2	1
Chile	3,853	1,418.1	3	422	46.7	3	705	264.9	3	85	8.6	3
Costa Rica	845	1,509.5	1	271	108.1	1	136	195.3	4	24	11.2	4
Cuba	1,313	564.7	4	82	8.6	4	237	122.7	4	41	4.3	5
Dominica	25	984.6	1	13	127.1	1	5	178.5	1	3	25.4	1
Dominican Republic	1,642	1,177.9	1	612	111.1	1	949	538.8	1	321	46.1	1
Ecuador	2,382	968.9	1	1,691	194.4	1	3,667	1,144.1	1	2,605	231.0	1
Guatemala	3,643	1,817.8	1	5,749	807.6	1	3,934	1,311.3	1	3,864	424.1	1
Honduras	880	792.7	1	1,166	299.5	1	926	873.5	1	624	11.4	1
Martinique	63	598.4	1	20	47.9	1	39	390.0	3	2	4.7	3
Mexico	37,197	1,744.2	1	20,464	274.0	1	30,805	1,258.8	1	11,393	127.2	1
Panama	275	588.6	2	209	112.5	2	158	305.9	1	158	77.2	1
Peru	5,501	1,802.1	3	3,798	209.1	3	4,872	751.8	1	3,058	144.6	1
St. Vincent	47	588.6	2	16	118.6	2	23	403.5	1	8	45.9	1
Trinidad and Tobago	169	710.0	2	28	25.5	2	159	676.0	1	43	43.1	1
Uruguay	254	479.2	-	14	6.4	-	284	521.1	5	15	7.1	5
Venezuela	1,673	874.7	1	1,373	94.2	1	2,836	600.8	2	634	38.2	2

(a) Per 100,000 live births.

Source: PAN AMERICAN HEALTH ORGANIZATION. Health conditions in the Americas 1977-1980. Scientific Publication No. 427. Washington, D.C., 1982.

The major pitfalls in measuring the impact of water supply and sanitation investments by the use of epidemiological data on diarrhoeal disease have been summarised by Blum and Feachem (1983). In spite of the methodological problems which they identify, the magnitude of the disease problem is such that we are bound to scrutinise the data for benefits wherever information becomes available. According to Walsh and Warren (1979) there are of the order of 5,000 million water borne infections resulting in at least 10 million deaths each year in Africa, Asia and Latin America. We therefore propose to examine the relevant health data for a large South American metropolitan area in the context of its water supply and water quality problems.

2.2.1 Existing problems of water supply and water quality in Lima

It is estimated that 65% of the inhabitants of Lima are served by severage and piped water. The water supply is derived from two principal sources. The whole of central Lima and areas peripheral to the city centre are supplied by the River Rimac, a grossly polluted Andean source, which is contaminated by excreta from towns and villages upstream as well as by mining wastes and annual land slides in the mountains. Its treatment plant has therefore to cope with both high microbial contamination and turbidity levels which exceed 10,000 JTU in the December to April rainy season in the Andes. The other major source of supply is deep bore holes, of which there are in excess of 240 in the metropolitan area, although the highest proportion are located in the suburbs. The water supply system is complicated by the fact that major areas on the north and south sides of the city have a mixed supply from both deep wells and the treatment plant. From the point of view of quality and quantity the city faces critical problems arising from the following causes:

a) The population of Lima is currently growing at an estimated 300 per day, largely by invasion of desertic areas on the fringe of the city.

b) There is negligible rainfall throughout the year and therefore no effective recharge of the groundwater other than in the zone adjacent to the river.

c) The groundwater table is (as a consequence of b) falling at an alarming rate - several meters per year. This is further aggravated by abstraction for agricultural purposes in the three river valleys of the Lima district. In other parts of Peru irrigation water frequently takes precedence over domestic supplies and in periods of water shortage sharing practices are highly organised. In the metropolitan area however it is clear that where there is competitiion between agricultutal and domestic use, agriculture is fast disappearing.

d) The depleted groundwater table is therefore at greater risk of contamination as the process of draw down continues, particularly in the area of the wells. Chlorination is essential, but rarely practiced.

e) An increasing demand is being imposed on the River Rimac and it has been predicted that its supply capacity will be exceeded before 1990. This may be partly offset by the Mantaro valley transfer scheme which proposed to extend the diversion of water from the Amazonian water shed to the Rimac. However it may already be too late to avoid a major crisis in supplying Lima with this water which is in any case of doubtful quality with respect to heavy metals.

f) Major sectors of the urban slums, amounting to almost one quarter of the total population of Lima, already have to be supplied by tanker to open household containers. These are inevitably subjected to gross microbial contamination.

g) Each year between December and March the Lima treatment plant is paralysed for a number of days by untreatable water due to excessively high turbidities. This results in some sectors of the metropolitan area being starved of water and a consequent high risk of contamination in an otherwise direct pressure system. In many districts there are no roof storage cisterns and in a large area of the central city district pressure is inadequate to raise water to the level of the first floor.

In the period 1971 to 1982 the population of Lima nearly doubled, from 2.7 million to almost 5 million when the port of Callao is included. This growth was accompanied by urban sprawl as the area of the capital increased from 255 km^2 to 458 km^2 at the expense of 200 km^2 of agricultural land. All of the foregoing point to a crisis in water supply and it is therefore vital that the capacity of the Lima water authority (SEDAPAL) should be developing effectively at this time. The master plan for water supply to Lima has proposed an emergency plan for groundwater exploitation which has recently been financed. This is intended to enable a postponement of the Mantaro Valley transfer scheme, but it will be demonstrated in the discussion that follows that the groundwater sources themselves are suspect.

2.2.2 The relationship between water quality and health data in Lima - a case study

Diarrhoeal disease incidence in Lima and contiguous Callao has an age distribution which is typical of that found in most developing countries. Figure 4 demonstrates the very high incidence of infection in the first year of life. In many of the urban slum districts it has been reported that six to eight episodes of diarrhoea are the norm in the first year of life. Figure 4 clearly emphasises the major risk of exposure during the first five years.

When we examine the seasonality of diarrhoeal disease and typhoid one is impressed by their peak coincidence with temperature in the first quarter of the year and their progressive reduction through the cooler months. This is only partially complemented by the data for hepatitis which nonetheless exhibit a similar trough in the coolest months (Figure)

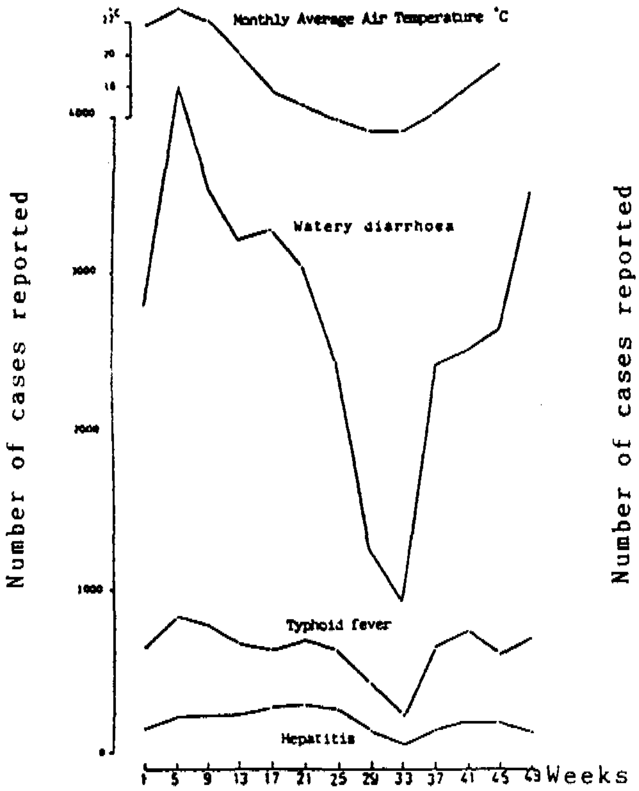

Fig.2.Seasonality of diarrhoea, typhoid and hepatitis in Lima.

Fig.3.Seasonality of diarrhoea in Roma, Lesotho.

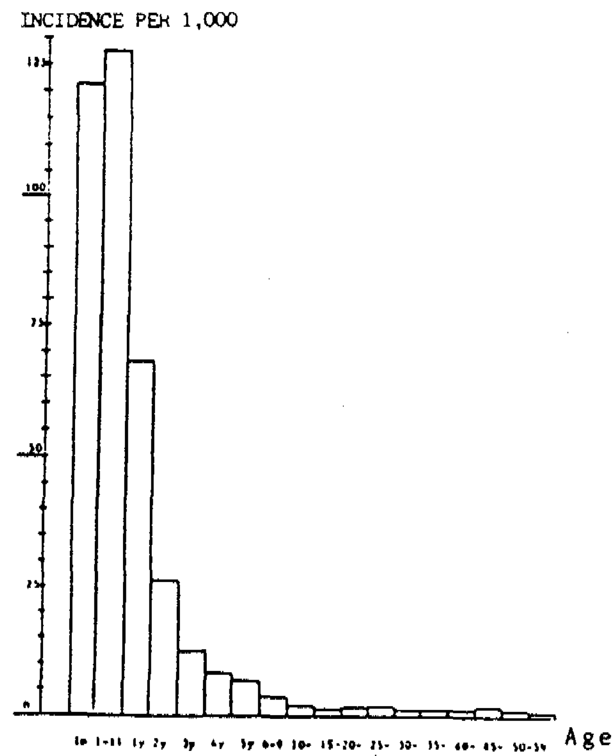

Fig.4.Diarrhoeal disease incidence by age in Lima and Callao (Peru).

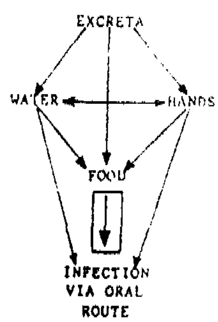

Fig.5.Faecal-oral transmission routes of bacterial pathogens

It is of interest to compare this with diarrhoeal disease reportings at rural hospitals in Lesotho in southern Africa (Figure 3). Although the temperature range is somewhat wider the coincidence of peaks and troughs is similar through the year. However in Lesotho the peaks also correspond to the wet season whereas Lima experiences almost no rainfall throughout the year. We will examine the Lesotho case study more closely under the final section since some water quality data are available for assessing the influence of water supplies in that location. However systematic water quality data have become available since 1981 for almost all of the metropolitan districts of Lima which may therefore be compared with the incidence and distribution of diarrhoeal disease, typhoid and hepatitis in the districts in the same year. Although it must be accepted that disease diagnosis and reporting in some districts is poorly developed nonetheless a population of five million is statistically more than adequate to attempt correlations with water quality data.

On the water quality side we consider that two critical parameters are essential to judge the hygienic quality of water. These are faecal coliform count (F.C./100 ml) and presence or absence of chlorine residual throughout a particular supply zone. We therefore propose a water quality additive index which is a composite of both parameters. We define this WATER QUALITY ADDITIVE INDEX as:

"Percentage of F.C./100 ml positive results + percentage of chlorine residual negative results".

This produces an index range of zero to 200; zero thus representing highest quality water and 200 highest risk supply districts. Thus a district with greater than 95% of all samples throughout the year having no faecal coliforms and 100% chlorinated will have a water quality index of less than five and we will call this category A water. However we will only permit indices to be calculated and included in the general analysis if there are 10 or more sampling occasions throughout the year.

We have resisted the temptation to further complicate the water quality index at this stage e.g. by weighting the level of faecal contamination in the calculation, since broad categories are already clear.

Water Quality Category	Index range	
A	0 - 4.9	First class quality and service throughout the year.
B	5 - 49.9	Spasmodically unchlorinated and frequently contaminated.
C	50 - 200	Normally untreated and regularly contaminated. Spasmodic interruptions in supply. Well supplies and tankered water.

Since diarrhoeal disease, typhoid and hepatitis may all be transmitted via the water route we have elected to combine all three into an index which we shall call the DISEASE PRODUCT INDEX (DPI). This is calculated from the incidence per 1,000 of each disease thus:

Diarrhoea x Typhoid x Hepatitis = D.P.I. We have chosen to use a product rather than an additive index to avoid a single disease incident being unfairly weighted whilst increasing the range and hence the sensitivity of the DPI scale.

The 1981 disease incidence data for Lima are presented alongside the corresponding water quality data for each district in Table 3. The water quality additive index is plotted against the DPI in Figure 6. The correlation coefficient is impressive, at 0.779, but more importantly three categories of water supply quality and service level can be readily distinguished which correlate well with the various levels of disease product index.

Category A

In spite of grossly contaminated raw water the Atarjea treatment plant supplies water of a consistently high quality to six central metropolitan districts of Lima throughout most of the year. The supply is properly chlorinated and these districts fulfil the WHO guideline for 95% of samples throughout the year being negative with respect to coliform contamination. Significantly none of the six districts have been found to be deficient in chlorine, and five of them are in the low water-borne (low disease product index) category. Equally significantly the top three represent the top residential areas of the city and the lowest DPI. This points up the additional significance of the socioeconomic variables including wealth, hygiene and nutrition although a separate analysis of these has been excluded.

Category B

Also within the central metropolitan area there are districts served by both treatment plant and supplemented by well supplies. It is important to note that those areas are all at times deficient in either bacteriological quality or chlorination or both. There are undoubtedly subdistricts in which the distribution system is spasmodically subject to gross contamination and without the safeguard of residual chlorine an ever present risk of water borne infection. This is indicated by the elevated DPI in the range 5-25 and correlates well with a water quality index in the range 5-50. Nine districts fall into this category, although two are suburban rather than central and include low pressure areas to which water has to be tankered.

Category C

The worst category is exclusively suburban and supplied either by wells or by tankering. The risks of tankering to unprotected storage cylinders are obvious, but it is noteworthy that five of eight districts in this group are continuously supplied by piped well supplies. These are uniformly unchlorinated and subject to an ever present risk of pollution particularly under the drought conditions of Lima. It is also important to note in this category that the district of La Molina is predominantly populated by the upper socioeconomic groups in which hygiene and nutritional factors should therefore play a lesser role.

Only three districts have DPI values which fall below the category predicted by the water quality index. Two of these are believed to be deficient in disease reporting procedures, the third requires more advanced socioeconomic analysis.

TABLE 3

Water quality and water-related disease incidence data for districts of Lima (1981-1982)

DISTRICT	WATER QUALITY			DISEASE INCIDENCE/1,000			Disease Product Index (DPI)
	Faecal coliform (% + ve)	Chlorine Application (% - ve)	Additive Index	Diarrhoea	Typhoid	Hepatitis	
1. Miraflores	1.3	0	1.3	5.28	0.37	0.164	0.32
2. San Isidro	4.1	0	4.1	1.04	0.70	0.365	0.26
3. Lince	0	0	0	6.07	0.75	0.211	0.96
4. San Luis	0	0	0	9.43	1.31	0.192	2.37
5. La Victoria	3.3	0	3.3	5.12	1.07	0.572	3.13
6. Jesús María	4.5	0	4.5	5.65	1.29	0.986	7.19
7. Callao	10	10	20	4.63	1.40	0.420	2.72
8. Rímac	3.5	20	23.5	7.16	1.64	0.580	6.81
9. Breña	12.1	0	12.1	2.67	2.41	0.943	6.06
10. Surquillo	6.4	20	26.4	12.48	1.89	0.306	7.22
11. Pueblo Libre	5.0	20	25.0	9.31	1.67	0.607	9.44
12. Lima - Central	8.1	20	28.1	11.61	1.88	1.137	24.82
13. Santiago de Surco	4.4	20	24.4	14.23	1.81	0.300	7.73
14. San Juan	9.1	10	19.1	12.81	1.76	0.507	11.43
15. Villa María	4.5	10	14.5	10.75	3.44	0.545	20.15
16. Chorrillos	21.9	20	42	10.82	1.17	0.522	6.61
17. San Miguel	16.0	50	66	3.87	1.06	0.373	1.53
18. Comas	16.2	70	86.2	5.56	2.49	0.378	5.23
19. San Martín	6.0	80	86.0	7.62	1.68	0.704	9.01
20. Lurigancho	14.8	80	94.8	13.66	5.48	1.56	116.77
21. Independencia	50	95	145.0	9.92	2.58	0.646	16.53
22. Puente Piedra	22.5	100	122.5	14.8	3.10	0.825	37.85
23. La Molina	21.4	100	121.4	29.13	2.11	0.887	54.52
24. Pachacamac	54	100	154	23.60	1.77	1.622	67.75
25. Lurín	100	100	200	32.95	6.06	0.981	195.88
26. Pucusana	100	100	200	99.42	6.09	1.462	885.19

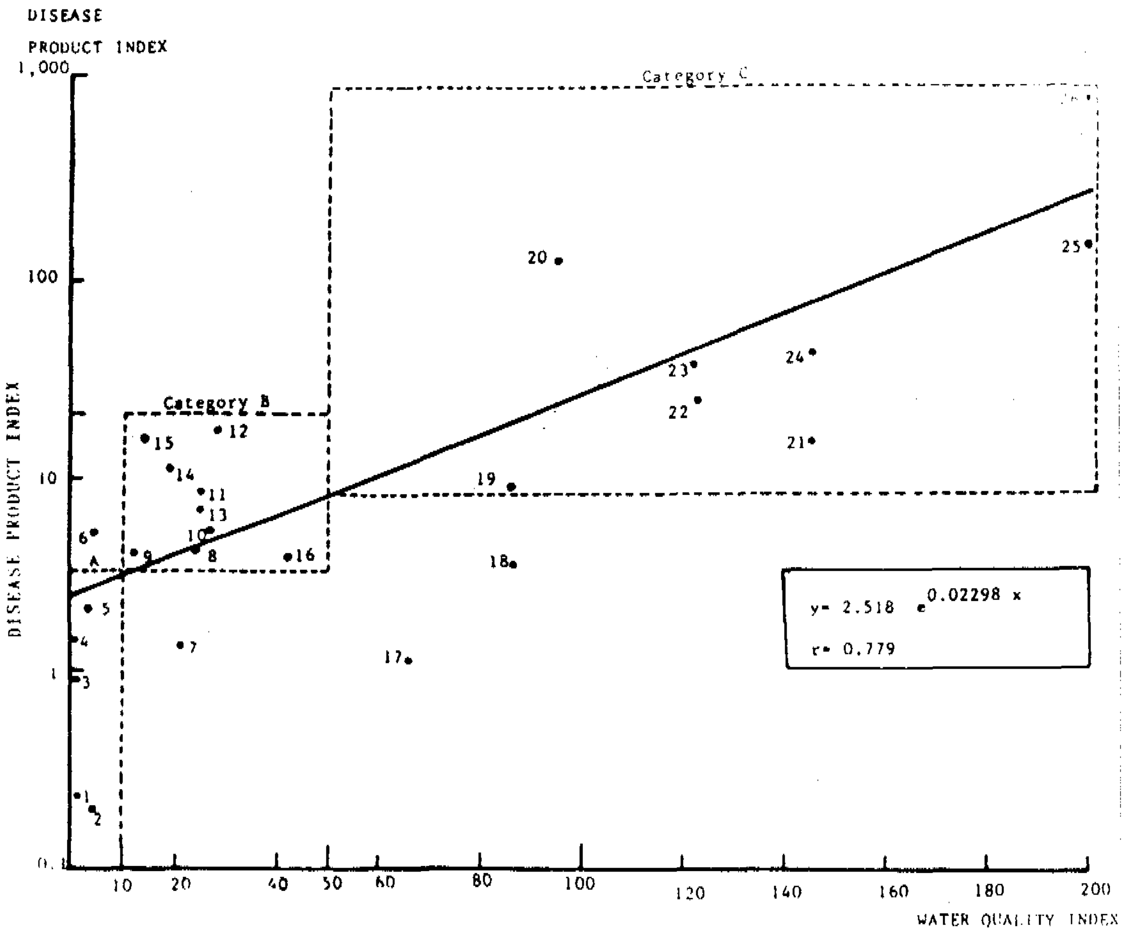

Fig. 6. Relationship between water related disease indices and water quality for districts of Lima -Peru (1981-82).

3. DISCUSSION

Water quality and water-related disease

Feachem et al (1978) have examined diarrhoeal and typhoid reporting to hospitals in Lesotho in areas where water supply has been improved and others which have not. They concluded that where water quality was the only parameter improved and where there was neither any increase in the volume of water used nor any change in domestic and personal hygiene, then there was no detectable change in the incidence of water-related diseases in study villages. Furthermore they concluded that the spatial and temporal distribution of typhoid reportings did not support a water-borne transmission hypothesis. They also believed that the wet season peaks of diarrhoeal disease were not associated with poor water quality. They suggested that the survival of pathogens in the moist, warm conditions of the wet season in Lesotho may be significantly better than in the dry, cold conditions of the winter, and that this might be an important factor in food contamination and hence food-borne transmission. However, they also reported that 69 percent of water sources tested showed bacterial contamination to have overall mean concentrations 5.4 times higher in the wet than in the dry season. Although they rejected a water-borne explanation of both typhoid and diarrhoeas they were careful to point out that the data at their disposal were insufficient to make other than informed guesses.

The Lesotho study raises important questions about the level of improvement of water quantity and quality which is necessary to eliminate water-borne infections arising from rural supply systems. Whilst the argument that quality is less important than quantity is valid when there is not enough water available in the home for basic hygiene purposes, the question which is still begging is as follows. Given sufficient water for domestic purposes (say 50 litres per capita per day) what level of faecal contamination does not pose a risk of water-borne infection to the community? The WHO Guidelines (1984) recommendation for large supplies is unequivocal, zero coliforms and E. coli, and not less than 95% of samples should be negative throughout the year. In practice however, this level of control is rarely achieved, even in some of the advanced countries' urban water supply systems. The debate then commences as to whether what were previously described as standards should be relaxed, at least for rural supplies.

The Lesotho data demonstrate that in the rural environment simple improvement projects such as the protection of spring water can readily reduce the level of faecal coliform contamination by almost two orders of magnitude, from say 1000 down to 20 faecal coliforms/100 ml. But these values represent average reductions and there is no guarantee that any source will remain with low levels of contamination throughout the year, and since there is no barrier against contamination other than source protection their safety is highly suspect. Feachem, et al (1978) argue that the improved supplies are still better than unimproved supplies and that since the diarrhoeal disease and typhoid do not appear to be primarily water-borne, the costs and maintenance problems of treatment under Lesotho village conditions are unjustified. The implication seems to be that the regular occurrence of low levels of faecal coliforms is acceptable. It is certainly inevitable unless there is an additional measure of protection such as routine chlorination to provide a free residual of hypochlorous acid in the distribution system. Feachem et al condone the Lesotho village water supply policy which is not to undertake disinfection, because of the problems of operation and maintenance. This is not an argument with which we concur. Whilst it must be admitted that the training needs for operating and maintaining water supplies and sanitation facilities in the developing countries present the greatest difficulty it is generally agreed that this sector should have a high priority. In the case of disinfection there is a strong case for introducing this into rural water supply practice. Not only does a free residual of chlorine provide protection against the introduction of many pathogens in a distribution system; it may also persist long enough in a bucket of water drawn from a standpipe system to control post collection contamination. For example, an initial free residual of 0.6 mg per litre was reduced by 66 per cent to a still useful 0.2 mg per litre after twelve hours at 21°C. This is particularly important in view of the commonly reported observation that an initial level of 0-10 faecal coliforms (F.C.) per 100 ml standpipe sample is converted to 100-500 F.C. per 100 ml in unchlorinated water, through careless transport, storage and use.

There have been very few controlled experiments on the reduction of the incidence of infant and early childhood diarrhoea resulting from chlorinated versus non chlorinated water. However, a recent unpublished report from West Bengal (Institute of Child Health, 1982) examined the influence of regular cleaning and refilling of household water pots with chlorinated water. A control group received a placebo of distilled water which was unchlorinated. The reduction of childhood diarrhoea in the group receiving chlorine was 75 per cent greater than in the placebo group. If true, this provides as strong a case for promoting chlorination as for the global oral rehydration programme. In the meantime less stringent guidelines for rural water supply quality have been proposed. Volume 1 of the 1984 WHO Guidelines states that for unpiped supplies:

> "the objective should be to reduce the coliform count to less than 10/100 ml, but more importantly to ensure the absence of faecal coliform organisms ... Greater use should be made of protected groundwater sources and rainwater catchment, as these are more likely to meet the guidelines for potable water quality."

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The views expressed are the responsibility of the authors and not necessarily those of the supporting organisations.

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REGIONAL CENTRE FOR THE PROMOTION OF
ENVIRONMENTAL PLANNING AND APPLIED STUDIES (PEPAS)

REGIONAL WORKSHOP ON DRINKING WATER
QUALITY MONITORING AND SURVEILLANCE

ICP/RUD/001-PROG.112

Kuala Lumpur, Malaysia
27 February - 3 March 1989

ENGLISH ONLY

INFORMATION MANAGEMENT AND DATA PROCESSING IN DRINKING WATER QUALITY MONITORING AND SURVEILLANCE

by

Dr Hishashi Ogawa
WHO Environmental Systems Engineer

1. INTRODUCTION

Success or failure of a drinking water quality surveillance programme depends to a great extent on the reliability of information transfer among the institutions involved. The transfer of information may not be trivial because a surveillance programme may involve several government agencies at national, regional and local levels and some actions in the programme require a series of timely execution of information transfers. In order to ensure high reliability of information transfer among the agencies involved, a carefully designed information management and data processing system needs to be developed.

Such an information management and data processing system should provide at least the following functions:

- timely distribution of information needed for immediate remedial actions in case of emergency; and

- generation of information necessary for management and planning of the water supply system and surveillance programme.

The first function is accomplished by a system of violation reporting which will generate corrective actions for the water supply system and activate warning and notification to the users. The second function is performed by a system of information and data collection, storage, processing and interpretation which will produce information necessary for decision-making in planning and management of the waterworks and surveillance programme.

The following sections of this paper present various components of an information management and data processing system for drinking water quality surveillance, and special considerations which must be given to the design of such a system and use of modern communication devices.

2. COMPONENTS OF INFORMATION MANAGEMENT AND DATA PROCESSING SYSTEM

A general information management and data processing system is composed of collection, storage, processing, retrieval and dissemination of information and data. The configuration of these components in an information management and data processing system for a drinking water surveillance programme could be complicated by the fact that the information and data are transmitted among different agencies at local, regional and national levels. In addition, the system must possess an element which activates information transfer in case of violation reporting, particularly violation of health-related parameters.

Figure 1 depicts a general flow of information and data for drinking water quality surveillance. It indicates that different agencies are involved to undertake various activities of information management and data processing. These activities are discussed as follows:

(1) Data collection and sample analysis. In a drinking water quality surveillance programme, data are collected regularly by water quality monitoring and sanitary survey. In the monitoring programme, water samples are taken at various locations in the water supply system and analysed for bacteriological and chemical contaminants, and physical parameters such as colour and turbidity. The analysis of water sample may be performed at the sampling point or at a laboratory after preserving and transporting the samples. In the sanitary survey programme, surveyors collect the information regarding conditions of various components of the water supply system through observation and inspection at the sites. The results of water quality analysis and sanitary survey are recorded in specifically designed reporting forms. The data collection and sample analysis activities are normally conducted by the local agency and often technically supported by the regional agency.

(2) Reporting. The reporting activities in a drinking water quality surveillance programme can be roughly divided into non-violation reporting and violation reporting. Violation reporting has to be processed quickly, and the information necessary for corrective actions including notification to the water user has to reach the personnel who carry out the actions. For both violation and non-violation reporting, the information is stored for processing later. These reporting activities are carried out at the local level.

(3) Storage, processing and dissemination. Violation and non-violation data are stored in such a manner that they can be easily retrieved and processed. Data handling can be done either manually or by a computer system. This depends upon the volume of data to be handled and the availability of computers and technical personnel for the computer system operation. Raw data and/or processed information will be disseminated to other agencies involved in the water supply programme for their further actions. The data/information storage, processing and dissemination are carried out at all government levels although the aims of such activities are different, depending on the roles of the agencies in the drinking water quality management system. The information is also transmitted from the local agency to the regional agency and from the regional agency to the national agency. Often, these data and information are arranged in a form of monthly or annual summary report.

(4) Data analysis and interpretation. Data compiled over a long period from different locations are analysed to provide the information necessary to improve the performance of the water supply system.

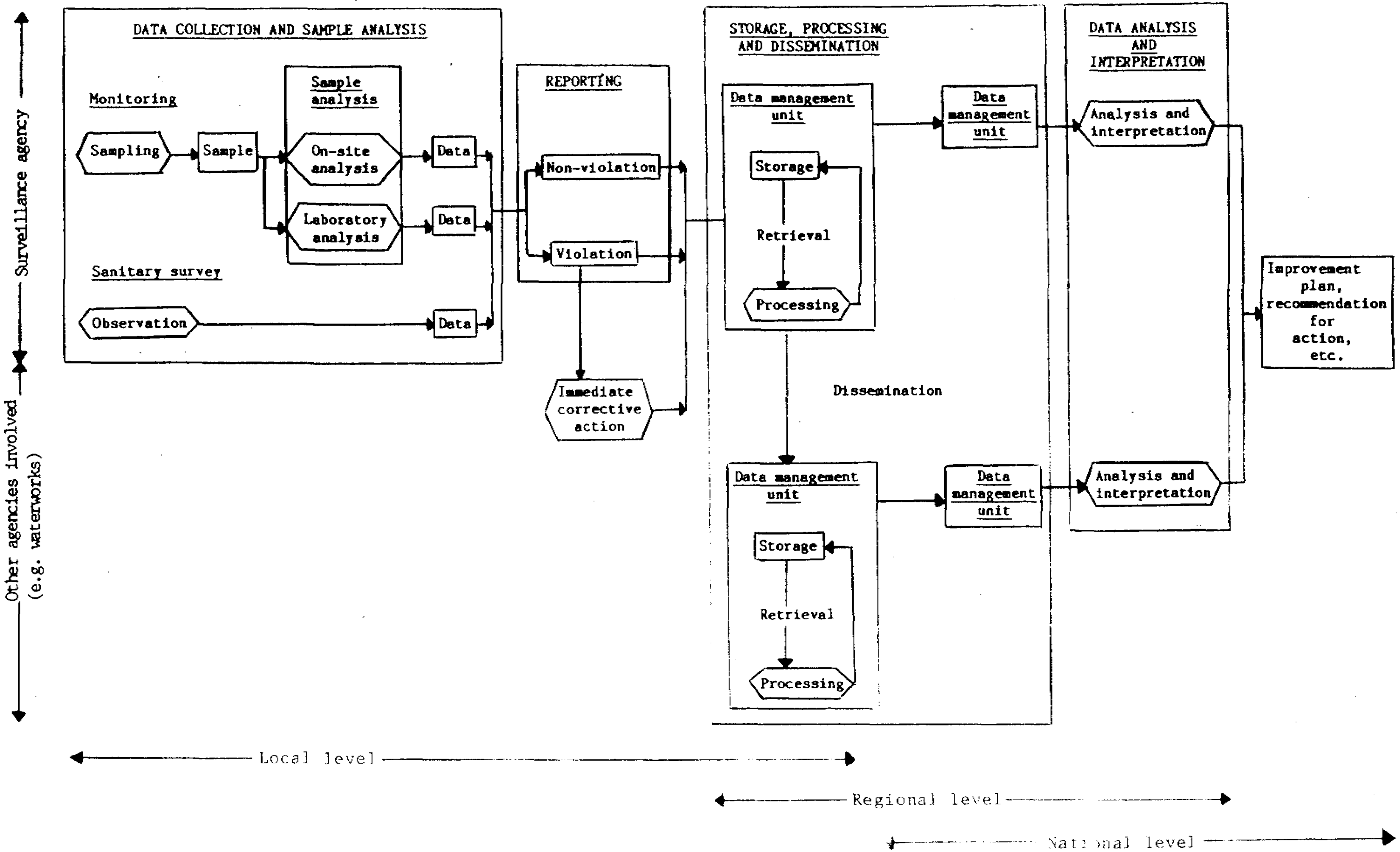


Figure 1 General flow [illegible] information [illegible] Drinking Water Quality Surveillance Programme

Various statistical techniques such as correlation, regression, analysis of variance, analysis of covariance, time series analysis and multivariate analysis, can be applied, in conjunction with graphical plotting, to show potential problem areas, predict future trends of violation at different locations, establish correlation between the frequencies of violation and the outbreak of a specific epidemic disease, and so on. Several commonly used statistical methods are given in Annex 1. Results of these analyses are then interpreted to produce recommended actions for improvement of the drinking water supply system and surveillance programmes.

3. DESIGN CONSIDERATIONS

3.1 Interagency communication

One of the most important aspects of the surveillance programme is communication among various units of the participating agencies. The effectiveness of surveillance operations depends greatly on whether or not the communication network among the participating agencies and the system of record keeping at the agencies are well designed, and on whether or not the programme permits uninterrupted flow of information through the communication network.

A typical surveillance programme involves the health agency as the facilitator of the programme and the waterworks authority as the responsible agency for implementation of remedial actions. In addition, the laboratory analysis may be provided by a separate organization, which plays a crucial role in activating corrective measures in case of violation of drinking water quality standards. The monitoring of ambient water quality such as source water quality may require involvement of yet another agency, usually the environmental agency.

A large amount of work in the surveillance programme is carried out at the local agency level. Smooth flows of information between the local agencies involved are vital in preventing and minimizing the health risks of water users. At the upper echelons of the government hierarchy such as state, provincial, prefectural and national governments, the information collected at the local level will be used for further analysis and future planning. In addition to these vertical flows of information from the local to the national agencies, communication systems among national agencies and among prefectural/provincial agencies need to be established.

The coordination of the agencies involved is by no means an easy task since they tend to operate on their own priorities. One missing link or one breakdown in communication will most likely cause the entire surveillance programme to fail because it is generally quite difficult to ensure the accountability of action by individuals belonging to different agencies. In designing a communication system for the surveillance programme, it is important that each individual involved be given clear-cut responsibilities, relatively simple and easy tasks to perform, and reliable communication devices.

3.2 Development of information flow diagrams

As mentioned above, the surveillance programme involves many people who must collect, store, process and disseminate information in a timely manner. The information flow of such a system can easily become complicated as the number of individuals involved increases. Development of a diagram showing the information flow in the surveillance programme can help the designer of the information management system greatly to clarify the intricacy of the information transmission between the individuals. One such diagram is earlier shown in Figure 1, which presents the overall flow of information in relation to the surveillance activities.

Examples of detailed information flow diagrams for routine and violation reporting systems are presented in Figures 2 through 6. These diagrams were developed for the Malaysian drinking water quality surveillance programme, and included five distinct information transmission activities, namely non-violation reporting, violation reporting for non-health parameters, violation reporting for health parameters, residual chlorine detection reporting and sanitary survey result reporting. There are four agencies involved in the reporting systems, including the Ministry of Health, the Public Works Department, the Department of Chemistry and the Department of Environment. Their respective agencies at the State or Regional and District levels also participate in the systems.

These diagrams are quite self-explanatory with the easily understandable symbols used. Notably, the diagrams specify the means of communication such as telephone, mail and persons with vehicle transportation, and the checking mechanism as to whether a particular corrective action has in fact been properly taken. They can also indicate the locations of the back-up files of certain information and the direction of the flow of information through a network of different agency units.

As demonstrated by these examples, a diagrammatic representation of information flows in the surveillance programme can make clear the complex information transmission activities. Therefore, information flow diagrams should be constructed as a first step towards developing an information management system for the surveillance programme.

3.3 *Recording format*

The design of a raw data recording format may not be a trivial task. For one thing, the format has to contain complete information necessary for subsequent actions such as violation and non-violation reporting. Some sample formats developed in Malaysia are presented in Figures 7 and 8.

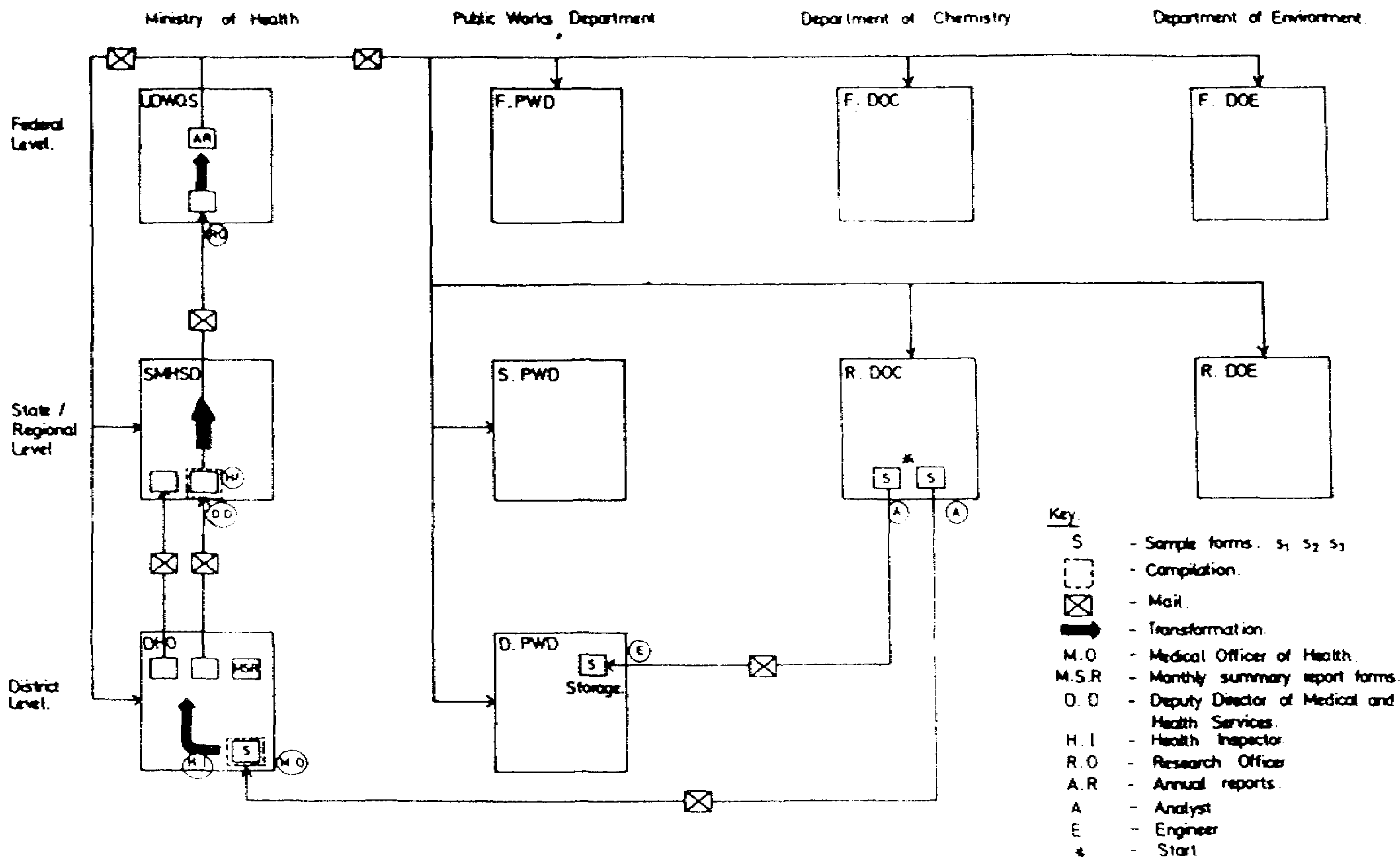


Figure 2 Data Flow for Non-violation Report

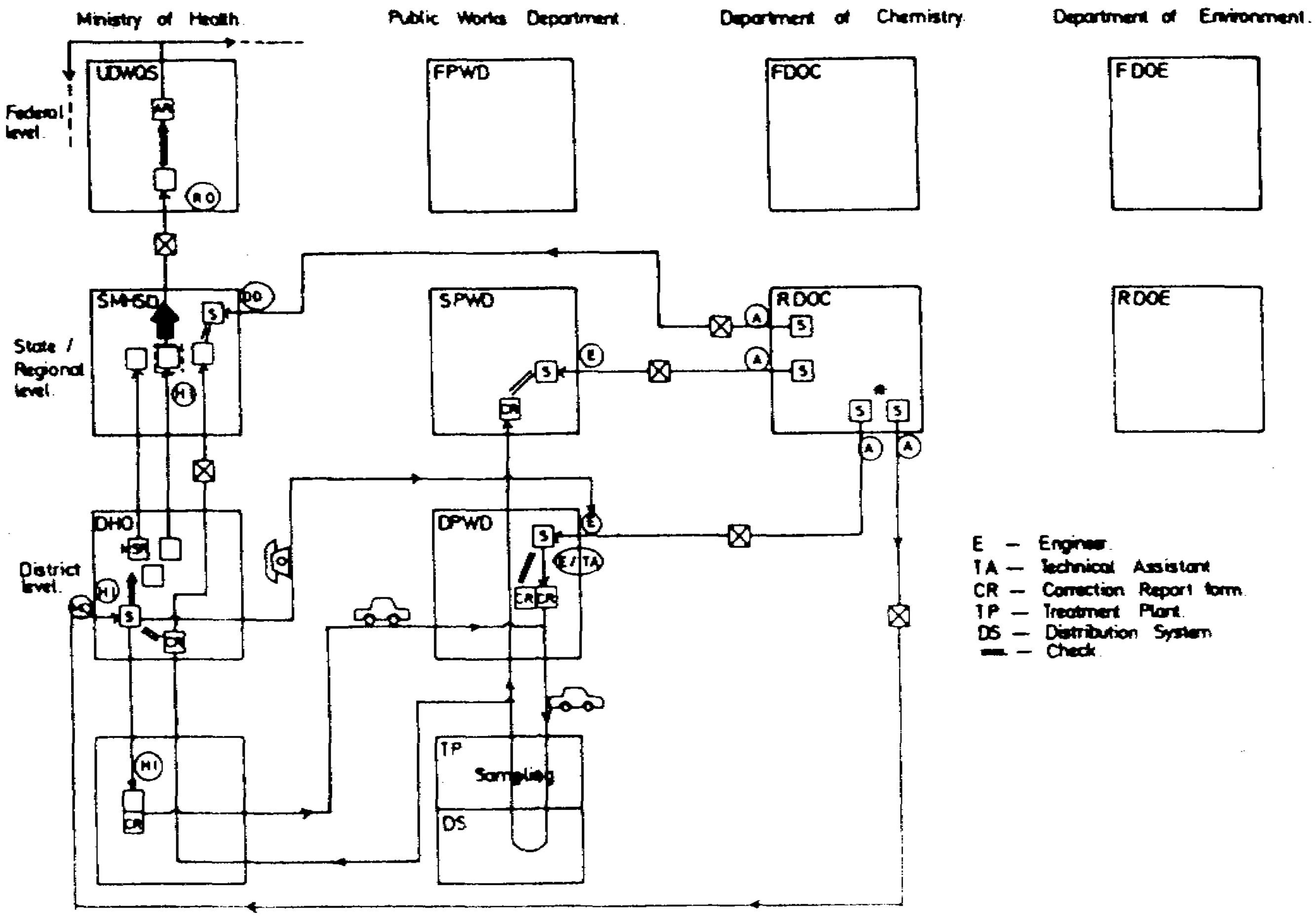
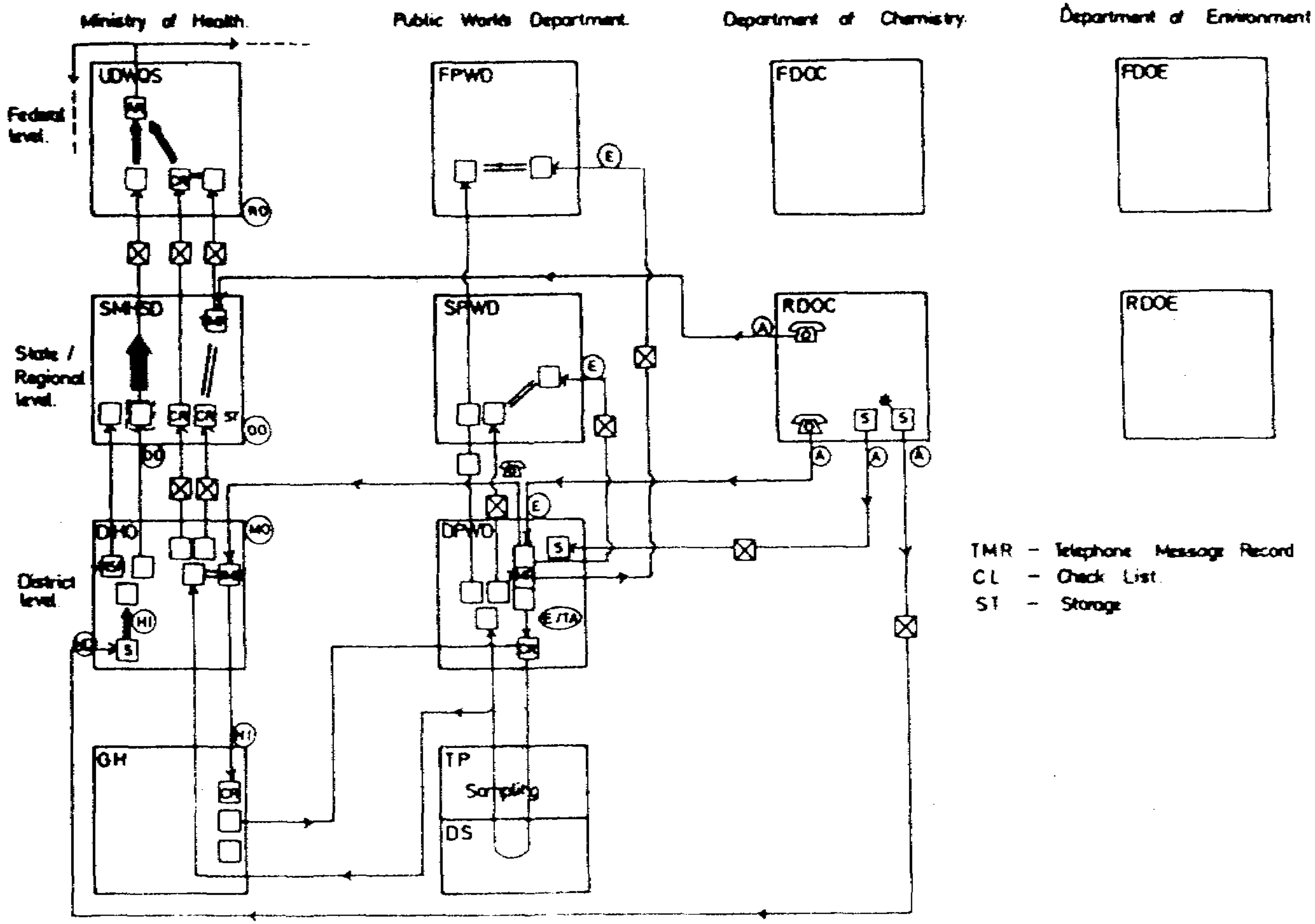


Figure 3 Data Flow for Violation Report
(Exceeding recommended levels and mandatory levels but not including those parameters described under health investigation levels)



TMR – Telephone Message Record
CL – Check List
ST – Storage

Figure 4 Data Flow for Violation Report
(Exceeding health investigation levels)

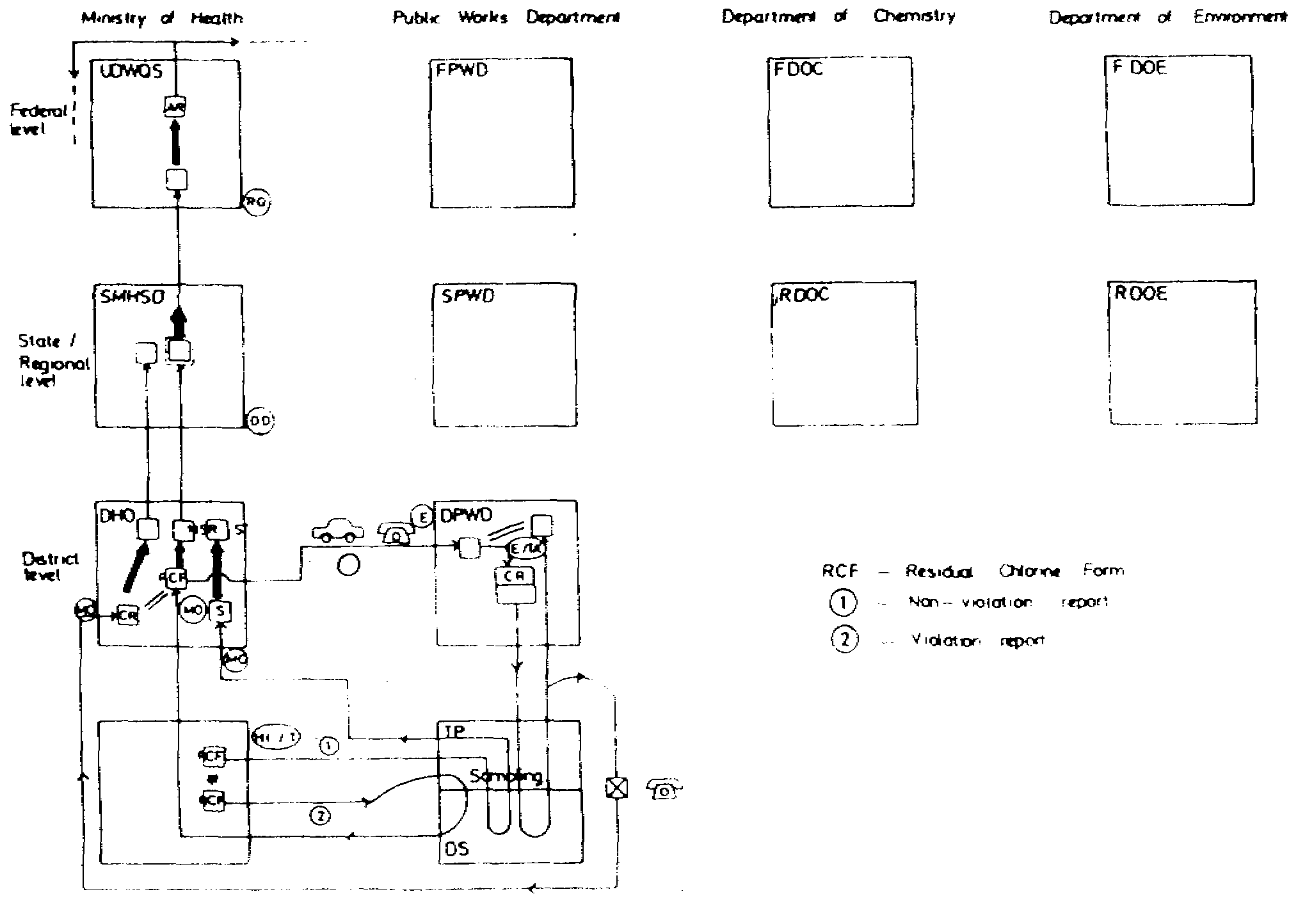


Figure 5 Residual Chlorine Detection Mechanism

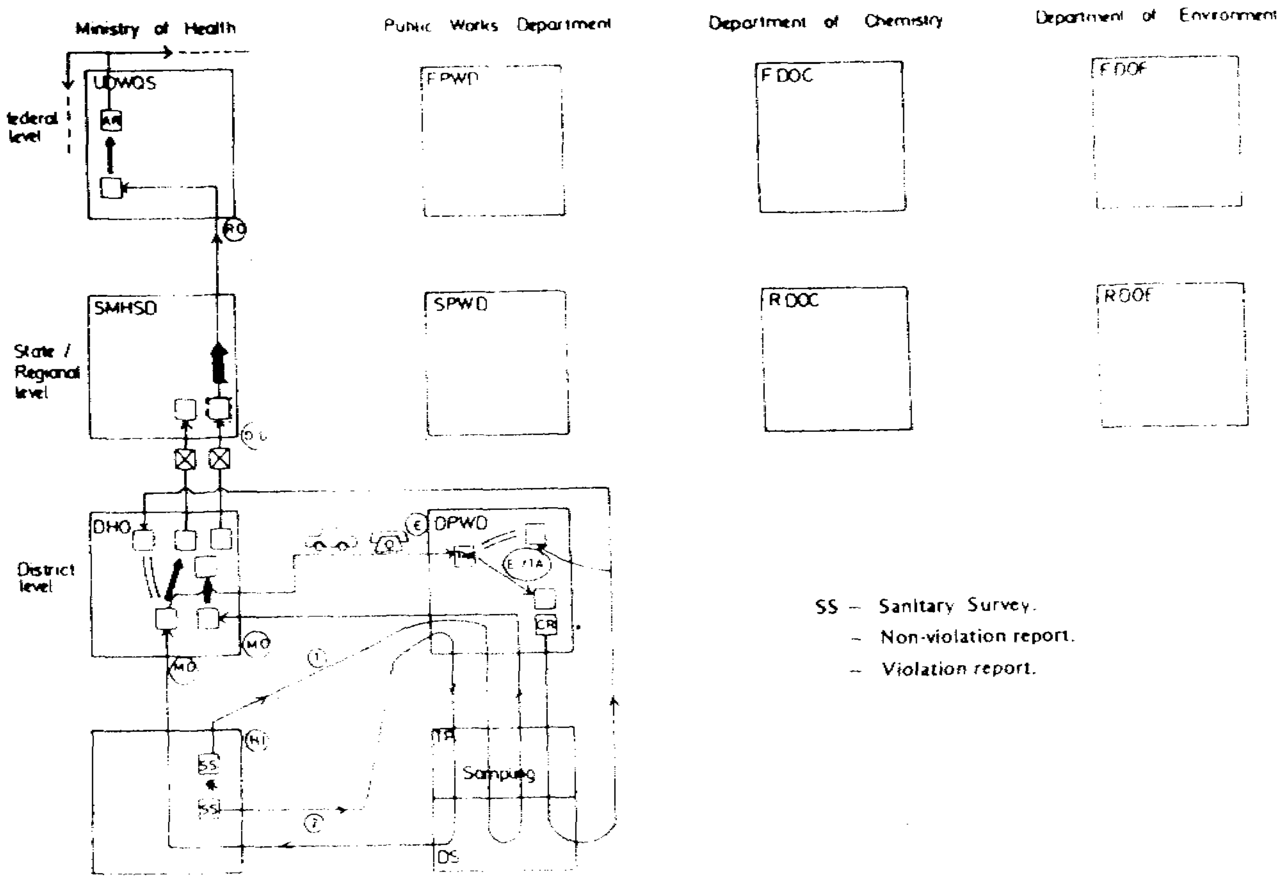


Figure 6 Detection Mechanism through Sanitary Survey

DEPARTMENT OF CHEMISTRY, MALAYS

REPORT ON BACTERIOLOGICAL EXAMINATION OF WATER

Lab. No. ....

Supply: ....

Date Received. ...., Time: .... am/pm .... 19 ....

Sender: Sender/Lorry/Bus/Railway*

No.	Sampling Point	Type of Water	Date Collected	Time Collected	Residual Chlorine**	pH**	MPN/100 ml Coliform	MPN/100 ml E.Coli	
1									
2									
3									
4									
5									

* Delete whichever is inapplicable ** As reported by the sampler.

Telephone report was made to: 1. Name of Officer: ....

P.W.D. ....

2. Name of Officer: ....

SMHSD Office ....

1. Water Works Engineer,

.... District P.W.D.

....

2. Medical Officer,

.... District Health Office.

....

Chemist,
For Director-General of Chemistry,
Malaysia.

Figure 7 Sample Recording Format for Bacteriological Test

DEPARTMENT OF CHEMISTRY, MALAYSIA
REPORT ON SHORT CHEMICAL EXAMINATION OF WATER

Lab. No. ....

Supply: ....

Date Received ...., time: .... am/pm. .... 19 ....

Sender: Sender/Lorry/Bus/Railway*

Sample Particulars / Analytical Results			
	Sampling Point		
	Type of Water		
	Sampling Date		
	Sampling Time		
GROUP I **			
Residual Chlorine			
pH			
Turbidity (N.T.U.)			
Colour (Hazen Unit)			
GROUP II			
Total Dissolved Solid			
TOC			
COD			
BOD			
Ammoniacal Nitrogen as N			
Nitrate Nitrogen as N			
Total Nitrogen as N			
MBAS			
Total Akalinity as $CaCO_3$			
Total Hardness as $CaCO_3$			
Fluoride as F			
Chloride as Cl			
Iron as Fe			
Manganese as Mn			
Aluminium as Al			

* Delete whichever is inapplicable.
** As reported by the sampler.
All results are in mg/l except for pH or otherwise stated.

COMMENTS

1. Water Works Engineer,

   .... District P.W.D. Office.

   ....

2. Medical Officer,

   .... District Health Office.

   ....

Chemist,
for Director-General of Chemistry,
Malaysia.

Figure 8 Sample Recording Format for Chemical Test

The recording format should also be designed in such a way that data entry or input is easily performed for subsequent calculations by a table-top calculator or computer. In general, the data input for computation is arranged in an array with "fields" and "records". A field is a parameter for which sample analysis or observation is made, while a record is assigned to each sample analysed or observation made. For example, at a certain monitoring station, samples taken for bacteriological analysis on two different days are called records, and a bacteriological test parameter such as coliform count is a field. The actual numbers of coliform bacteria counted are then placed in the entries in the array under that field and across those records (see Figure 9).

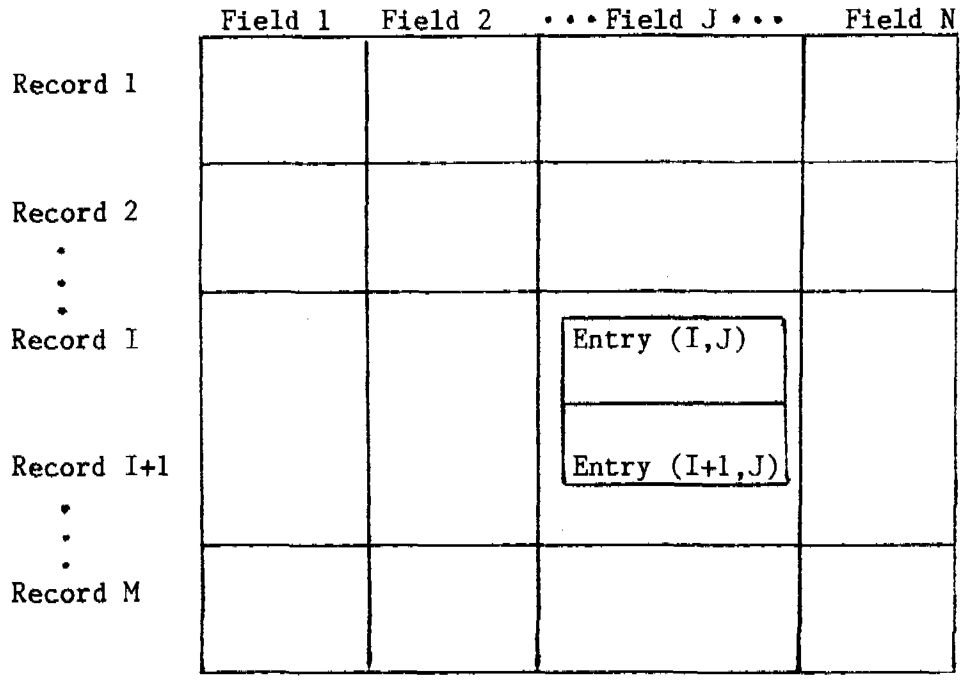


Figure 9 Two-dimensional (M x N) Data Recording Array with Record I being the Day of Sampling and Field J being a Water Quality Parameter

The data entry configuration shown in Figure 9 is a simple and most frequently used format for constructing a computer data file, and is particularly powerful for various statistical calculations. In this set-up, a data file contains the values of water quality parameters from the samples collected at a monitoring station in a time series. Thus, each data file corresponds to a monitoring station. A collection of such data files over some geographical area will then allow for statistical analysis on cross-sectional data. Therefore, the data entry configuration presented in Figure 9 provides a basic format for various computations in the information management and data processing system.

4. NOTES ON USE OF MODERN COMMUNICATION DEVICES

Recent development of telecommunication systems, coupled with advancement in computer technology, allows the designer of a surveillance information management system to establish an efficient system of data transmission. For instance, a facsimile can be used to transfer any written information (graphical or otherwise) through a telephone line. This mode of communication has a definite advantage over the conventional telephone communication since it minimizes the errors associated with verbal communication over the telephone.

A large volume of data is best processed by computers. Recent micro-computers are capable of storing and processing data used in the surveillance programme and are becoming less costly each year. Therefore, it is very likely that microcomputers will be extensively used in the drinking water surveillance programmes in the near future.

In introducing such a microcomputer-based surveillance programme, it should be ascertained that all participating agencies use compatible computer hardware and software. A popular mode of communication with micro-computers is presently the mailing of floppy disks which contain the data. At a further advanced stage, microcomputers can be directly connected through a telecommunication network, and the information is transferred by "electronic mail". In recent years, the mailing of CD-ROM (i.e. a compact disk which stores information optically with read-only memory) has become possible as an alternative to the floppy disk system. The advantage of this system, compared with the floppy disk system, is that a CD-ROM can store a far larger volume of data than a floppy disk.

Although the future is bright for computerization, it should be noted that the development of a computer system can take place only when the manual information management system is firmly established.

ANNEX 1

STATISTICAL ANALYSIS OF DATA

Data collected on various water quality parameters at different sampling points over a certain period can be analysed using a number of statistical techniques. The following techniques are commonly used to identify problem areas, predict future trends of various water quality parameters and show their spatial variations.

A. For data at each sampling point

Statistical analyses will be performed on time series of water quality parameters. This can be done either for each parameter or for a combination of parameters.

A.1 For each water quality parameter

(1) Frequency distribution - A histogram (Figure A.1) or cumulative frequency curve (Figure A.2) is constructed to examine the frequency of occurrence of a certain concentration or concentration range, or the frequency of occurrence of concentrations above or below a certain concentration. A cumulative frequency curve is particularly useful for determining the frequency of violation of water quality standards.

(2) Trend analysis by plotting - This method, strictly speaking not a statistical technique, is useful for visually examining the trend and periodicity of concentrations of a parameter over a certain duration. An example is given in Figure A.3 where a downward trend and an approximate interval of 12 months for peaks and troughs can be detected.

(3) Regression analysis - This technique can be used to study whether there is an upward or downward trend in a certain parameter. To perform this technique, the following equation is assumed:

$$C = a + b\ t \qquad (A.1)$$

where C is concentration of a parameter, t is time and a and b are coefficients. The technique determines the values of the coefficients using measured values of C and t. The coefficient b indicates the rate of change in concentration over a unit time period, and if its sign is positive, the concentration tends to increase and if it is negative, the concentration is in a downward trend. Whether b is statistically significantly non-zero can be tested by Student's T test. The resultant equation (A.1) can be used to predict the future trend of the parameter without any intervention.

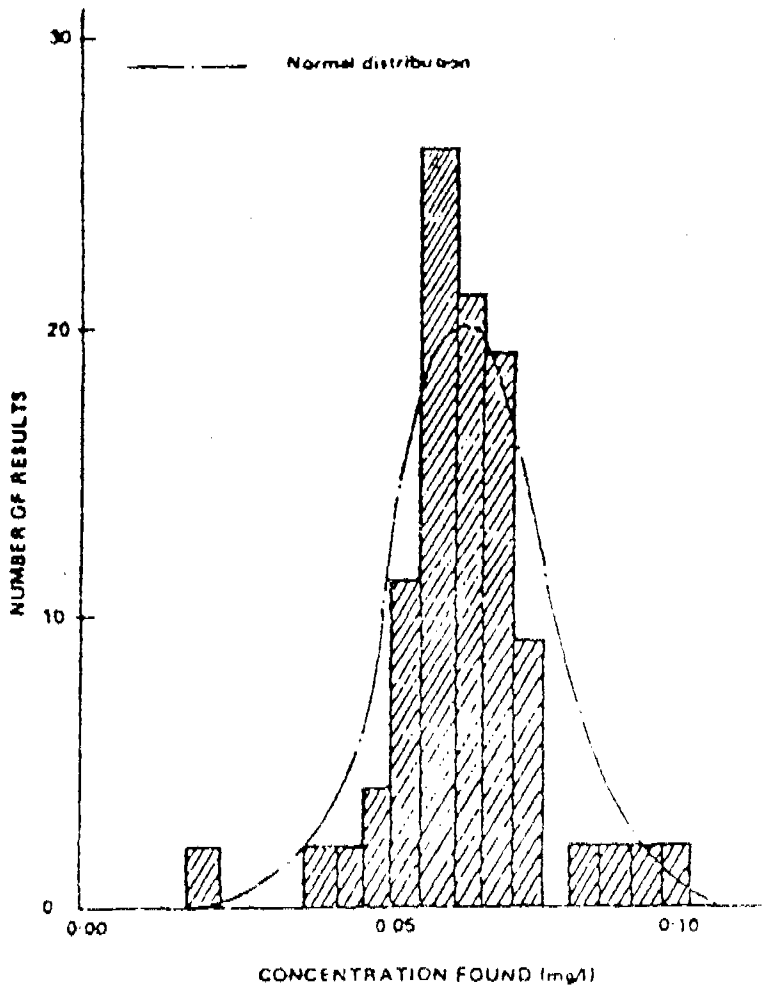


Figure A.1 Example of Histogram

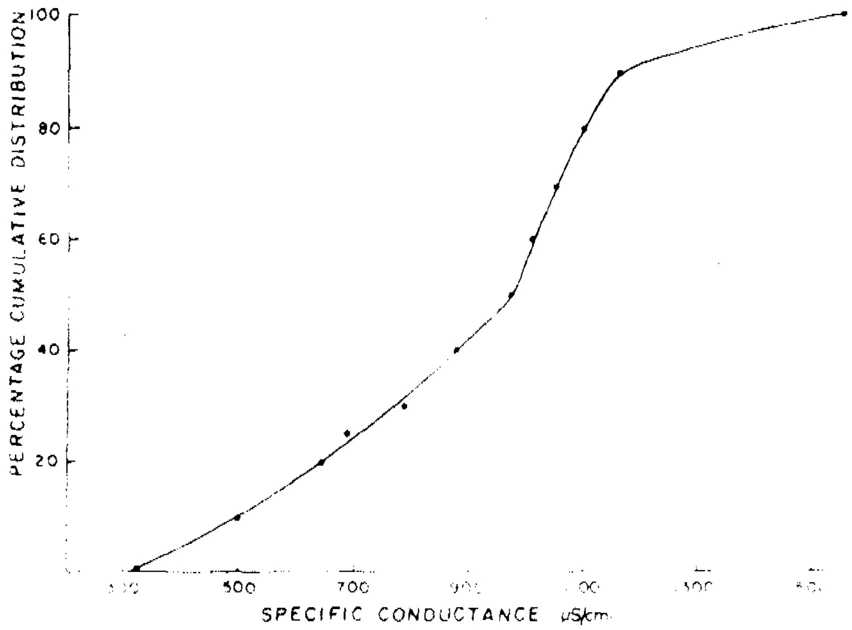


Figure A.2 Example of Cumulative Frequency Curve

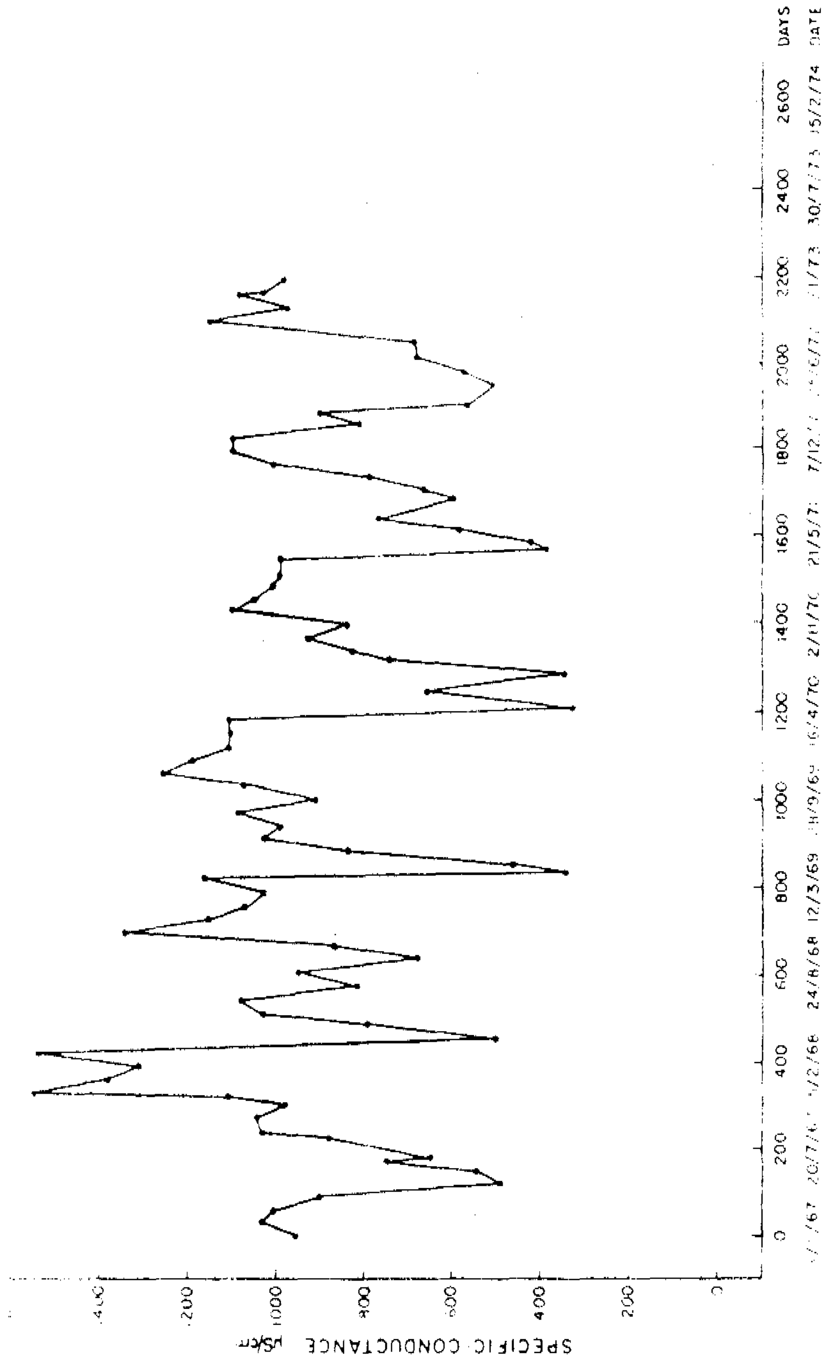


Figure A.3 Example of Data Plotting for Trend Analysis

(4) Power spectrum analysis - This technique can be used to study the periodicity of the data. The computation procedure is summarized in Table A.1 and the results of a sample calculation performed on the data shown in Figure A.3 are presented in Table A.2. This table indicates that a strong periodicity is found at an interval of 12 months. Seasonal periodicity in the data can also be detected at 3-month and 6-month intervals.

A.2 For a pair of water quality parameters

(1) Correlation - To determine if correlation exists between two parameters, a popular method is to plot one parameter against the other (Figure A.4). If the plots are scattered, then no correlation exists. If the points appear to follow a straight line or curve, then the two parameters are correlated. For a straight line relationship, its correlation coefficient can be calculated.

(2) Regression analysis - This technique can determine the relationship between the correlated pair of water quality parameters using the following equation:

$$Y = a + b X \qquad (A.2)$$

where Y and X are the measured concentration of the two parameters. Once the coefficients a and b are determined through regression analysis, the equation (A.2) can be used to predict the concentration of one parameter from that of the other and check whether abnormality is found in the data.

B. For data at multiple sampling points

Data at different sampling points can be used to study their spatial variations. Although not a statistical technique, colour-coded mapping with each colour assigned to a certain level of a parameter is useful for visualizing the spatial variation. For instance, the number of violations of standards plotted in this way provides useful information.

Correlation and regression analyses are useful to study whether a certain relationship exists in a water quality parameter at two different locations. Multiple regression analysis can be employed to establish a mathematical equation for the prediction of a water quality parameter from socio-economic, land use and topographic parameters which are considered to influence the concentration of the water quality parameter.

Table A.1 Computation Procedure of Power Spectrum Analysis

1. Examine the data to make sure that the points are equally spaced and there are no gaps. If the points are not equally spaced and/or gaps are found, the missing data points are calculated by interpolation.

   It is recommended that the last data point be taken in the same month (for monthly sampling intervals), same day of the week (for daily sampling intervals), etc. as the first point. For example, if in a monthly sampling programme, the first data point was taken in June, the last point must also be taken in June.

2. Choose the number of periodicity bands (lags) to be calculated when selecting the number of lags. It is convenient to select a number which will provide a logical and useful nominal (main) frequency for each of the calculated bands. The relation used for this purpose is:

$$P_r = 2(m-1) \times \Delta t / r$$

   Where P_r is the period corresponding to lag r, m is the total number of lags used in the computation, and Δt is the interval between the data points (the sampling interval).

   For example, if there are 72 points of monthly data, then the total number of lags m should be 13 or 25 because they will give, for example, periods of infinity, 48, 24, 12, etc., months when $m = 25$. The greater m is, the greater is the resolution of the power spectrum analysis. It is not recommended that m be greater than approximately 20% of the number of points available. In the case shown above, 20% of 72 points equals 14, therefore $m = 13$ is a good choice for the number of lags. The periodicity band corresponding to lag no. r is:

$$\frac{2(m-1)\Delta t}{(r-1)} \text{ to } \frac{2(m-1)\Delta t}{(r+1)} \text{ in } \frac{\text{time}}{\text{cycle}}$$

   The smallest period which can be resolved (detected) by this type of analysis corresponds to $2 \times \Delta t$. For example, if the sampling interval has been biweekly (every two weeks) the smallest cycle which can be detected is the one with a four-week period (it repeats itself every four weeks).

3. Calculate the average value of parameter P:

$$P_{av} = \frac{\sum_{i=1}^{n} P_i}{n}$$

4. Calculate a series of coefficients C_r for each of the m lags.

$$C_r = \left| \frac{1}{n-r} \sum_{i=1}^{n-r} (P_i - P_{av})(P_{i+r} - P_{av}) \right|$$

   where $r = 0, 1, 2, \ldots, m-1$
   n = total number of data points
   P_i = the value of the parameter P at point i
   P_{av} = the average value of parameter P.

5. Calculate the Fourier transform values V_r for each lag from

$$V_r = \frac{k}{m-1} \left(C_0 + C_{m-1} \cos r\pi \pm 2 \sum_{q=1}^{m-2} C_q \cos \frac{qr\pi}{m-1}\right)$$

   where r is the lag number, $r = 0, 1, 2, \ldots, m-1$
   $k = \frac{1}{2}$ for $r = 0$ and $r = m-1$
   $k = 1$ for $r = 1, 2, 3, \ldots, m-2$

6. Calculate the smoothed Fourier transform values U_r:

$$U_0 = 0.54\, V_0 + 0.46\, V_1$$
$$U_r = 0.23\, V_{r-1} + 0.54\, V_r + 0.23\, V_{r+1};\ r = 1, 2, \ldots, m-2$$
$$U_{m-1} = 0.46\, V_{m-2} \pm 0.54\, V_{m-1}$$

7. Calculate the percent contribution of each band (lag) to the total variance of the record from either the unsmoothed or smoothed Fourier transform values

$$(\%\ \text{contribution})\ \text{lag } r = \frac{V_r}{\sum_{i=0}^{m-1} V_i}$$

   or

$$(\%\ \text{contribution})\ \text{lag } r = \frac{U_r}{\sum_{i=0}^{m-1} U_i}$$

8. Notice that band 0 ($r = 0$) has a period ranging from infinity down to $2(m-1)\Delta t$. It includes therefore:
   (i) any truly random fluctuations in the record.
   (ii) any linear trends in the record.
   (iii) any periodic components which are of so low frequency or which have such a long period that they appear as linear trends.

Table A.2 Power Spectrum Analysis Results of the Data Shown in Figure A.3

Lag No.	$C_r \times 10^{-1}$	V_r Value $\times 10^{-[illegible]}$	V_r % Contrib.	U_r Value $\times 10^{-[illegible]}$	U_r % Contrib.	Period (months) Nominal	Period (months) Range
0	6.68	5.09	7.6	5.33	7.9	infinity	—
1	3.40	5.62	8.4	11.4	16.9	24	12–infinity
2	1.80	31.2	46.7	18.7	27.7	12	8–12
3	0.64	2.27	3.4	9.59	14.2	6	6–12
4	−1.22	5.18	7.8	3.93	5.8	6	4.8–8
5	−2.09	2.68	4.0	2.93	4.4	4.8	4–6
6	−1.70	1.28	1.9	1.70	2.5	4	2.4–4.8
7	−2.23	1.72	2.6	2.70	4.0	3.4	3–4
8	−1.85	6.43	9.6	4.05	6.0	3	27–3.4
9	0.53	0.78	1.2	2.29	3.4	2.7	2.4–3
10	1.18	1.69	2.5	1.63	2.4	2.4	2.2–2.7
11	2.51	2.36	3.5	1.78	2.6	2.2	2–2.4
12	3.59	0.50	0.7	1.35	2.0	2	1.8–2.2

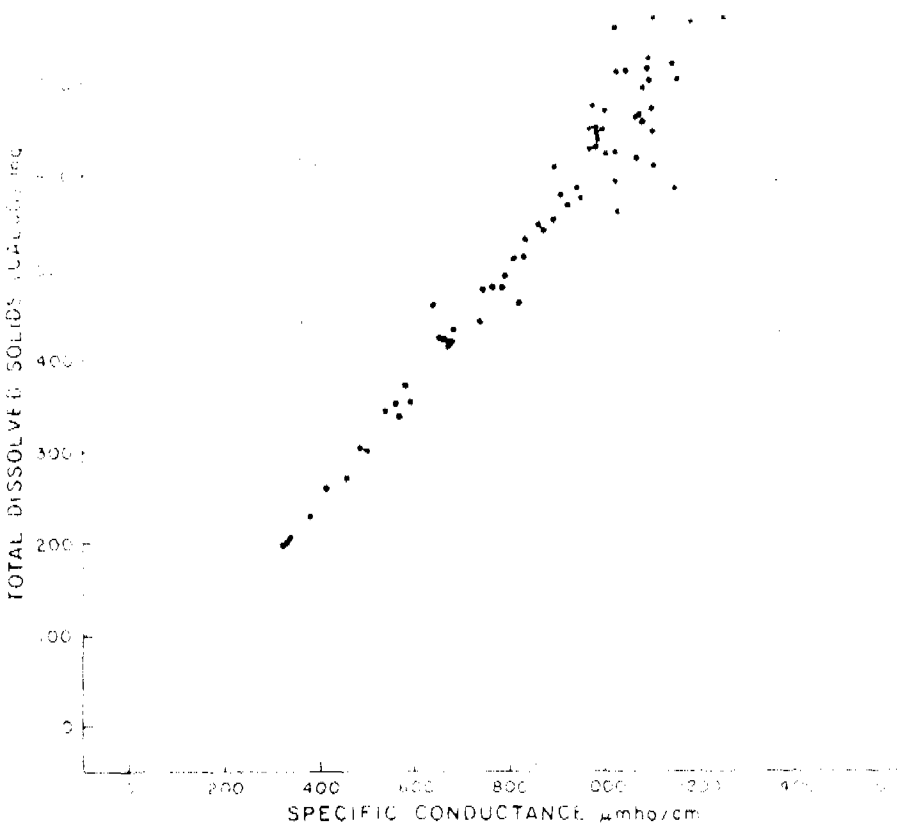


Figure A.4 Example of Correlation Plots

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QUALITY MONITORING AND SURVEILLANCE

Kuala Lumpur, Malaysia
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RADIONUCLIDES IN DRINKING-WATER, THE HEALTH IMPACT, MONITORING AND CONTROL

by

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INTRODUCTION

Radionuclides are by definition distinct atomic species with a specific atomic number, mass and measurable stability. Their unique property that distinguishes them from other elements and compounds is their spontaneous transformation ("decay") into other elemental species accompanied by one of

- emission of subatomic particles from the nucleus
- capture or ejection of electrons
- fission to produce "heavy" particles of comparable mass.

This sequential decay to a final stable isotope may occur with half times for the intermediate species of hundreds of thousands of years (e.g. ^{238}U) to fractions of a microsecond.

During the decay process characteristic ionizing radiation is emitted from each intermediate ("daughter") product. Generally, the subatomic particles emitted comprise:

a) Alpha (α) particles - 2 protons together with 2 neutrons accompanied by a high decay energy.

b) Beta (β) particles - electron ejection with conversion of neutron to proton also often a high decay energy process.

c) Gamma (γ) photon emissions - short wavelength electromagnetic radiation. Usually in association with nuclear restabilization following α or β particle emission.

The occurrence of radionuclides in drinking water may be derived from three distinct sources based on their formation: naturally occurring nuclides; cosmic ray produced nuclides and man-made products.

Characteristically, these may be classified as in Table 1a/1b.

Table 1a

Source	Characteristic	Properties	Examples
Naturally occurring	(a) long half lives	(β emitter) (β emitter)	^{40}Potassium ^{87}Rubidium
	(b) uranium and thorium series	(about 50% α and 50% β emitters)	^{238}Uranium ^{232}Thorium ^{235}Uranium (and their daughter products)

The amount of particle emission per unit time and consequently radiological impact of the specific members of the uranide isotope decay series is related to their occurrence, concentration and decay half times (specific activities). For example, naturally occurring uranium in drinking water includes 99.28% ^{238}U and 0.005% ^{234}U but their radioactivity is almost equivalent because of the short half-life of ^{234}U.

Table 1b

Source	Characteristic	Properties	Examples
Cosmic ray produced	Produced from fragmentation atmospheric gases	(All β decay)	^{14}C, ^{3}H, ^{81}Kr
Man-made radionuclides	Nuclear weapons tests Nuclear reactors Particle accelerators	(pre-dominantly β emitters)	$^{89/90}Sr$ $^{134/137}Cs$ ^{131}I

Typically, man-made radionuclides (even post-Chernobyl) comprise only a small percentage of naturally occurring isotopes.

The concentration of a particular radioisotope in a drinking water supply depends on:

- concentration of parent radionuclide
- isotopic half-life
- geochemical environment.

In ground waters, sources include dissolution of the aquifer solids, insitu radioactive decay of the parent, the physicochemical properties of the daughter product, and desorption from soil particulates. Major sources of radioisotopes in surface waters include weathering and run-off from the source rocks, insitu radioactive decay of the parent and groundwater discharge.

Drinking water samples are frequently analyzed for gross α particle and gross β activity only since if these values are below the internationally accepted values based on acceptable risk, no further analysis is normally required. Ideally, to use the gross activity screening procedure, the reference levels for alpha and beta activity will require to meet two criteria:

a) they should be such as to ensure that, irrespective of the individual nuclides contributing to the gross activity, the associated exposure will be low enough not to necessitate further detailed analyses and consideration;

b) they should be sufficiently high to ensure that the vast majority of drinking-water supplies satisfy such reference levels and hence the need for detailed analyses can be avoided.

The WHO Guidelines for Drinking Water Quality has defined guidance levels of 0.1 Bq L^{-1} for gross α activity and 1.0 Bq L^{-1} for gross β activity calculated on an adult drinking water intake of 2 litres per day. These values assume that only the most toxic radionuclides likely to be present (^{90}Sr and /or ^{226}Ra) contribute to the gross radioactivity.

Where these values are exceeded, more detailed radionuclide analysis may be necessary. Normally, this would comprise measurement for ^{226}Radium, ^{228}Radium, total uranium and ^{222}Radon.

HEALTH EFFECTS

Induction of harmful effects of radiation on human tissue arises from the potential of the isotope of concern to cause ionization of constituents of body cells. These harmful effects may be somatic or hereditary. Chemotoxicity of some compounds may also occur from their chemical properties (e.g. nephrotoxicity of uranium isotopes). The primary basis for international guidelines and national regulatory activities for radionuclides in drinking water is the carcinogenic potential of the compounds. The aim of radiation protection is to prevent detrimental non-stochastic (i.e. severity varies with dose) effects and to limit the probability of stochastic effects to an acceptable level. This second requirement is achieved by setting dose equivalent limits at values sufficiently low that the threshold limits would not be reached during a calculated lifespan (70 years). In practice, the level of radioactivity in drinking water required to reduce the incidence of stochastic effects to an acceptable level automatically excludes the possibility of non-stochastic effects. The predominance of naturally occurring radioactivity over man-made sources, the radiotoxicity of the α decay in the uranium and thorium series and the occurrence of these series in both surface and groundwaters has resulted in these radionuclides being the focus of concern. In particular, the involvement in metabolic pathways (^{226}Ra/^{228}Ra), nephrotoxicity (^{238}U, ^{235}U, ^{234}U) and specific target effects (absorption/inhalation ^{222}Rn) has identified these particular isotopes as being of primary concern.

Determining the health risks of exposure to radon in drinking water is especially difficult. Radon exists in water as a dissolved gas with the principal exposure pathway from inhalation when the radon is released from water following agitation. Since indoors exposure is the primary source, estimations require knowledge of building air exchange rates, variation in concentrations due to water use in domestic activities and the amount of time spent indoors. This latter factor varies widely with a weighting towards sensitive groups particularly young children.

The problem of estimating health risk is further confounded by the multiple sources of radon. USEPA calculations estimate the annual effective component of radon from water usage to be 1-12% of total annual exposures.

METHODS OF EXAMINATION

Before starting the analysis for alpha activity, ^{222}Rn and ^{220}Rn should be eliminated. If the alpha activity is less than 0.1 Bq/litre, no further examination is necessary except for routine surveillance. If the alpha activity exceeds 0.1 Bq/litre, further examination of the water is required.

The following alpha-emitting radionuclides occur naturally and have high toxicity: ^{226}Ra, ^{224}Ra, ^{210}Po, ^{232}Th, ^{234}U and ^{238}U. In addition, beta-emitters such as ^{228}Ra and ^{210}Pb, which have alpha-emitting daughters, are associated with these radionuclides. The need to examine the water for particular radionuclides should be based on knowledge of local hydrogeological and other information.

If the beta activity measured in a sample of water is less than 1 Bq/litre, no further examination is necessary except for routine surveillance.

The following have been identified as beta-emitting radionuclides having high toxicity: ^{90}Sr, ^{89}Sr, ^{134}Cs, ^{137}Cs, ^{131}I, and ^{60}Co. Examination of the water for these particular radionuclides should be based on local knowledge concerning discharges of specific radionuclides from operations in the river basin.

The determination of sampling frequency and the choice of methods of collection and analysis should take into account the fluctuation of observed activity levels of radionuclides in the water and the vicinity of nuclear installations and other sources of radioactive pollution.

Many radionuclides are readily absorbed on to surfaces and solid particles. It is important, therefore, to choose sampling points in the distribution system and at the sources of supply with care so that the sample will be representative of the water to be examined. Water samples for radiological examination should be collected in suitable bottles which reduce absorption on to the walls of the container to a minimum.

The guideline value recommended does not take into account soft beta-emitters, so if a method such as liquid scintillation counting is used which does detect these emitters, the soft beta-emitters must be excluded when the results are compared. However, when the presence of potentially significant quantities of ^{3}H is suspected, a special examination for this radionuclide should be carried out.

It should be noted that the gross alpha guideline value excludes radon and whichever method of screening if used, radon must be eliminated from the sample. Before a "non-action" level in drinking-water can be set, further investigations are required to determine the actual radon concentration in drinking-water and the relationship between this concentration and the doses resulting from inhalation of the released radon.

If treatment is required to reduce excessive exposure to radium, typical water-treatment processes that should be considered include lime or lime-soda softening, cation exchange softening, or reverse osmosis. Since uranium is often present as the negatively charged uranyl ion, anion exchange may be a promising treatment.

Less information is available on water-treatment methods that might be applied to other radionuclides (assuming that the source cannot be controlled); however, lime and ion exchange softening may generally be effective.

Since radon (which also occurs naturally in some ground-waters) is an inert gas, aeration would be effective.

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COUNTRY REPORT

CHINA

by

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COUNTRY REPORT ON DRINKING-WATER QUALITY MONITORING AND SURVEILLANCE IN CHINA

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The total area of the People's Republic of China (PRC) is 9.6 million square kilometers with the population about 1,096 million by the end of 1988. The country is short of water resources and the distribution of it is extremely unbalanced. There is a scarcity of surface and underground water in the north-western and other drought regions, while the rivers, lakes and brooks can be found everywhere in the southern and south-eastern part of China, where the underground water is abundant. The development of economy and culture in the whole country is also uneven. In the rural areas, it is difficult that the peasants engaged in constructions of water improvement projects and made the water borne diseases under control.

With the development of the hygienic undertakings, many infectious diseases have been effectively controlled, but the waterborne infections such as typhoid fever, hepatitis, bacillary dysentery and diarrhea are still the diseases having high incidence. Among these infections, the incidence of diarrhea is the highest, which accounts for 45 percent of total acute infectious diseases. The annual incidence of bacillary dysentery is 500/100,000. The annual incidence of typhoid fever and paratyphoid is 10-15/100,000. Owing to the effective treatment, the mortality reduced to 0.27 percent in 1983.

In order to ensure the drinking water quality in city and rural areas to meet the safe and hygienic requirements, the protection of water sources is the prerequisite. Therefore, the China government has put forward the strategic thinking, "The symptoms are needed to be alleviate, but permanent control is more important". The countermeasure can be summarized as: "Overall planning, rational distribution, combination of prevention and cure, taking prevention first, relying on the masses and strengthening surveillance. "Overall planning and rational distribution" means that in the selection of location for factories, the possible contamination of water sources and the surroundings from industrial waste should be taken into account. On the other hand, it is also necessary to heighten the cultural level of the masses by strengthening the dissemination and education and by spreading the drinking water sanitary knowledge. The drinking water quality have been improved. Now, 300 million people already had the qualified tap water in the whole country. In 1980, China participated in the activity of the international drinking water supply and sanitation decade. The programme for improving drinking water quality was formally placed in the seventh five year plan of the national economy and social developments (1986-1990) of PRC, in which it clearly demands that 80 percnt of rural population will drink safe water by 1990.

One of the most important measures to guarantee the sanitation and safety of drinking water is to protect the drinking water sources from contamination. For many years, we have made a great effort to protect the water systems and drinking water sources from being polluted. In order to solve the problem of water sources contamination in almost 100 cities. Several billion yuan has been used in changing the water sources and constructing other water pumping sites. So as to ensure the urban finished water quality to accord with the drinking water standard.

China has drawn up a series of standards and regulations to protect drinking water sources and improve the water quality. "laws for prevention of water contamination" has been issued by the National People's Congress. In 1982 our country promulgated regulations "Sanitary standard for the construction of industrial enterprises" including the sanitary standard of surface water and the allowable concentration for harmful substances in it. The two other regulations, "the environmental quality standard for surface water" and "sanitary standard for drinking water" were issued in 1983 and in 1985. respectively. These regulations stipulated that the protective zone of drinking water sources must be set up to ensure the quality of drinking water.

China is vast in territory and there are great difference in the topographical, hydrogeological and climate conditions. The types of drinking water sources are also varied. Therefore, it is necessary to prevent and control the contamination of drinking water sources effectively in line with local conditions. Since 1970's, the local regulations for protecting drinking water sources have been worked out in 27 provinces and cities in the country.

The responsibilities of related unit in the government at all level on the protection of water sources are stipulated in the regulations mentioned above.

1. The environmental protective institutions of the government at all level should carry out the management and surveillance of water quality according to the "laws for prevention of water contamination", and then gradually control total amount and concentrations of pollutants to accord with the discharge standard.

2. Surveillance of non-community water supply and monitoring the rural simple tap water are taken charge by the local anti-epidemic stations, which are entrusted by the village and town government. During the Summer and Fall season when the water borne infectious diseases are prevalent, the village government will assign persons to carry out drinking water disinfection. The county anti-epidemic station is in charge of technical direction for water quality monitoring and examination.

3. According to the principle that one who causes pollution should be responsible for making the pollution under control. The factories and other institutions should make effort to lower the quantities of their sewage in accord with the pollutant discharge standard.

4. The drinking water quality surveillance should be carry out by the anti-epidemic stations of provinces municipalities and counties. Their responsibilities are as follows:

(1) To carry out surveillance and monitoring regularly on the quality of drinking water sources in the protection region; on water plant finished water; pipe water and tap water; only those water, which meet the drinking water standard and obtain the certificate of inspection is allowed to be consumed.

(2) To carry out the sanitary evaluation on the quality of water

sources in their responsible area and give guide to water supply unit on water cleaning and sterilization technique.

(3) To take part in the selection of places, making design, giving sanitary investigations to new built and rebuilt drinking water project.

(4) To investigate and deal with the accidents of the drinking water contamination.

In order to realize the ambitious goal that 80 percent of the population in the countryside of China will have safe and sanitary drinking water by 1990, in addition to the necessary monitoring measures mentioned above, we must make a comprehensive survey on the present situation of drinking water quality; the concentration and distribution of each kinds of harmful substances in it; the area and the percentage of people supplied with unsafe drinking water; the distribution and the extent of seriousness of water borne diseases. These information are necessary for policy formulating.

In 1983, China Centre Committee of Patriotic Health Campaign and the Ministry of Public Health organized the Health Bureau and anti-epidemic station in provinces, municipalities and autonomous regions to take part in a nation-wide survey on drinking water quality and water borne diseases. Chinese Academy of Preventive Medicine was entrusted with the task of technical instruction. The staff members took part in the survey were all well trained and the water analysis work were under strict quality control.

It took 5 years to complete this nation-wide survey, more than 40,000 personnel took part in this investigation, they are majored in the field of sample taking, sanitary investigation, chemical analysis, computer technique, statistics and map-making. 58,000 water samples were collected in 29,000 sampling sites, 900 labs and 5,000 analysts were involved, about 4,000 analysts were being trained with the methods of water analysis quality control. At least 15 items were determined for each water sample, more than 2 million parameters have been got, the population of the survey areas was about 980 million people. The qualified analytical data reached 95%.

The main problems present in the drinking water supply and drinking water quality in China are as follows:

1. The way of water supply in the rural areas is backward, contamination of water sources is serious and the drinking water quality for 70 percent population is unqualified.

In China, about 200 million people drink tap water, account for 21% of the total population, 79% of the population drink the water supplied in the noncommunity way (most in the rural areas). Because of the water sources located dispersively, they are difficult to be protected. In the population fetching water by manpower, 85% people consumed water with total coliform exceeded sanitary standard. Therefore, the possibility of intestinal diseases from water medium existed. This is an important reason for the high incidence of intestinal infectious diseases in China.

Much attention is given to improving the drinking quality in rural area. For example, water sources from well, puddle pond have been changed into running water partially treated or untreated or into hand pump well. However, since the contamination sources have not been eliminated, the drinking water quality is difficult to reach the sanitary standard. Therefore, the way of noncommunity water supply should be changed into central water supply and people would be encouraged to carry out drinking water sterilization.

2. Drinking water was contaminated seriously by the "three wastes" from factories.

Almost 72% sewage in cities was discharged into surface water without adequate treatment. This is the main reason for the contamination of central water supply in the cities.

The ministry of Public Health of China is requesting the antiepidemic station at all levels must strengthen the monitoring of the drinking water and water sources. For the task, the antiepidemic station was equipped with facilities and replenished with technical personnel. Regulations promulgated by Environment Protection Agency on the prohibiting new built drainage opening close to the drinking water sources; Giving regular monitoring on the old drainage opening, so that the pollutant discharged could be controlled; Prohibiting the use of industrial and life polluted water and harmful pesticide in the field in the water source protection region.

3. There are about 4 7 million people in China lived in the areas 'with shotage of water supply. This problem is expecting to be solved in some area by water conservancy construction.

During the recent years, thanks to the profound concern of the central and local government who have been with their particular emphysis on the drinking water served, the task of water improvement has made an encouraging progress. Up to the end of 1987, there were 54% of the total 879 million rural population who were better supplied to varying degrees with drinking water improved, 17% of them had tap water served. But we still have a long way to go.

We should strengthen the drinking water routine monitoring especially for water source, finished water and tap water in urban area. It is possible to find the accident on time. In rural area, it is expected that 1/5 - 1/10 counties of the country may set up the drinking water monitoring site. Then the effect and progress of the water improvement may be collected, and to indicate the project on going well.

To prevent water borne diseases occurred, we would conduct hygienic surveillance on central water supply system according to the laws and regulations issued.

WORLD HEALTH ORGANIZATION

WESTERN PACIFIC REGION

ORGANISATION MONDIALE DE LA SANTE

REGION DU PACIFIQUE OCCIDENTAL

REGIONAL CENTRE FOR THE PROMOTION OF
ENVIRONMENTAL PLANNING AND APPLIED STUDIES (PEPAS)

REGIONAL WORKSHOP ON DRINKING WATER
QUALITY MONITORING AND SURVEILLANCE

ICP/RUD/001 PROG/112/CR-002

Kuala Lumpur, Malaysia
27 February - 3 March 1989

ENGLISH ONLY

COUNTRY REPORT

FIJI

by

Mr Uraia N. Lesu

COUNTRY REPORT

FIJI

BY

U. LESU
CHIEF HEALTH INSPECTOR
MINISTRY OF HEALTH
SUVA
FIJI

1. GENERAL

Fiji is made up of about 320 islands which vary in sizes from 10,000 square kilometres to tiny islets a few metres in circumference, and has a total land area of 18,333 square kilometres. It has a population of approximately 770,000 and an annual average growth rate of 2%.

It enjoys a tropical maritime climate with a highly variable rainfall which is usually abundant in the summer months, especially over the larger islands.

Fiji is therefore blessed with its plentiful supply of drinking water from rivers and streams on the larger islands and from ground water and rain water in the smaller islands.

1.1 WATER SUPPLIES

Approximately 80% of Fiji's population is connected to a piped supply. However only supplies within the main centres (cities and towns) are treated as these are maintained by the Central Government.

Individual supplies to villages and settlements are maintained by individual communities and treatment cost is the main obstacle which these communities just cannot afford.

Emphasis however in small untreated supplies has always been on prevention of contamination or pollution of the source and regular maintenance of pipe reticulation.

1.2 WATER-BORNE DISEASES

Illnesses attributable to water supplies are commonly diarrhoeal diseases, infectious hepatitis, bacillary and amoebic dysentery and water related parasitic diseases. Morbidity and mortality in respect of these diseases are 5% and 9%, respectively.

1.3 NATIONAL POLICY/PROGRAMME

A national plan for the Water Decade was completed in 1980 and included provision for a feasibility study on setting up of an autonomous water authority to help achieve the Decade aims. The principal aim of the Government plan is to provide as far as practicable a safe water supply to all its population.

Currently the implementation of the programme is undertaken by four Ministries of the Government namely, Ministry of Works, Ministry of Rural Development, Ministry of Energy and the Ministry of Health.

The Ministry of Works carries out all proposed works and maintenance of major water supplies. It also funds the Ministry of Energy in prospecting and boring for ground water in the smaller islands and the drier parts of the two main islands.

The Ministry of Rural Development through its Development Committees machinery allocates funds for small rural water supplies construction. The latter is also undertaken by the Ministry of Works on a self-help basis where the community provides one-third of the cost plus the unskilled labour.

The Ministry of Health through its Primary Health Care programme also carries out surveys and construction of small water supplies wherever possible. However the total cost of the construction is borne by the individual community and in instances partly funded by Foreign Aiding Agencies.

1.4 WATER QUALITY MONITORING

Under the current Government machinery water quality monitoring is the responsibility of the Ministry of Health through its Health Inspectorate Section. This includes all water supplies, both Government and private community water supplies.

However the Ministry of Works by the very nature of their work and responsibility of construction and maintenance of Government water supplies also monitor these supplies.

Monitoring of the Health Inspectorate Section of the Ministry of Health is carried out by periodic surveys of the water intakes and regular monthly sampling of the supply from the water mains and service pipes to individual homes or premises.

Samples both chemical and bacteriological are then forwarded to the Government laboratories for analysis.

Microbiological samples are collected in sterilized 250 ml. glass-stoppered bottles and forwarded to the laboratory in a cooler or ice box. These should reach the laboratory within 6-8 hours. Chemical samples are collected in dark 2 litre bottles and should reach the laboratory within the same period or kept under refrigeration if they are to reach the laboratory the following day.

1.5 QUALITY STANDARDS

There is currently no standards under the legislation. However the quality standards recommended by the World Health Organization has always been used for monitoring purposes. All Government supplies have always been maintained along these standards. Should any sample from Government supplies fall below these standards then a repeat sample is taken and investigation made promptly.

The private supplies because they are untreated are often below the W.H.O. standards.

The communities have always been advised to keep their water intakes free from animals and cultivation, and to maintain their pipe reticulation. Furthermore if the private supplies after sampling and analysis are found to be abnormally contaminated, then a prompt investigation is made.

1.6 MANPOWER TRAINING

Health Inspector training has been an ongoing programme where water supplies quality surveys and monitoring is an integral part of the programme and its curriculum.

Training curriculum has recently been upgraded with the help of W.H.O. and the University of Western Sydney.

In-service training is also part of the programme for serving officers.

1.7 PROBLEMS ENCOUNTERED

Our current problems with monitoring is the transportation problems with the time limit for samples from outlying islands. Otherwise there should be no problems with our Government supplies.

1.8 CONCLUSION

(a) The main public supplies are treated and their standard are compatible with that recommended by the World Health Organization.

(b) Although the private supplies are not treated there has not been any outbreak of water-borne diseases as a result of their below than the recommended standard.

(c) The Government in its plan aims to provide to every community a safe and wholesome supply of drinking water.

(d) Quality monitoring through sampling, analysis and surveys is on a regular basis or as often as possible.

(e) Morbidity and mortality rates from water-borne diseases are low for a developing nation.

(f) Training of Health Inspectorate Staff for both new and serving officers has been reinforced with our new curriculum for the 3-year Diploma in Environmental Health.

Fiji is a healthy country and free from most tropical diseases.

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800 (400 units)
Chinese
Delegation 2000

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ORGANISATION MONDIALE DE LA SANTE

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Kuala Lumpur, Malaysia
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ENGLISH ONLY

COUNTRY REPORT

KOREA

by

Dr Yang Soo Lee

COUNTRY REPORT

DR LEE, YANG SOO
KOREA

1. General Country Profile

Name : The Republic of Korea

Total Area: 98,922 square kilometers

Population: 42 million

DISEASE OCCURRENCE

DISEASES	86		87		88	
	Cases	Deaths	Cases	Deaths	Cases	Deaths
CHOLERA	-	-	-	-	-	-
TYPHOID FEVER	278	1	184	1	419	1
PARATYPHOID FEVER	14	-	20	-	23	-
BACTERIAL DYSENTERY	57	-	37	-	50	-

2. National Policy and Programme of Drinking-water Quality Monitoring and Surveillance

- The broad objective of a drinking water service sanitation programme is the protection of the health of the people. More specifically, however, such a programme is designed to accomplish the following.

A. Protect the water against contamination

Sanitation standards have been developed to reduce to a minimum the opportunity for microorganisms to gain entrance and multiply in water. Those organisms that may cause communicable disease and water borne illness merit primary consideration.

B. Ensure the soundness of water

Soundness is frequently thought of in terms of purity. Drinking water should be free of any substance delecterious to the health of the citizen. The addition of toxic chemicals, either by accident or otherwise, may render food unsafe.

C. Sewage treatment

All sewage, including liquid waste, shall be disposed of by a public sewage system constructed and operated according to law.

- The legal provisions

  Food service sanitation ordinance

  - 1967. 3. 30 by law

  The ordinance of drinking water standard

  - 1984. 3. 31 by M.H.S.

(Total - solids content, colour, turbidity, off taste or odour, iron, manganese, cooper, zinc, calcium, magnesium, sulfates of magnesium and sodiusm chloride - and hydrogen-ion concentration, phenolic substances, carbon chloroform extract, and ethyl benzyl sulfonates, and other wastes.)

(Water quality inspection standards is almost same as the W.H.O.)

3. Water treatment plants - procedure

Storage, aeration, coagulation, sedimentation. Softening, filtration (slow-sand filtration, rapid-sand filtration), disinfection, and other physical and chemical processes.

- Laboratory equipment

  control desk (- turbidity, PH, Alkeli degree)

  Doublebeam spectrophotometer, COD meter,stirring apparatus, Jar tester, turbidimeter, vacum oven, centrifuge, microscope, etc.

- Monitoring employee

  25 - 30 x 9 = 225 - 270

  laboratory technichian

  5 - 8 x 9 = 45 - 72

KOREA IN GENERAL

Geography

The Republic of Korea occupies the southern half of the Korean peninsula which borders on Manchuria and the Soviet Union to the north, and faces China to the west across the Yellow Sea, and Japan to the east and south across the East Sea and Korea Strait.

Korea, which in overall size is approximately equivalent to Great Britain, lies between 33°06' and 43°01' north latitude, and between 124°11' and 131°53' east longitude.

The land mass of the Republic of Korea is roughly 98,922 square kilometers and comprises steeply rising mountains along the east coast, while the western regions are associated with wide alluvial plains gentle slopes, and sinuous rivers.

Climate

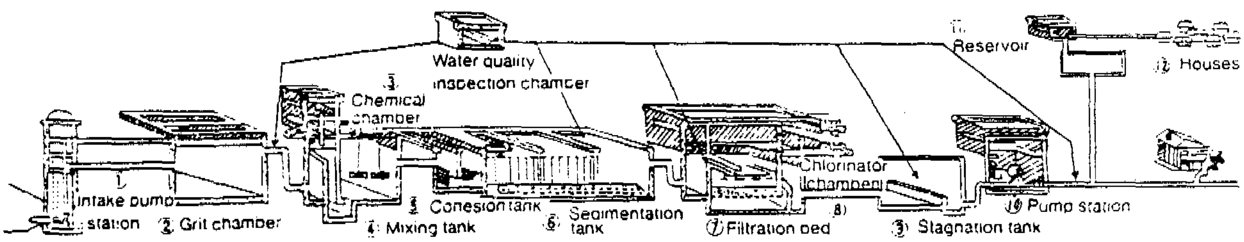
The climate of Korea is temperate, midway between the continental and marine types, but tending more toward the former. The hottest months are July and August, when the mean temperature is above 25°C (77°F), while the coldest months are December and January, with the mean temperature at 5°C below freezing (23°F).

Korea has a humid, East Asian monsoonal climate. There is a monsoon-induced rainy season in late June and July, during which half of the annual precipitation is recorded. The milder winter of Korea is characterized by three successive cold days followed by four warmer days.

Disease-Causing Agents

Water is a potential carrier of pathogenic microorganisms and can endanger health and life. The pathogens most frequently transmitted through water are those responsible for infections of the intestinal tract (typhoid and paratyphoid fevers, dysentery, and cholera) and those responsible for polio and infectious hepatitis. Historically, the prevention of water-borne diseases was the primary reason for pollution control in water. Modern disinfection techniques have greatly reduced this danger in KOREA.

Water Production Process



Water taken from the Han River is led to grit chamber and then into mixing tank to be mixed with purifying chemicals. Water is then led into sedimentation tank where floating particles are removed by making them settle to the bottom. Minute floating particles not removed by this process are completely eliminated at filtration bed. Water then is chlorinated and subject to through water quality inspection. Water is finally being distributed after being pressurized.

Control of Water Quality

The quality of water is examined five times in the course of eight-stage filtration at water plants to ensure the quality of the water. Water preserves are thoroughly managed to ensure the quality of the water, while all water tanks are cleaned and sterilized twice a year. Steel tanks are being replaced with FRP tanks which are more sanitary.

Mid- and Long-Term Water Supply Plans

Demands on the supply of water have increased sharply as a result of rapid socio-economic development, concentrated population growth and the elevated living standard. The municipality has worked out and is implementing a plan to expand the size of the water production and distribution facilities with a view to increasing the water supply to 100 percent and also coping more reasonably with the ever-increasing demands on the water supply.

Health Services

Prevention and Treatment of Diseases

Thanks to the improved living standard and improvements in health care, the cases of water-borne contagious diseases have declined substantially, while virus-caused diseases such as Japanese encephalitis and measles are reported more of ten than in the past. Through organized quarantine programs, efforts are being made to forestall the outbreak of contagious diseases, and to discover patients early and thereby prevent the spread of disease. To establish a system of early patient discovery when there is an outbreak of a contagious

The Natural Environment of Seoul

Seoul, located in the middle-western part ($126^{\circ 59}$ of the East Longitude and $37^{\circ 34}$ of the North Latitude) of the Korean peninsular, was not only the capital city of the Yi-Dynasty lasted for 500 years (1394-1910) but also the important strategical place ever since to administrate the peninsular.

As Han river, one of the five longest rivers in the Korean peninsular as well as the main stream of the capital city is flowing with the western direction from northeastern region to the Yellow Sea. Seoul has very modernized urban area outstretched very widely on the northern and the southern districts along the river.

Han -river running slowly through Seoul as mentioned above had formed many islands on the river such as Chamsil-sum(island), Ttuksum, Chungjido, Youido, Nanjido and developed the alluvial plain.

By the way, although "The Complex Development Project of Han -river" completed recently has protected against the flood, it caused to attach Chamsilsum and Nanjido to land and developed Youido to a marvelous business district with the National Assembly, buildings and apartments.

As a result of its location, Seoul has the continental climate which has up to 30 degrees in centigrade of yearly different temparature, influenced by the cold and chilly prevailing westerlies with high atmospheric pressure in the winter, and by the oceanic atmospheric currents with high temperature and moisture in the summer.

The annual rainfall is 1,269 mili-meters and nearly 72% of annual rainfall is concerntrated in the rainly season from June to September which generated by Monsoon.

Flood disasters have sometimes occurred in this season because of partly the influence of typoon and party the concentrating rainfalls.

·Water Supply

The purificating capacity of water supply is up to 4,720,000 m^2 per day from 9 water sources at the end of 1987.

The rate of water supply in 1991 when the medium- and long- term plan ('87 - '91) complete, will be higher up to 99.8 percent. To provide the concentrating people in the Sanggye region, the northern part of Seoul, caused by the large scale development, the expanding projects for the water supply plants will be planned to start to construct in this year and complete in 1991. In addition with these plans, 425km of the worn-out pipes will be repaired and replaced to improve the quality of water and to prevent the leakage.

(Table: The Basic Indices of the Medium-and Longterm Plan)

Classification \ Year	Unit	'87	'88	'89	'90	'91
Population	1,000 persons	9,991	10,116	10,245	10,352	10,437
Population Supplied Water		9,841	10,065	10,204	10,321	10,416
Rate of Water Supply	%	98.5	99.5	99.6	99.7	99.8
Capacity of Water Supply	10,000m^3/day	472	497	522	547	573
Max. water supplied to 1 person		480	493	512	530	550
Ave. water supplied to 1 person		408	420	435	451	468

disease monitoring and diarrhea treatment centers are operated. Medical check-ups are conducted on potential germ-carriers to discover for the early detection of patients.

Pollution Control

The protection of the environment should be a constant concern of every person.

In Seoul, environmental pollution grows ever worse due to the concentration of facilities caused by increased population and urban development. Environmental pollution seriously affects all facets of human life, especially health. With a view, therefore, to protecting the health and lives of the inhabitants of Seoul and to strengthening guidance and supervisory activities on the prevention of environmental pollution, the municipality is carrying out programs to protect the environment, to bring down the degree of pollution to below the permissible level and to foster a clean living environment.

Water Pollution

Present Water Pollution Situation

The Han River which flows through Seoul from the east to the west is the major source of household water for the 12 million people along its basin and also of agricultural and industrial water. The river is also a source of rest and relaxation for the people. The contamination of the river is becoming increasingly worse due to an increasing amount of pollutants prompted by the growing urban population and rapid industrialization. The BOD (Biochemical Oxygen Demand) an indicator of water pollution, had increased continuously until 1978 when it declined to a level half as much as the previous year. After the decline, BOD began to inch up again. The upstream area registered less than 3 ppm or water source Grade 2 (a level where water can be drunk after simple filtration) whereas the contamination of the downstream area was very serious.

There are various factors behind the contamination of the Han River but the major source is household sewage, which totals 1,930,000 m^3 a day or 91 percent of the total waste water flowing into the river. The remainder includes 201,000 m^3 of industrial waste water, roughly 9 percent of the total. In terms of the BOD, household sewage is responsible for 290 tons or 70 percent of the total while industrial waste water produces 120 tons of the BOD contamination load a day.

Thus seen, it goes without saying that the expansion of sewage treatment facilities is the key to basically prevent the contamination of the Han River.

第2節 人口現況

○年度別 人口現況

區分	'83	'84	'85	'86	'87	'88
總人口(千名)	39,929	40,513	41,056	41,569	42,082	42,593
增加率(千名當)	14.6	13.4	12.5	12.4	12.1	11.9
人口密度(名/㎢)	403	409	414	419	424	430
年增加人員(千名)	584	543	513	513	511	506
出生率(千名當)	21.7	20.6	19.7	19.4	19.1	18.7
死亡率(千名當)	6.3	6.3	6.2	6.1	6.0	5.9
嬰兒死亡率(出生千名當)	34.2	33.3	32.6	31.8	31.0	30.3
母性死亡率(萬名當)	3.8	3.6	3.4	3.3	3.2	3.1

○年齡別 分布現況('88)

(單位:千名)

區分		0~4歲	5~9	10~19	20~29	30~39	40~49	50~59	60~69	70以上
計	42,593	3,937	4,063	8,656	8,496	6,508	4,577	3,369	1,888	1,099
男	21,476	2,050	2,111	4,464	4,338	3,368	2,354	1,616	803	372
女	21,117	1,887	1,952	4,192	4,158	3,140	2,223	1,753	1,085	727

※ 老人人口(65歲以上): 1,904 千名

○6次 5個年計劃 人口 目標

(單位:千名)

區分	'87	'88	'89	'90	'91
總人口	42,082	42,593	43,099	43,601	44,094
增加率(千名當)	12.1	11.9	11.6	11.3	10.9

第3節 醫療人力 및 施設現況

○醫療人力 現況

('87. 6月末現在)

區分	免許登錄(%)	醫療機關從事者			從事者比率(%)
		計	郡部	市部	
計	303,669(100.0)	104,888	9,022	95,866	34.5
醫師	34,185(11.2)	23,413	1,941	21,472	68.5
齒科醫師	6,761(2.2)	4,585	380	4,205	67.8
韓醫師	4,426(1.5)	3,412	373	3,039	77.1
助産師	6,849(2.3)	1,038	83	955	15.2
看護師	69,829(23.0)	21,487	1,187	20,300	30.8
藥師	32,855(10.8)	1,648	91	1,557	5.0
醫療技士	32,416(10.7)	10,363	1,083	9,280	32.0
看護助務士	116,348(38.3)	38,942	3,884	35,058	33.5

○醫療施設 現況

('87. 6月末現在)

機關種別	計		郡部		市部	
	機關	病床	機關	病床	機關	病床
計	17,311	114,511	2,102	17,249	15,209	97,262
綜合病院	205	57,863	23	3,808	182	54,055
病院	323	26,798	50	7,373	273	19,425
齒科病·醫院	3,599	54	329		3,270	54
韓方病·醫院	3,235	643	367	2	2,868	641
醫院	9,089	27,861	1,176	5,775	7,913	22,086
附設醫院	356	859	57	224	229	635
助産所	504	433	100	67	404	366
藥局	17,973		2,335		15,638	

제 5 표. 제 1 종 주요전염병

Table 5. Class 1 Major Communicable Diseases; Number of Cases,

	콜레라 Cholera				장티푸스 Typhoid fever			
	발생 Cases	이환율 Incidence rate	사망 Deaths	치명율 Fatality rate	발생 Cases	이환율 Incidence rate	사망 Deaths	치명율 Fatality rate
1981	–	–	–	–	164	0.4	1	0.6
1982	–	–	–	–	319	0.8	–	–
1983	–	–	–	–	391	1.0	1	0.3
1984	–	–	–	–	184	0.4	2	1.0
1985	–	–	–	–	208	0.5	–	–
1986	–	–	–	–	278	0.7	1	0.3

제 6 표. 제 2 종 주요

Table 6. Class 2 Major Communicable

	폴리오 Poliomyelitis		백일해 Whooping Cough		홍역 Measles		유행성이하선염 Mumps		일본뇌염 Japanese Encephalitis		공수병 Rabies	
	발생 Cases	이환율 Incidence rate	발생 Cases	이환율 Incidence rate	발생 Cases	이환율 Incidence rate	발생 Cases	이환율 Incidence rate	발생 Cases	이환율 Incidence rate	발생 Cases	이환율 Incidence rate
1981	2	0.0	1,622	4.2	2,307	6.0	1,524	3.9	194	0.5	–	
1982	2	0.0	700	1.8	6,776	17.2	1,487	3.8	1,197	3.0	1	0.0
1983	5	0.0	443	1.1	695	1.7	1,050	2.6	139	0.4	–	–
1984	–	–	1,854	4.6	2,246	5.6	919	2.3	–	–	1	0.0
1985	–	–	479	1.1	1,283	3.1	1,237	3.0	–	–	–	–
1986	–	–	188	0.5	1,818	4.4	939	2.3	–	–	–	–

주 : 전염병 예방법에 의한 각 시도의 보고 숫자임.
인구수는 연앙인구임.

$$이환율 = \frac{발병환자}{전국인구} \qquad 치명율 = \frac{사망}{발생} \times 100$$

이환율 및 치명율

Deaths, Incidence and Fatality Rate

파라티푸스 Paratyphoid fever				디프테리아 Diphtheria				세균성이질 Bacterial dysentery			
발생 Cases	이환율 Incidence rate	사망 Deaths	치명율 Fatality rate	발생 Cases	이환율 Incidence rate	사망 Deaths	치명율 Fatality rate	발생 Cases	이환율 Incidence rate	사망 Deaths	치명율 Fatality rate
10	0.0	–	–	43	0.1	2	4.7	110	0.3	1	0.9
14	0.0	–		17	0.0	–		62	0.1		–
39	0.1	–	–	19	0.1			82	0.2	–	
21	0.0	–	–	16	0.0	–		37	0.0	–	
12	0.0	–		7	0.0			41	0.1		
14	0.0	–	–	–	–			67	0.1		

전염병 이환율

Diseases; Number of Cases by Year

말라리아 Malaria		성홍열 Scarlet Fever		발진열 Typhus		유행성수막구균성수막염 Meningococcal Meningitis		유행성출혈열 Epidemic Haemorrhagic Fever		파상풍 Tetanus		재귀열 Relapsing Fever		아메바성이질 Amebic Dysentery	
발생 Cases	이환율 Incidence rate	발생 Cases	이환율 Incidence rate	발생 Cases	이환율 Incidence rate	발생 Cases	이환율 Incidence rate	발생 Cases	이환율 Incidence rate	발생 Cases	이환율 Incidence rate	발생 Cases	이환율 Incidence rate	발생 Cases	이환율 Incidence rate
–	–	70	0.2	–	–	4	0.0	46	0.1	9	0.0			57	0.2
	–	94	0.2	–	–	6	0.0	32	0.1	7	0.0			20	0.1
–		94	0.2	–	–	6	0.0	29	0.1	16	0.0		–	22	0.3
–	–	197	0.5	–	–	1	0.0	36	0.1	5	0.0			23	0.1
–	–	207	0.5	–		2	0.0	64	0.1	5	0.0			24	0.1
–	–	354	0.8	–	–	8	0.0	52	0.1	2	0.0			41	0.1

Note: This table is based on the report from cities & provinces under Communicable Disease Control Law, Denominator is estimates of mid-year population.

$$\text{Incidence Rate} = \frac{\text{Number of Cases}}{\text{Total Population}} \times 100{,}000 \quad \text{Fatality Rate} = \frac{\text{Deaths}}{\text{Number of Cases}} \times 100$$

제 131 표. 배 출
Table 131. Pollutant

	계 Total				1 종 Class I	
	계 Total	대 기 Air Pollution	수 질 Water Pollution	소 음 Noise and Vibration	대 기 Air pollution	수 질 Water Pollution
1 9 8 1	33,182	14,297	5,819	13,066	216	82
1 9 8 2	35,873	15,893	6,526	13,454	224	89
1 9 8 3	37,256	16,582	7,022	13,652	230	83
1 9 8 4	39,162	17,894	7,919	13,549	223	88
1 9 8 5	44,646	19,714	8,457	16,475	256	92
1 9 8 6	48,748	21,507	9,916	17,325	278	122
서 울 특 별 시 Seoul-tukpyolshi	9,685	5,487	1,321	2,877	37	8
부 산 직 할 시 Pusan-jikalshi	5,996	2,535	1,185	2,276	20	6
대 구 직 할 시 Taegu-jikalshi	3,558	1,277	685	1,596	14	6
인 천 직 할 시 Inchon-jikalshi	2,862	1,129	473	1,260	28	1
광 주 직 할 시 kwangju-jikalshi	825	465	181	179	-	1
경 기 도 Kyonggi-do	9,065	3,487	2,114	3,464	44	39
강 원 도 Kangwon-do	1,285	569	374	342	9	6
충 청 북 도 Chungchongbuk-do	1,336	616	298	422	9	3
충 청 남 도 Chungchongnam-do	2,710	1,094	688	928	11	8
전 라 북 도 Chollabuk-do	1,821	770	382	669	14	6
전 라 남 도 Chollanam-do	1,527	674	399	454	21	7
경 상 북 도 Kyongsangbuk-do	2,925	1,208	540	1,177	13	12
경 상 남 도 Kyongsangnam-do	4,603	1,941	1,091	1,571	56	19
제 주 도 Cheju-do	550	255	185	110	2	-

자료 : 환경청

시 설 현 황
Facilities by Classes.

2 종 Class II		3 종 Class III		4 종 Class IV		5 종 Class V	
대 기 Air Pollution	수 질 Water Pollution	대 기 Air Pollution	수 질 Water Pollution	대 기 Air Pollution	수 질 Water Pollution	대 기 Air Pollution	수 질 Water Pollution
477	131	578	202	3,080	1,243	9,946	4,161
484	137	592	217	3,242	1,419	11,351	4,664
510	132	597	211	3,041	1,362	12,204	5,234
500	137	665	227	3,193	1,329	13,313	5,938
507	146	709	318	2,846	1,154	15,396	6,747
600	155	735	317	3,002	1,264	16,892	8,058
171	21	233	13	983	95	4,063	1,184
47	5	81	17	323	121	2,064	1,036
36	7	58	26	235	232	934	414
27	2	27	14	178	45	869	411
5	-	12	1	41	14	407	165
124	48	134	125	538	355	2,647	1,547
7	2	4	4	33	31	516	331
25	3	19	8	71	41	492	243
35	12	25	15	148	69	875	584
11	3	14	9	55	32	676	332
9	6	9	10	30	36	605	340
30	15	38	21	166	71	961	421
69	31	79	50	191	118	1,546	873
4	-	2	4	10	4	237	177

Source : Environment Administration

제 132 표. 주요도시별 대기오염실태 (SO_2)

Table 132. Air Pollution in Major Cities (SO_2)

단위 : ppm

Unit : ppm

	1981	1982	1983	1984	1985	1986
서 울 Seoul	0,086	0,057	0,051	0,066	0,056	0.054
부 산 Pusan	0,061	0,065	0,051	0,050	0,047	0.042
대 구 Taegu	0,046	0,039	0,046	0,040	0,039	0.043
인 천 Inchon	0,043	0,033	0,037	0,056	0,052	0.053
수 원 Suwon	0,042	0,029	0,037	0,065	0,055	0.058
성 남 Songnam	0,058	0,033	0,036	0,063	0,049	0.056
춘 천 Chunchon	0,025	0,030	0,033	0,035	0,034	0.032
청 주 Chongju	0,011	0,014	0,018	0,024	0,029	0.033
충 주 Chungju	0,011	0,011	0,015	0,019	0,028	0.024
대 전 Taejon	0,029	0,029	0,028	0,030	0,033	0.027
천 안 Chonan	0,024	0,027	0,031	0,034	0,033	0.026
전 주 Chonju	0,015	0,015	0,022	0,022	0,021	0.020
이 리 Iri	0,022	0,016	0,021	0,027	0,025	0.020
광 주 Kwangju	0,021	0,024	0,029	0,026	0,020	0.020
구 미 Kumi	0,030	0,025	0,024	0,019	0,031	0.038
안 동 Andong	0,028	0,031	0,031	0,031	0,025	0.035
마 산 Masan	0,025	0,029	0,032	0,035	0,035	0.032
울 산 Ulsan	0,057	0,039	0,033	0,024	0,030	0.032
제 주 Cheju	0,015	0,005	0,006	0,010	0,010	0.010

자료 : 환경청

Source : Environment Administration

제 133 표. 주요 수계별 수질오염실태 (BOD)

Table 133. Water Pollution for Major Rivers (BOD)

단위 : mg/l　　　　Unit : mg/l

		1981	1982	1983	1984	1985	1986
한강 Hangang	춘천댐 Chunchontaem	0.6	0.6	0.9	1.2	1.1	1.1
	소양댐 Soyangtaem	0.4	0.4	0.6	0.8	0.7	0.9
	의암댐 Uiamtaem	0.7	0.9	1.3	1.4	1.1	1.3
	팔당 Paldang	1.4	1.8	1.5	1.6	1.5	1.4
	구의 Kuui	1.5	1.5	2.7	2.5	1.7	1.7
	보광 Bokwang	4.8	4.9	5.0	7.0	3.8	3.0
	노량진 Noryangjin	5.2	5.4	6.1	6.7	4.7	4.1
낙동강 Naktonggang	안동댐 Andongtaem	1.3	1.2	1.5	1.2	1.3	1.0
	구미 Kumi	1.6	3.9	1.7	1.6	1.8	1.7
	달성 Talsong	1.8	3.0	1.8	1.5	1.7	1.7
	고령 Koryong	-	11.7	11.0	10.2	8.5	14.1
	삼랑진 Samnangjin	1.6	2.4	3.0	3.0	3.2	3.7
금강 Kumgang	대청댐 Taechongtaem	1.9	1.2	1.1	1.1	1.1	1.2
	청원 Chongwon	-	4.1	3.0	3.2	3.2	2.3
	부여 Puyo	2.0	2.4	2.3	2.9	2.5	3.0
	연기 Yongi	2.2	2.8	2.6	2.9	2.6	2.8
영산강 Yongsangang	담양 Tamyang	2.1	1.9	1.8	1.3	1.3	1.9
	금성 Kumsong	3.8	3.9	5.6	6.5	5.2	5.2
	무안 Muan	-	3.0	3.0	2.9	1.9	1.9

자료 : 환경청　　　　Source : Environment Administration

WORLD HEALTH ORGANIZATION

WESTERN PACIFIC REGION

ORGANISATION MONDIALE DE LA SANTE

REGION DU PACIFIQUE OCCIDENTAL

REGIONAL CENTRE FOR THE PROMOTION OF
ENVIRONMENTAL PLANNING AND APPLIED STUDIES (PEPAS)

REGIONAL WORKSHOP ON DRINKING WATER
QUALITY MONITORING AND SURVEILLANCE

ICP/RUD/001 PROG/112/CR-004

Kuala Lumpur, Malaysia
27 February - 3 March 1989

ENGLISH ONLY

COUNTRY REPORT

LAOS

by

Dr Nouantha Manipousy

Mr Oth Keomanivong

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC

COUNTRY REPORT

REGIONAL WORKSHOP ON DRINKING WATER QUALITY MONITORING AND SURVEILLANCE

KUALA LUMPUR, MALAYSIA

27 February - 3 March 1989

Jointly prepared by: Dr. Nouanta MANIPHOUSAY, Directorate of Water supply and Sanitation (DWSS) and Mr. Oth KEOMANIVONG NAM PAPA LAO.

February 1989

Vientiane,

Lao PDR

I. LAO PDR - General profile

-Laos is a landlocked country in South East Asia surrounded by China, in the north, Vietnam in the north east, east and south east, Kampuchea in the south, Thailand in the west and Burma in the north-west covering an area of about 236,800 sq.Km. The 1985 census estimated the total population at around 3.6 million- with an annual growth rate of 2.9% .Around 85% of the people of Lao PDR live in villages outside the main urban and semi-urban area. The average density is 15 persons per sq.Km. About two thirds of the country is forest and mountain.

-The topographic pattern is that three fourths of the country is mountainous (north, northeast and east) and one fourth is the plain of the Mekong river (centre, west and south), which originates in China and flows through LAOS.

-The incountry transportation land roads are difficult. The main roads for all year practiceable are Route 13 which runs from Luangprabang in the north to the south of the country and Route 9 from Savannakhet to the east. Only some parts of the northern roads can be useful. And during the rainy season, many roads which take to the East are impracticeable. The transportation by the river is mainly possible from Vientiane to Savannakhet or to Luangprabang or up to Bokeo. In the other parts of the country, it becomes more difficult especially during the wet season due to the low level of the water .

-The country is divided in 17 provinces, 112 districts and more than 11 000 villages. There are 3 ethnic groups and 68 minorities living in varions part of the country and earning their life by rice planting and animals raising for those ethnic groups who live on the plains of the Mekong by slush and burn cultivations for other different minorities who used to be the migrant mountainous people.

Each minority people have their own way of livings, traditions and langages. But the official language is Lao.

-The weather of the Lao PDR is composed of 2seasons;

-Dryseasons, from December to May. The weather is hot from the end of February to May, the cold weather is short, from December to February, in the northern area, mountainous area; in the northern east of Xiengkhouang plateau, and one area in the Borovenh plateau in the south the weather is very cold. in some years till 0°C or below than this and takes times.

-Rainy season: The weather is hot and takes times, starting from April to November. Sometimes, some years there is flood. In some areas, the density of the rain throughout the year is 600-2000 mm. Because of that tropical weather, there are developments of the vectors and becoming the most simple sources of infections into the humain body.

Most of diseases occur:

1) Malaria is the number 1 killer of the humain body more than the others, which occur as endemic throughout the country, specially in the country.
2) The diseases of intestinal system: Most of them are intestinal bacterias which cause diarrhoea in the community in both areas, in the town and in the country. The cause of these diseases are from contaminated food and dirty water, specially E. coli, Shigella dysenteria, Salmonella typhi, paratyphi. Beside from these, there are still other instinal parasites and other infectious parasites such as: Ascaris, toenia, ankylostoma, strongyloid, trichiuris trichura, trichinella, clonorchis sinensis, opistherchis, paragonimus ringeri, schistosoma mekongi and mycosis...
3) Respiratory system diseases: which cause pneumonitis, cough, pneumonia, pneumalgia caused by pulmonary tuberculosis are still the most occuring in the community in both areas, in the town and in the country. In the mountainous areas which the immunization programme did not reach, there are still cases of whooping cough (Pertussis).
4) Other communicable diseases still remain such as:

--Viral hepatitis HBs, Australian antigens still be found in the blood donors at 12- 13% or more than that in case of hepatitis.

-Encephalitis aigue still remain many cases in the children, but, this the types can not be classified.

-Beside this, there are still Dengue fever, Hemorrhagic Dingue fever which already have been occured as endemic in LAOS for two times causing death of many children in the big city (Vientiane) in 1984, and in Pakse, and Savannakhet in 1986.

-Measles remain the problem in the mountainous areas which the immunization programme did not reach yet, and there are still many cases of other diseases.

-Gynecological diseases, because lack of personal hygiene, lack of health education, low education, late custom and lack of services of clean water for bathing and for washing, mortality rate of the maternal and child are still high, specially the mortality rate of the children under one year of age is 117 per thousand, the average of of life is 50 years.

Because of the mentioned situation, it makes the incomplete participation of the social, the development of the socio-economy is still very low, the average incomes per person is about 202 US dollars, specially the development of Drinking water supply and sanitation in the country, is not smoothly done due to low grade of the community participation, the Administrative committee have not cooperative funds, the communication is not feasible into every where, etc...

Most the technicians trained, were emphasized into the arrangement for water supply . Water on the training were slightly orientated to the treatment of the water supply quality. In the treatment of water supply quality, was uded the chloration method (Chlorination test . And in making concrete bowl-seal) latrine .

RELATION BETWEEN ENVIRONMENTAL SANITATION AND DRINKING WATER SAFETY:

In LAO P.D.R. , even there is expansion of heavy industry, but the preventi system and the treatment of dirty water in the city were not yet well organized. Even the dangerous ~~toxins of~~ from the chemical compounds were still at low level ,but this mater is under study for the solution of the prevention The dirt of the surface water ~~on the surface~~ or of the groud water still mixed together with general environment such as the water flow system from the mountains is dirty ~~with the jungle~~ from the wild animals. The community in the country is affected by the various diseases as mentioned in the generality . The causes of these diseases are because of insuffiency of water supply throughout the country as a whole . In dry season the population in the flat field still lack of drinking water for 4-5 months . The finding the sources of water is faraway more than 2 Km . If digging the well is too deep more than 10-15 meters to reach the level of the big river , or if they can reach they have to past the hard rock ~~sub-soil~~ . In some areas are dry , and some are salty~~ground~~ . Health education still has shortage the far away habitants are low educated , boiling water before drinking can not be done in every house .

Water quality control can not be done throughout everywhere, only in some regeous such as :

1. WATER SOCIETY. (NAM PAPA LAO)

Has examined some daily water producte in industry, especially ~~inraining~~ in rainy season . In this case , the analysis done as follows:

- -Turbidimetry
- -Color
- -Jarr test
- -pH
- -Chlorination test
- - Hardness
- -Bacteriological analysis
- - and some other chemistry...

SUMMARY REPORTS

After Organizing the Directorat for Water supply and sanitation under the supervision of Ministry of Health and Social Welfare of the LAO.P.D.R. and with the equipments and supplies and technical assistance from the International Organization in LAO with the present of UNDP, UNICEF, WHO, and other NGO'S which has been established from 1982 to the present .

- UNDP began to assist in training workers inside the country and abroads ; some equipments and supplies , together with technical consultant .
- WHO also has assisted in training workers, and technical concerned .
- UNICEF also has assisted in provision the equipments and supplies majority for construction and supervision the technics .
- Non Governmental Organizations also have assisted in some materials and technics .

I. Functions of the project.

- Organizing and selving for services of clean water in the country and responsible for environmental sanitation by motivating the availability of the ~~toilet~~ Latrine .
- In the city (town) is the responsibility of the water Society (NAM PAPA) belonging to the Ministry of Construction .

- IN THE PAST.

1) NAM PAPA Society has been constructed in providing clean water supply in the town such-as .
   - two ~~tanks~~ systems in Vientiane Municipality
   - One ~~tank~~ system in Luang prabang province
   - One ~~tank~~ system in Savannakhet province
   - One ~~tank~~ system in Pakse
   - one ~~tank~~ system in Xay district, Oudomxay province

2) Directorat for water supply and sanitation has had arrangement for water supply as follows :
   - more than 16,86 wells with good enough of standardized concrete ~~block~~ Ring and with more than 337,000 utilizers .
   - Flowing water system more than 127 dams to confine water have been constructed to allow the slow flow of water from the mountain , or from the small river on the mountain by the connection the ~~rubber tube~~ HDPE Pipe to the villages at the bottom, and there are more than 190,500 utilizers .

- Bored well system . there are 478 of the old ones, and 33 of the new.

Beside from that, there are private wells which are correct and incorrect technics done and most of villagers are living along the mountains basing to utilize the water flow from the those mountains throughout the year or some have digged the wells along the border of the small and bigger rivers as possible, and out of those were living through the flat field along the river utilise the water from those river .

Generally , there are utilized of different system of wells as follows :

- 337,000 people have utilized water from standardized concrete ring well .
- 190 500 people have utilized the water flow system from the mountains .
- 126 100 people have utilized bored well water.

The total of utilizers is 653.600, equals to 16 % .

- Those who have the private wells are 350 000 people, equal to 8-10 %
- The utilizers of NAM PAPA in the city from 6 systems in the whole country equals to 4 % .

Total in percentage :

- From DWSS 16%
- From private construction 8%
- From water society 4%

Total......... 28 %

ARRANGEMENT ACTIVITIES FOR THE AVAILABILITY OF THE TOILET.

In the past , because lack of motivation , health education, and lack collection for exact data, especially in the country which has shortage of water supply , and water supply is far away from the utilizers . But, before 1981 we have distributed many PVC seals of latrine, due to lack of water supply, these PVC seals of latrine were improper used. Noweday after there is gradual expension of DWSS, there are many requests from the provincial administrative committees for the toilet bowls, but we stell have many shortage of construction materials .

TRAINING OF TECHNICIANS

We have formed all technicians for 9 courses at different levels. In theses courses there was one B level. There were formal technicians and retraining. There were 230 people were trained , but there are more than 140 people only remaining in the actual network .

Most the technicians trained, were emphasized into the arrangement for water supply . Water on the training were slightly orientated to the treatment of the water supply quality. In the treatment of water supply quality, was used the choration method (Chlorination test . And in making concrete bowl seal latrine .

RELATION BETWEEN ENVIRONMENTAL SANITATION AND DRINKING WATER SAFETY:

In LAO P. . . even there is expansion of heavy industry, but the preventive system and the treatment of dirty water in the city were not yet well organized. Even the dangerous ~~toxins of~~ from the chemical compounds were still at low level ,but this mater is under study for the solution of the prevention . The dirt of the surface water ~~on the surface~~ or of the ground water still mixed together with general environment such as the water flow system from the mountains is dirty ~~with the jungle~~ from the wild animals. The community in the country is affected by the various diseases as mentioned in the generality . The causes of these diseases are because of insuffiency of water supply throughout the country as a whole . In dry season the population in the flat field still lack of drinking water for 4-5 months . The finding the sources of water is faraway more than 2 Km . If digging the well is too deep more than 10-15 meters to reach the level of the big river . if they can reach they have to past the hard ~~sub-soil~~ rock . In some areas are dry , and some are salty~~ground~~ . Health education still has shortage the far away habitants are low educated , boiling water before drinking can not be done in every house .

Water quality control can not be done throughout everywhere only in some regeons such as

1. WATER SOCIETY. (NAM PAPA LAO)

Has examined some daily water products to industry, especially ~~irraing~~ in raining season . In this case , the analysis done as follows:

- Turbidimetry
- Color
- Jarr test
- pH
- Chlorination test
- Hardness
- Bacteriological analysis
- and some other chemistry...

2. ~~Laboratory of Irrigation Department~~ has analysed the ground water as the majority.

-Sampling programme and analysis:

For water samples, they collected at 9 stations

3 at the main river (Mekong):

-Luangprabang

-Vientiane

-Pakse

6 at the Tributaries:

-Nam Ou at Luangprabang

-Nam Ngum at Thalath below the dam

-Nam Ngum at Tha-Ngone

-Se Bang Fai

-Se Bang Hieng

-Se Done (Pakse)

-Frequency: For water chemistry analysis, samples are taken once a month.

-Analytical and control procedures:

Three years of experiences has been gained, from the analyses about 20 parameters of importance for water quality. Fecal coliforms and Fecal streptococci concentrations of sediments and identify the numbers of individuals and of species of bottom fauna.

-Concentrations of substances:

Major constituents:

Ca + Mg and Alkalinity are the dominant ions at all 3 main river stations. This is due to the influence of limestone. In the southern part, in Mekong at Pakse the concentration of Ca + Mg and Alkalinity are lower than those at Luangprabang and Vientiane.

Ca + Mg and Alkalinity are the dominant ions, it is due to the limestone, at Nam- Ou, also at Se Bang Fai and at Thalath Nam Ngum.

There are two capable laboratories for water analysis in the country, in our National Institut of Hygiene and Epidemiology, and provincial laboratory in Savannakhet; the water that have been analysed, most of them from the private and public wells, the fecal coli and other coliforms have been found in many water samples. This resulted from unsanitary well, which lack of cover, there is infiltration of dirty water into the ground, it has no drain lack of canalization of waste water , the concrete ring well has not been jointly pasted, so that, there are spreading of bacterias into the well. Actually, we want to expand our capable laboratories, but we have shortage of budgets.

Regarding the community health, we must educate the publics to boil the water before drinking.

The chemical analysis of the water from different sources which have been done in Laboratory of the Irrigation Department shown:

-Shallow wells and bored wells: the water from these sources were analysed and found Fe, and some areas present with numerous quantity of NaCl, and some are NO_2, NO_3.

-Water from gravity flow system: many areas found numerous quantity of Ca, Mg which cause thick rust obstraction the pipe during a few years of service.

To prevent diseases caused by the dirty water, National Institut of Hygiene and Epidemiology have proposed the following directives:

-DWSS is trying to expand this programme as many as possible throughout the country. In these directive the treatment of the ground water (Ring wells or dug wells) to avoid the contamination from outside

-Expansion of the manual bored well teams,

-Spring protection

-Health education on drinking water supply service and participation to this activity.

To be able to do this task, the technicians at central, provincial and district level must be trained and continued the training course. And this kind of funds is to be increasingly requested.

*Institute of Hygiene inspection:

This institute to set up for the expansion of water capably analytic laboratory throughout some points as follows:

-At Central level, in Vientiane

-At mid-land, in Savannakhet province

-At southern-land, in Pakse

-At northern-Land, in Luangprabang...

*Environmental achievements

Spread of Environmental Action:

1) Water: We have not yet organized the operation, only to supply water , but not for the achievement to operate the preventive measure programmes against the polluted water from the environments.

*Westage destruction areas:

Still lack of destruction system, Only at Km 20 far away from Vientiane has been allocated for destruction area. The soiled westages were improper dissiminately thrown, only burning at the middle of the ground and resulted the diffusion of the smoke and dirty odor throughout the areas. If it rains, in case of cannot burn, it leads to be fermentated, spoiled and flown throughout the field with scrutching of some animals.

In general view, we are lacking of technicians to supervise the preventive organization methods and some funds to support its complete construction system to be able to do:

-proper collection of the westages
-taking out and means of transport.
-destruction of the westages,

Regarding the sewerage remains problems to be paid attention . there was no system of severagéd of dirty water served by household from the town yet, the canalization system of dirty water from the town is still difficult, resulted to the congestion the dirty water served by household flowing over the roads which cause the contamination of the general areas.The waste water which have been served from hospital, from household, throughout the small industry in the in the town are not severed or extracted separately the dirt. Sometimes only caralizing to the rice field or directly to the river:

-We are lacking of technicians to set up the preventive measures
-We have shortage of preventive equipments and materials
-Lack of funds to support the complete construction system to do the sewerage

Generally, nothing done on this matter.

WORLD HEALTH ORGANIZATION

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REGIONAL WORKSHOP ON DRINKING WATER
QUALITY MONITORING AND SURVEILLANCE

ICP/RUD/001 PROG/112/CR-005

Kuala Lumpur, Malaysia
27 February - 3 March 1989

ENGLISH ONLY

– polluted water [illegible]
– no copyrights of model docts

Analysis by Chem Dept and DOE

upgrading of plantation

COUNTRY REPORT

MALAYSIA

by

Ir Mukundan Sugunan Pillay/Ms Debbie Siru

Water is State Govt resp.
JKR advising

rural - Gravity fed
open dug well
[illegible]

5th Malaysia Plan (86-90)
$4.4 billion 174 R.W.S for 2 million people
British project no comm. practice

No standards! [illegible] coll

DRINKING WATER QUALITY MONITORING AND SURVEILLANCE

COUNTRY REPORT

MALAYSIA

February 1989

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1. COUNTRY PROFILE

Malaysia comprises the Malay Peninsula, Sabah and Sarawak covering a total land area of approximately 330,433 sq. km. and populated by about 17 million people. A map of Malaysia is provided in Appendix 1.

Peninsula Malaysia extends some 740 km from Perlis in the north to the Straits of Johor in the south. It consists of eleven states namely Johor, Kedah, Kelantan, Melaka, Negeri Sembilan, Pahang, Perak, Perlis, Pulau Pinang (Penang), Selangor, Terengganu as well as the Federal Territory of Kuala Lumpur. The Peninsula's coastline extends for 1930 km and is separated from Sabah and Sarawak by about 530 km of the South China Sea.

Sabah and Sarawak stretch some 1120 km from Tanjung Datu (Sarawak) in the west to Hog Point (Sabah) in the east and have a coastline of around 2253 km.

Malaysia just as the other countries in the region is affected by communicable diseases namely cholera, typhoid, dysentery and viral hepatitis. However, epidemiological studies have not been able to clearly determine the cause as definitely waterborne. Many other factors are involved including contamination of food, poor personal hygiene etc. Nevertheless, there is evidence to show that water resources are being increasingly polluted and this definitely poses potential disease threat to large sections of the population.

Appendix 2 shows the trends of waterborne diseases from the year 1976 - 1988 while Appendix 3 shows the number of cases and deaths (shown in brackets) for the year 1988. It should be noted that the number of deaths is small compared to the number of cases and this is perhaps a reflection of good treatment and after care nursing provided by the medical services.

2. NATIONAL POLICY AND PROGRAMME OF DRINKING WATER QUALITY MONITORING AND SURVEILLANCE

2.1 National Policy

Although the medical service is efficient, it is the national policy to raise the standard of health of the people by reducing the incidence of communicable diseases. Several programmes have been formulated and implemented to achieve this, one of which is the National Drinking Water Quality Surveillance Programme which was launched in 1983 under the auspices of the International Drinking Water Supply and Sanitation Decade.

Malaysia's policy is unique in that health is a federal matter while water comes under the authority of the State. As such the Ministry of Health has control over its State and District Health Offices in all matters pertaining to health. The Public Works Department Headquarters on the other hand, carries out research, identifies and appraises new projects and provides technical standards on water supply equipments, water treatment design of water installations and facilities, while funding and operation are controlled by the State government.

The national programme has targeted 1990, the end of the International Drinking Water Supply and Sanitation Decade for the successful completion of all 5 phases of the programme as outlined in Appendix 4.

The scope of the programme covers all public water supply systems in the country which includes :

i) urban public water supply systems

ii) rural public water supply systems

iii) privately owned public water supply systems and the remote rural public water supply systems.

2.2 Legal Provisions

A lack of legislation for enforcement of the National Drinking Water Quality Surveillance Programme did not deter its implementation. Instead, existing legislation was made use of to enforce various aspects of the programme i.e.

i) Environmental Quality Act 1974 (Act 127). The Department of Environment, Ministry of Science and Technology is responsible for enforcement of the Act and is empowered to prosecute any agency or organisation found to be polluting the waterways.

ii) Food Act 1983 (Act 281) and Food Regulations 1985 (P.U. (A) 437/85). Although the Act does not have a direct bearing on the National Drinking Water Quality Surveillance Programme it nevertheless empowers the Ministry of Health to prosecute any persons who sell, use, cause or permit to be used any water, ice or steam in the preparation or manufacture of food unless that water, ice or steam complies with the standard prescribed in the regulations.

iii) Workers (Minimum Standards of Housing) Act 1966. This Act enforced by the Ministry of Labour ensures that the minimum requirements of housing which includes proper sanitation and water supply are provided by an employer. Thus this enables the Ministry of Health to extend its National Drinking Water Quality Surveillance Programme to private water purveyors thus ensuring the quality of water supplied.

2.3 National Drinking Water Quality Standards/Guidelines

The drinking water quality standards enforced by Malaysia are for the main adopted from the WHO Guidelines for Drinking Water Quality 1984. For those parameters not listed in the WHO Guidelines, standards from countries such as Australia, Canada as well as the USEPA were adopted and incorporated into the Malaysian Guidelines for Drinking Water Quality.

2.4 Agencies Involved

The Malaysian National Drinking Water Quality Surveillance Programme requires inter-agency cooperation with the Ministry of

Health taking the lead role as the surveillance and coordinating agency. This responsibility is undertaken by the Unit of Drinking Water Quality Surveillance Programme of the Engineering Services Division, Ministry of Health through the State Medical and Health Services Department and the District Health Office.

At the federal level, the Water Supply Branch of the Public Works Department Headquarters is responsible for all matters pertaining to water supply. The responsibilities are executed through the State Public Works Department or State Water Supply Department and the District Public Works Department or District Water Supply Department. However, in two states namely Malacca and Penang, as well as some districts of Sarawak, Water Boards have been established to undertake the responsibilities of water supply. The State Public Works Department and the State Water Boards are the main producers of water supplying 77% of the nation's water requirements. They provide treated water under pressure to urban and rural areas.

However in the more remote rural areas the Ministry of Health through its State Medical and Health Services Department assist these communities in obtaining sufficient quantities of untreated water. The other agency involved in supplying water are the private purveyors e.g. in estates and mines.

The analytical function is provided by the Department of Chemistry and its 8 regional laboratories while pollution control through the Environmental Quality Act of 1974 is enforced by the

Department of Environment, Ministry of Science and Technology through its 7 regional offices.

Figure 1 shows the various agencies and the administrative set-up of the various agencies involved in the National Drinking Water Quality Surveillance Programme as well as the inter and intra-agency relationship.

In the case of private water supply systems, cooperation from other agencies such as the private water purveyors and the Labour Office is necessary.

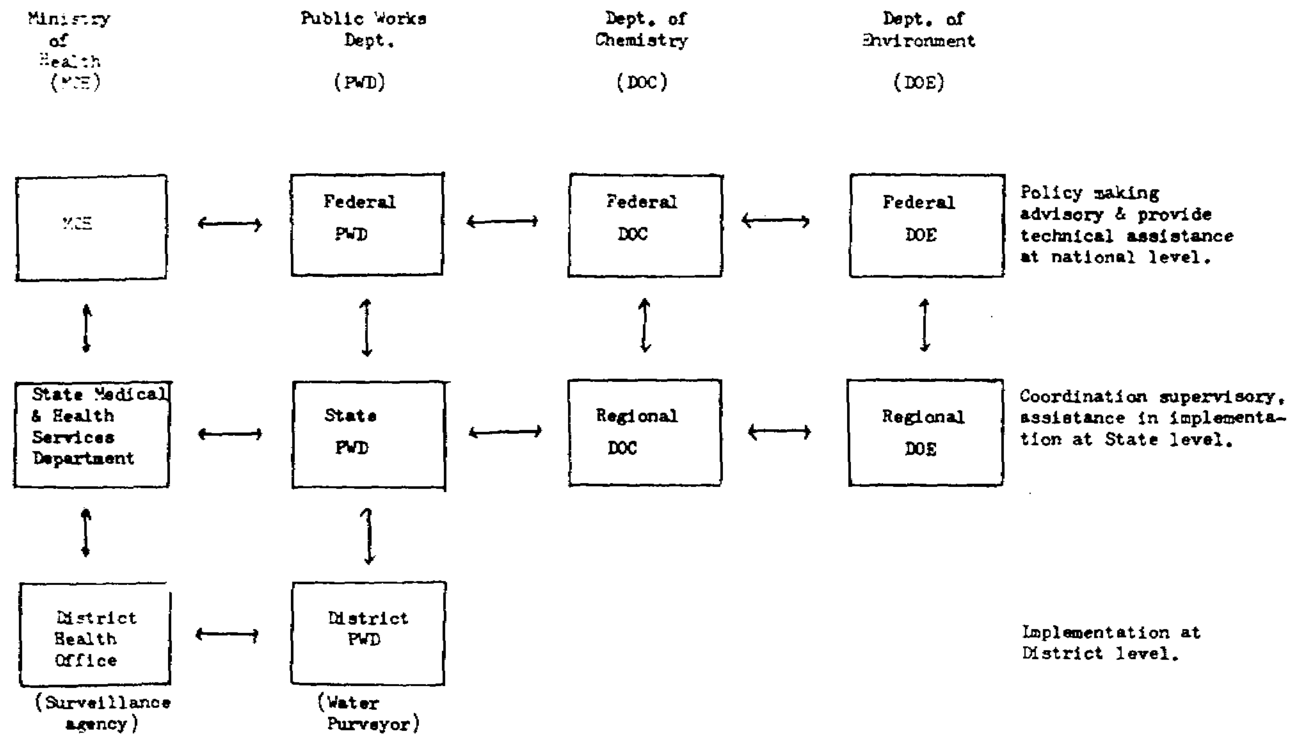
3. DESCRIPTION OF PROGRAMME

In Malaysia, monitoring of drinking water quality has been carried out for the last 50 years. However the high incidence rate of waterborne diseases (about 2600/100,000 population/year) in 1982 prompted the Engineering Services Division, Ministry of Health to review the existing Drinking Water Quality Monitoring Programme.

Several shortcomings were identified and the conclusions drawn were that the existing programme was found to be inadequate in the face of the developments that have taken place in the discipline, as well as the increasing demands on our water sources and water supply systems resulting from increase in urbanisation, industrialisation and agricultural activities which is further compounded by a general lack of centralised sewerage treatment facilities throughout the country.

Figure 1

Inter & intra-agency organisation chart
(Drinking Water Quality Surveillance Programme)



Thus in 1983 a reformalisation of the existing programme was undertaken and, a National Drinking Water Quality Surveillance Programme was established with its primary objective defined as follows :-

" To raise the standard of health of the people by ensuring the safety and acceptability of the drinking water provided by the consumer."

To achieve this objective the key elements of the National *Drinking Water Quality Surveillance Programme* provide a continuous and vigilant public health assessment and overview of drinking water supplies. These key elements are :-

i) monitoring

ii) sanitary surveys

iii) data processing and evaluation

iv) remedial action

v) institutional examination

As mentioned earlier, there is no legislation for the programme and thus the successful implementation of the programme relies on the cooperation of the agencies involved. The activities of the programme are jointly carried out by two or more agencies to ensure the relevant laws and regulations as well as the quality requirements are enforced.

For example, monitoring is jointly carried out by the Health as well as the Waterworks personnel and thus any deficiency in the quality of water can be immediately rectified to conform with the standards as required in the National Guidelines for Drinking Water Quality.

Sanitary surveys are also jointly carried out by the Health, Waterworks and the Department of Environment. The Department of Environment is then able to see the effects of pollution on the entire water supply system from the source to the distribution, and enforce the Environmental Quality Act accordingly to lessen the stress on the treatment plants and thus improve the quality of the water. Sanitary surveys on the treatment plants and distribution will allow all agencies to make recommendations for improvement in the treatment, operation and maintenance of the treatment plants and reticulation systems.

Three documents were also prepared as a guide to Public Health and Waterworks personnel. They are :-

i) the "National Guidelines for Drinking Water Quality" which lays out a set of criteria, standards of quality and requirements of public water supply systems for maximum health protection.

ii) the "National Programme on Drinking Water Quality Surveillance" which is a workplan aimed at accomplishing the objectives set out in the National Guidelines.

iii) the "Manual on Drinking Water Quality Surveillance" which describes the standard procedures and methods in fulfilling the requirements stipulated in the National Guidelines.

A federal inter-agency committee was formed to discuss the three documents for adoption and implementation. Following the adoption of the three documents at the federal level, a national training course was organised to train "trainers" from the relevant federal and state agencies.

3.1 Phase I

As shown in Appendix 4 the first phase of the programme aims at consolidating and reformalisation of all urban public water supply systems. This in effect covers all State owned water supply systems which also serves some rural areas. This first phase was initiated with the implementation of a pilot programme in the State of Negeri Sembilan after which a second pilot programme was launched in the State of Kelantan. Before the launch of each pilot programme, a workshop was conducted to train and to formulate the State Drinking Water Quality Surveillance Programme. This formulation of the State Drinking Water Quality Surveillance Programme was carried out jointly with the cooperation of all relevant district and regional agencies. After the formulation of the State Drinking Water Quality Surveillance Programme, a State meeting was called comprising of representatives from all four relevant agencies including the State Secretariat and the Federal Ministry of Health. The State Drinking Water Quality Surveillance Programme is then officially adopted by the State government after which implementation of the programme begins. This procedure was adopted for the implementation of the programme throughout the country.

3.2 Phase II

Although Phase II of the programme was scheduled to begin by 1986/87 it did not begin until mid 1988. Phase II of the programme was initiated with the implementation of the programme for "Investigation and Upgrading of Water Quality in Estates".

There are 1306 estates in Peninsular Malaysia and 336 estates in East Malaysia each having a land area of more than 100 acres housing in total a population of 447,315. Over the past few years waterborne diseases have been reported in estates due to poor water supply and sanitation.

A survey carried out in 157 estates found that 76% of the estates were using private/individual water supplies provided by the estate management. Although the treatment methods varied depending on the estate management's capability, quality of raw water and costs involved, many of the water samples taken were found to be contaminated with faecal coliform organisms, besides being aesthetically unacceptable.

A set of guidelines was prepared which outlines the background, planning and selection of estates to be monitored and the methodology of investigation and analysis to be employed. A briefing of the guidelines was then given to the State Chief Public Health Inspector who in turn gave a briefing to the relevant district public health workers involved in the programme. As with

Phase I of the programme, a monitoring programme was formulated by the state and district public health personnel in cooperation with the estate management, which in this case is the water purveyor, and the Labour Office which is responsible for enforcing the Workers (Minimum Standards of Housing) Act 1966.

4. CURRENT PRACTICES

4.1 Phase I

Ideally the monitoring programme should cover the whole water supply system, that is the source, the treatment plant and the distribution system. Unfortunately due to the high cost of monitoring, only the minimum required number of representative points are evaluated under the National Drinking Water Quality Surveillance Programme taking into account the following factors:-

i) past experience, the frequency of outbreak of disease or pollution, waterworks efficiency.

ii) existing problems, the availability of manpower, funding and laboratory facilities and also social economic, legal and administrative limitations.

iii) potential area; densely populated areas with poor sanitation, industrial areas with heavy pollution, low pressure areas, dead ends in pipe lines, etc.;

iv) climatic conditions; droughts and flood for example place stress on the waterworks. Therefore the programme should provide for more stringent monitoring during these times. This is also true for wells which are likely to be contaminated by flood waters.

v) population distribution and geography; the population is normally not evenly distributed in a particular geographical area therefore the sampling points should be selected based on population distribution rather than purely geographical.

The sampling points were then sited to be as representative of the water supply system as possible, taking into account the factors mentioned above so that contamination can be isolated.

To obtain the most accurate evaluation of water quality, samples are drawn where possible directly from the mains. Permanent sampling stations with the following features are being installed throughout the country for this purpose :

i) the station must be directly connected to the main, with the shortest possible length of pipe;

ii) the connecting pipe, tap etc. must be made of corrosion and heat resistant material;

iii) the sampling tap should be within an enclosed metal or concrete cabinet which can withstand tampering. The cabinet must be tightly sealed to avoid possible contamination of the water supply through cross connection and, the unit must be self draining;

iv) the entire unit should be located in the street close to the tapped main. It should be accessible at all times.

The frequency of sampling was determined depending on :

i) the population served,

ii) relative importance of parameters concerned,

iii) relative importance of sampling station involved,

iv) complexity of water supply system,

v) past experience.

Estimation of the number of sampling points necessary for a public water supply was calculated as follows :

i) The number of bacteriological samples from a public water supply system required for monthly examination is obtained from the graph in Appendix 5 which depends on the population served by the water supply system.

ii) This number divided by the interval of sampling per month should yield the number of sampling points required.

For uniformity, an assumption was made that all samples are to be examined weekly and therefore the total numnber of sampling points per public water supply system should approximately be one quarter of monthly total samples required.

Appendix 6 shows the frequency of sampling of the various parameters at the respective sampling stations while Appendix 7 shows a schematic of a model urban public water supply system. Appendix 8 gives the list of parameters and the parameter grouping tested for under the National Drinking Water Quality Surveillance Programme.

Under Phase I of the programme, the Department of Chemistry analyses for both bacteriological and chemical parameters while the physical analysis for residual chlorine and pH are done on site using field test kits. The methods for analysis employed by the Department of Chemistry and its regional laboratories are those recommended in "Standard Methods of Examination of Water and Waste Water" by the American Public Health Authorities and American Water Works Association. The Department of Chemistry and its regional laboratories are also responsible for providing proper sampling bottles with the appropriate treatment to the water sampler.

The water sampler is required by the National Drinking Water Quality Surveillance Programme to be a trained Health Inspector, who should be accompanied by a Technician or Technical Assistant from the Waterworks. This would then allow rapid remedial measures to be taken especially in the case where analytical results obtained on site shows non-compliance of the standards.

Under Phase I of the programme, routine sanitary surveys are required to be carried out once a year. However when regular monitoring warrants an investigation, a sanitary survey is carried out as part of the remedial action plan to help in identifying the cause as well as the source of sanitary deficiencies.

Sanitary surveys, as mentioned earlier are to be conducted jointly by health, waterworks and environment personnel. This involves the District Waterworks Engineer, the Regional

Environmental Officer with coordination provided by the State Public Health Engineer, the District Medical Officer of Health and the District Health Inspector who is directly responsible for surveillance of the water supply systems in his district.

Procedures for remedial action, without which would render the monitoring programme futile, is also outlined in the Manual on Drinking Water Quality Surveillance. Different data flow and remedial action mechanisms are employed depending on the nature of data generated from the monitoring and the subsequent health effects it might have on the consumers. Appendices 9 - 13 show the different remedial action response mechanisms that are to be employed.

Data handling involves a three tier system in the case of the Ministry of Health and the Public Works Department, where all data are compiled at the district level and forwarded to the State Office. The State Office then compiles all data from the various districts and forwards a monthly summary report to the Federal level. In the case of Department of Chemistry and the Department of Environment, most of the data are confined only to the regional offices. A yearly report on the National Drinking Water Quality Surveillance Programme is prepared annually by the Federal Ministry of Health and circulated to all the relevant federal agencies concerned.

4.2 Phase II

As outlined in the Manual on Drinking Water Quality Surveillance, every rural or privately operated public water supply system has to be sampled at least once every two years. In the case of villages, the sampling interval will be half yearly. However due to constraints which will be explained in section 6 of the report, Phase II at present is confined only to the programme for Investigation and Upgrading of Water Quality in Estates.

The programme requires each estate water supply system to be monitored over a period of six months at two monthly intervals. Each monitoring or investigation requires sampling and analysis of water samples as well as a sanitary survey to be conducted. From the observations made and from the analytical results obtained after each investigation, a recommendation for upgrading the water supply system, be it intake location, treatment methods or otherwise, is to be given to the estate management.

At the end of the six month investigation, a report is to be compiled by the District Public Health personnel which should include :-

i) basic data on the estate monitored

ii) sample location and analytical results

iii) observations made during the sanitary survey

iv) data analysis

v) recommendations made to the estate management

vi) improvements made by the estate management.

The completed report is then forwarded to the State Medical Health Office and the District Labour Office as well as the Federal Ministry of Health.

Analysis under Phase II of the programme employs field testing equipment for physical, bacteriological as well as chemical analysis. Where necessary, samples are sent to private laboratories accredited by the Department of Chemistry. All costs for analysis are borne by the Estate Management.

5. TRAINING AND DEVELOPMENT OF MANPOWER

Appendix 14 lists the major categories of staff of the various departments. involved in the National Drinking Water Quality Surveillance Programme.

The Enginnering Services Division, Ministry of Health with a unit comprising of a Biochemist, a Microbiologist and a Public Health Engineer is responsible for the nationwide coordination and implementation of the National Drinking Water Quality Surveillance Programme. The State Medical and Health Services Department of which there are thirteen has the responsibility of coordination and implementation of the programme at the state level. This responsibility is undertaken by the Deputy Director for Health who is assisted by his State Public Health Engineer, State Chief Health Inspector as well as a Senior Health Inspector. There are a total of 100 administrative districts, some of which may have two or more health districts. Each administrative district is headed by a District Medical Officer of Health who will have a minimum of one Health Inspector in each health district. Together they are responsible for the formulation and implementation of the programme. Depending on the workload and the extensiveness of the water supply system, the Medical Officer of Health may appoint more than one Health Inspector for the implementation of the programme. In the Federal Territory of Kuala Lumpur and other local authority areas, the Health Inspectors of the City Hall/Local Authority Areas assist in the monitoring as well as the data evaluation and remedial procedures that it entails.

Like any programme, the National Drinking Water Quality Surveillance Programme requires proper training of personnel as one of the prerequisites for its successful implementation. Since most of the existing staff already have the basic qualification and field experience, hence only short, inservice training courses were conducted, first to highlight to them the various aspects of the National Drinking Water Quality Surveillance Programme, and later to keep them abreast of the developments and practices in the discipline.

The training courses that have been conducted since the reformalisation of the National Drinking Water Quality Surveillance Programme in 1983 are as follows :

i) a five day National Training Course on Drinking Water Quality Surveillance was conducted by the Ministry of Health with the assistance of three WHO consultants. The course was aimed at training the relevant staff from the federal and state agencies of the Public Works Department, Department of Chemistry, Department of Environment and the Ministry of Health.

ii) The staff of the State agencies trained at the National Training Course then conducted individual State Training courses jointly with the Ministry of Health staff acting as facilitators for the course. A WHO consultant was also invited to give lectures on selected topics.

iii) A training seminar was conducted to train the Health Inspectors on the use of the Millipore Bacteriological Field Test Kit.

iv) A National Sanitary Survey Training Course was conducted by the Public Works Department and the Ministry of Health to train the relevant federal and state personnel on all aspects of a sanitary survey. The course required the participants to conduct a sanitary survey from the source right to the distribution system of a selected water supply system and to prepare and present a report at the end of the two week course.

v) A one day briefing on data reporting and analysis was conducted by the Ministry of Health staff for public health personnel at the state and district level.

vi) One-day refresher courses were conducted from time to time on the use of field testing equipment as and when requested by the State Medical and Health Services Department.

vii) Four regional training courses are planned for this year to train and refresh the state and district health personnel on the general aspects of the National Drinking Water Quality

Surveillance Programme. Besides the above training courses, other projects have been carried out such as the transfer of technology to the staff of the Ministry of Health for the development of a chemical as well as a bacteriological field test kit. This transfer of technology was carried out with assistance from WHO/PEPAS consultants from the Republic of China.

6. PROBLEMS

Some of the problems encountered in the implementation of the programme are as follows :

i) There is no direct provision to allow the Ministry of Health to enforce the standards of water quality as stipulated in the Guidelines for Drinking Water Quality. This was overcome in part by using the existing legislation as mentioned earlier, and therefore necessitated the close cooperation between the Ministry of Health and the relevant agencies empowered to enforce the Acts.

ii) Insufficient funds and manpower limited the scope of the programme as well as the number of samples and the frequency of monitoring. Nevertheless the programme was designed to be as representative of a water supply system as possible with a view to improving the surveillance when funds and manpower permit. The additional construction of sampling cabinets as required after the reformalisation of the National Drinking Water Quality Surveillance Programme was phased in to lessen the financial burden. The restructuring of Phase II of the programme was also aimed at maximising the limited manpower and funds available.

iii) Inadequate numbers of suitably trained and qualified personnel on certain aspects of surveillance such as sanitary surveys was overcome by conducting suitable courses. However, before such courses could be conducted, initiative had to be taken by the staff of the Unit of Drinking Water Quality Surveillance, Engineering Services Division, Ministry of Health to learn as much as they could through self and on-the-job training.

iv) The Department of Chemistry and its regional laboratories were also found to be inadequate in catering to the analytical needs of the programme in terms of manpower and equipment, thus impairing the efficient surveillance of water quality. To overcome this, the Ministry of Health conducted a study on the shortcomings of the Department of Chemistry and its impact on the programme. A report and working paper was prepared and submitted for the upgrading of the Department of Chemistry to cater to the needs of the National Drinking Water Quality Surveillance Programme. In the meantime, the Ministry of Health purchased the chemical field test kits from the Republic of China with the assistance of WHO/PEPAS and the Millipore bacteriological field test kits for use in analysis of water samples under Phase II of the programme. Where required, water samples were sent for analysis to private laboratories accredited by the Departmnet of Chemistry. Thus the Department of Chemistry and its regional laboratories were only required to analyse water samples for Phase I of the programme.

v) Because of the amount of data generated throughout the country, analytical analysis especially at the federal level was made difficult with the limited manpower. As such a computer programme was formulated using DBase III+ to handle the data. To lessen the amount of paperwork of the health personnel responsible for sampling, preprinted computerised formats were sent out for data entry and compilation.

vi) Many of the treatment plants are being run by insufficiently qualified plant operators and thus proper treatment and remedial measures could not be conducted effectively. This reflects the low priority given by the Water Authorities on water quality since their major concern was the increase in water supply. With the implementation of the National Drinking Water Quality Surveillance Programme however, the importance of water quality has been emphasised and thus proper training is now being conducted routinely on all aspects of water treatment processes for the benefit of the plant operators. Where budgetary constraints permit, technicians are now stationed at treatment plants to supervise the operators on the proper operation and maintenance. Nevertheless many of the treatment plants are still operating under stress because of the high demand for water.

vii) The present trend of waterborne diseases reflects the unsatisfactory performance of the surveillance programme in meeting its objective of providing safe and acceptable drinking water to the consumer. As shown in appendix 1 there is an increasing incidence rate of Infectious Hepatitis and Typhoid Fever in the country. This is due to the fact that the State Drinking Water Quality Coordination Committees are not playing their role effectively. Many of these committees have not met since their formation to review, discuss and solve problems related to the programme. To overcome this problem, the the State Committees are now required to meet at least once a year while the District Committees are required to meet monthly. Directives to this effect have been sent out by the Ministry of Health requiring the Deputy Director for Health of the State Medical and Health Services Department as well as the District Medical Officer of Health of the District Health Office to initiate and provide better coordination for the successful implementation of the programme.

viii) Some of the State governments were not agreeable to approving the adoption of the State Drinking Water Quality Surveillance Programme. To overcome this, working papers were prepared stressing the importance of the programme in meeting the objectives of the national policy. Cases where outbreaks of communicable disease have been directly linked to poor water supply were also highlighted.

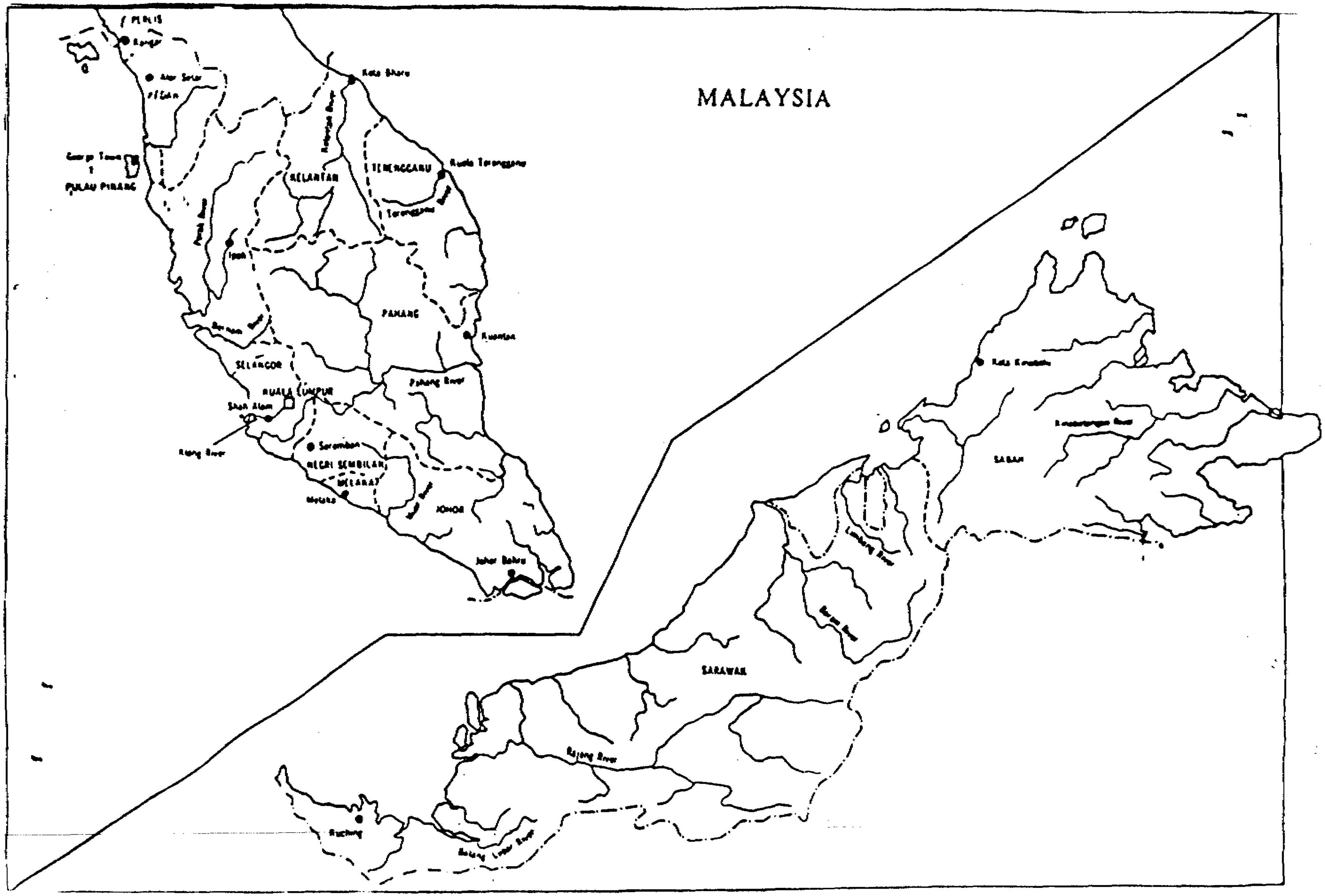
ix) In many instances the Department of Environment is powerless to enforce the Environmental Quality Act thus placing great stress on the treatment plants. This is due to the fact that land is another matter which falls directly under the jurisdiction of the State government. However a seminar, "Pollution of Water Sources" conducted by the Public Works

Department has helped to educate the policy makers of the State government.

7. SUMMARY AND CONCLUSION

The National Drinking Water Quality Surveillance Programme has, since its formulation and implementation achieved great success in sensitizing water purveyors and policy makers on the need to provide safe and wholesome water. The greatest success has been its ability to bring together various departments and agencies related to the povision of drinking water in a cooperative effort without the need to enforce any laws or regulations. With the increase in the water supply network throughout the country, it is anticipated that this National Programme will be expanded and strengthened to be able to continue being an important supportive programme to the National Water Supply Programme. The next few years to come will see the improvement of this programme through the use of modern technology such as computers, better management, information systems and wider coverage of the programme in both urban and rural areas. It is hoped that the experiences gained in Malaysia and the future developments will serve other developing countries and the region towards the aim of providing safe and wholesome water to all people.

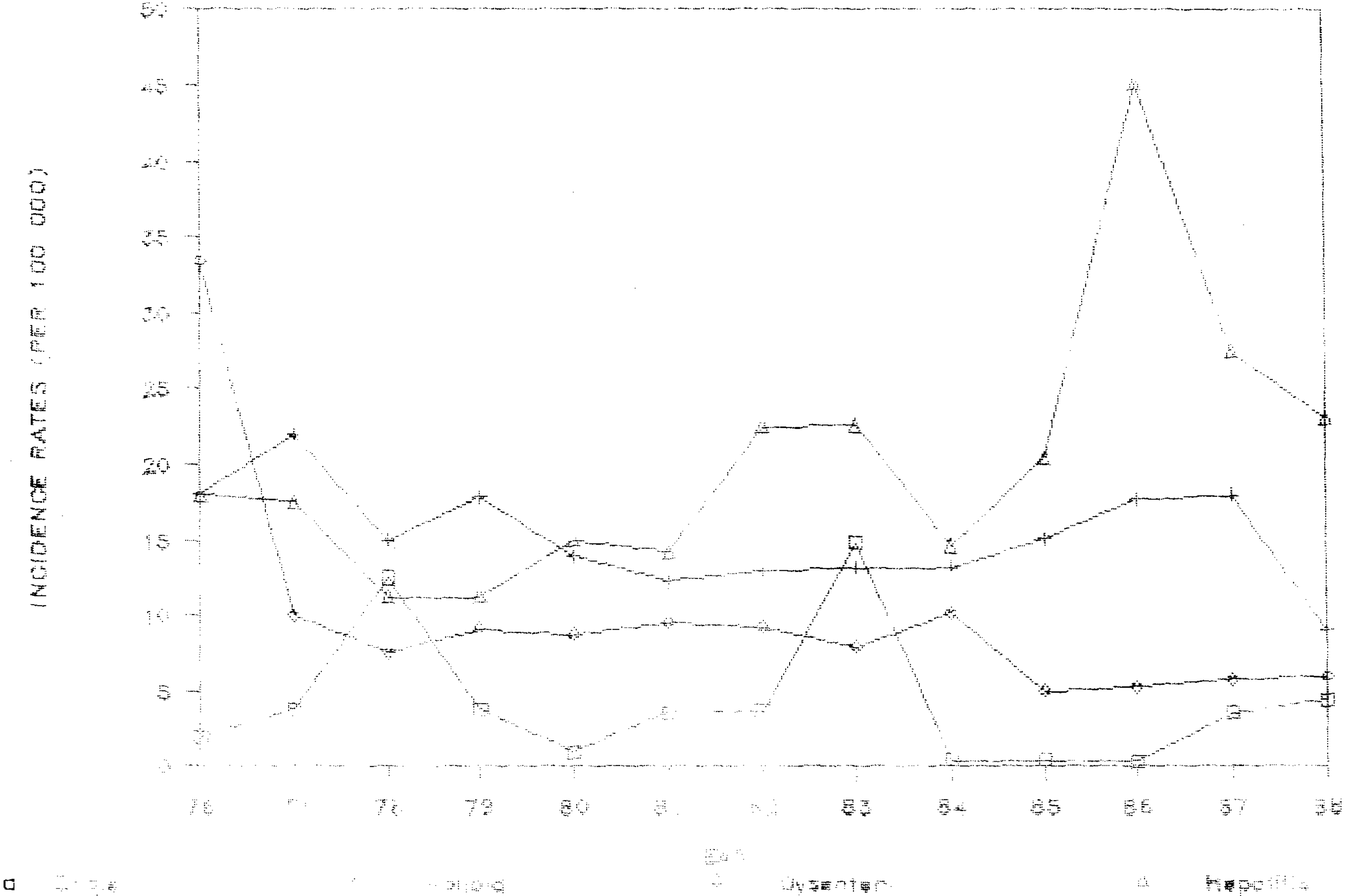
Appendix 1


MALAYSIA
PERLIS
Kangar
Alor Setar
George Town
PULAU PINANG
Kota Bharu
KELANTAN
TERENGGANU
Kuala Terengganu
Ipoh
PAHANG
Kuantan
SELANGOR
KUALA LUMPUR
Shah Alam
Klang River
Pahang River
Seremban
NEGRI SEMBILAN
MELAKA
Melaka
JOHOR
Johor Bahru
Kota Kinabalu
SABAH
Limbang River
SARAWAK
Rajang River
Kuching
Batang Lupar River

Appendix 2

TRENDS OF WATERBORNE DISEASES

MALAYSIA (1976 - 1988)



APPENDIX 3

NUMBER OF CASES AND THE INCIDENCE RATES FOR WATERBORNE COMMUNICABLE DISEASES FOR 1987 AND 1988

1987

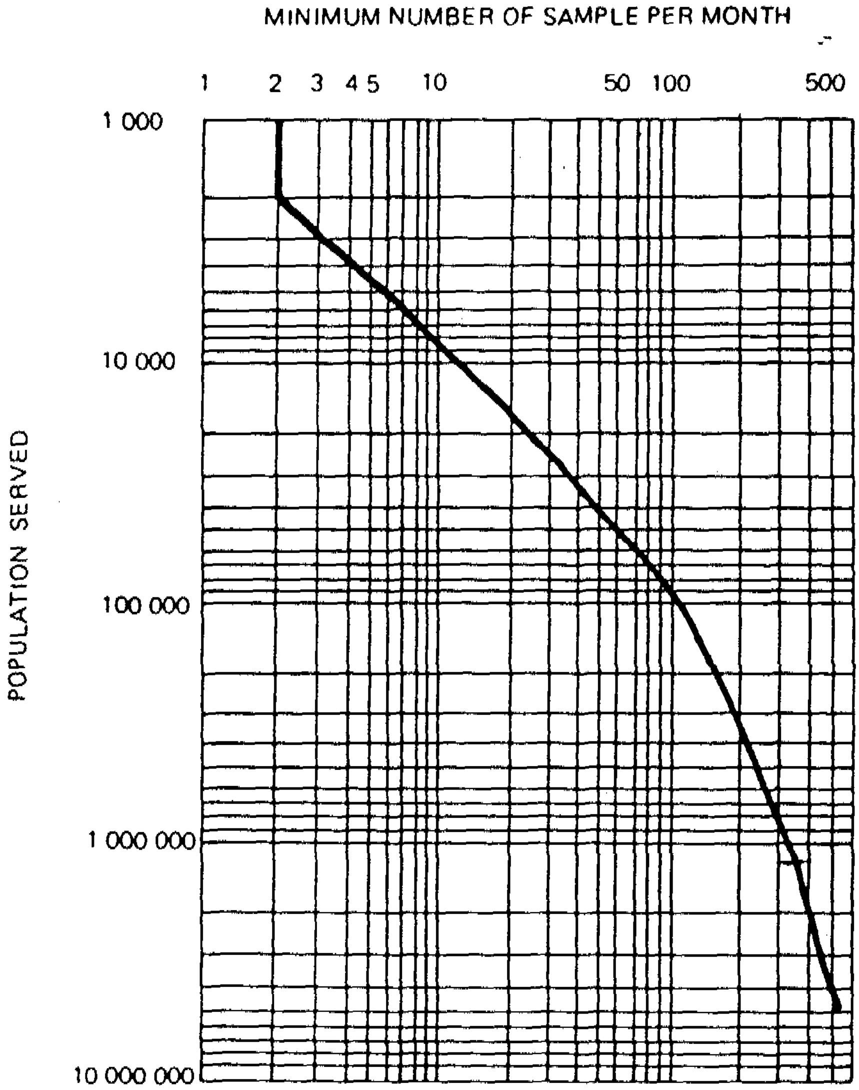
DISEASES / STATE	TYPHOID		DYSENTERY		VIRAL HEPATITIS		CHOLERA	
	NOTIFIED CASES	INC. RATES	NOTIFIED CASES	INC. RATES	NOTIFIED CASES	INC. RATES	NOTIFIED CASES	INC. RATES
Perlis	26	14.80	2	1.13	144	82.00	24	13.66
Kedah	193(4)	14.55	28	2.11	551	41.56	186(3)	14.02
P. Pinang	901(1)	82.88	7	0.64	447	41.11	14	1.28
Perak	260(1)	12.33	128	6.07	526	24.95	7	0.33
Selangor	82	4.47	20	1.09	150	8.19	8	0.43
W. Persekutuan	85	7.34	14	1.20	208	17.96	6	0.51
N. Sembilan	34	5.00	13	1.91	91(1)	13.40	2	0.29
Melaka	11	2.00	4	0.72	72	13.11	-	-
Johor	87(1)	4.42	142	7.23	355(1)	18.07	1	0.05
Pahang	174	17.79	30	3.06	333(1)	34.04	3	0.30
Terengganu	76	11.11	10	1.46	517	75.57	13	2.33
Kelantan	308(1)	27.58	113	10.11	527	47.19	256(1)	22.92
Peninsular Malaysia	2,237(8)	16.38	511	3.74	3,921(3)	28.71	520(4)	3.80
Sabah	319(4)	24.11	291(1)	16.55	444	33.56	49(4)	3.70
Sarawak	406	26.19	153	9.87	164(1)	10.58	15(1)	0.96
MALAYSIA	2,692(12)	17.92	955(1)	5.77	4,529(4)	27.40	584(9)	3.53

1988

DISEASES / STATE	TYPHOID		DYSENTERY		VIRAL HEPATITIS		CHOLERA	
	NOTIFIED CASES	INC. RATES	NOTIFIED CASES	INC. RATES	NOTIFIED CASES	INC. RATES	NOTIFIED CASES	INC. RATES
Perlis	5	2.78	1	0.55	68	37.77	1	0.55
Kedah	144	10.61	47	3.46	383	28.2	26	1.92
P. Pinang	99	8.96	4	0.36	93	8.41	124(1)	11.22
Perak	187	8.69	150	6.97	376	17.47	5	0.23
Selangor	20	1.06	29	1.54	208	11.05	2	0.11
W. Persekutuan	13	1.10	24	2.02	206	17.36	4	0.33
N. Sembilan	4	0.58	8	1.15	18	2.59	-	-
Melaka	4	0.71	1	0.18	26	4.63	-	-
Johor	44	2.19	114	5.67	346	17.1	-	-
Pahang	123	12.21	32	3.18	258(1)	25.61	-	-
Terengganu	63	8.91	21	2.97	399	56.44	-	-
Kelantan	310(1)	26.93	35	3.04	120	10.42	1	0.09
Peninsular Malaysia	1,016(1)	7.26	466	3.33	2,501(1)	17.87	163(1)	1.16
Sabah	118	8.61	211	15.39	1,153	84.11	494(3)	36.03
Sarawak	413	25.95	338	21.2	263	16.53	96(13)	6.03
MALAYSIA	1,547(1)	9.12	1,015	5.99	3,917(1)	23.10	753(17)	4.44

PHASES OF THE PROGRAMME

Phase	Plan	Time
I	Consolidate the existing urban drinking water quality surveillance programme.	by 86
II	Integrate the isolated rural water supply systems and the privately owned public water supply systems into the programme.	by 86/87
III	Gather data on the suitability of surface and ground sources for potable supply.	by 87
IV	Develop a data processing system for on-going water quality surveillance programme.	by 89
V	Review of the whole programme in terms of cost and effectiveness.	by 90



Recommended minimum monthly samples per population served by water supply (bacteriological).

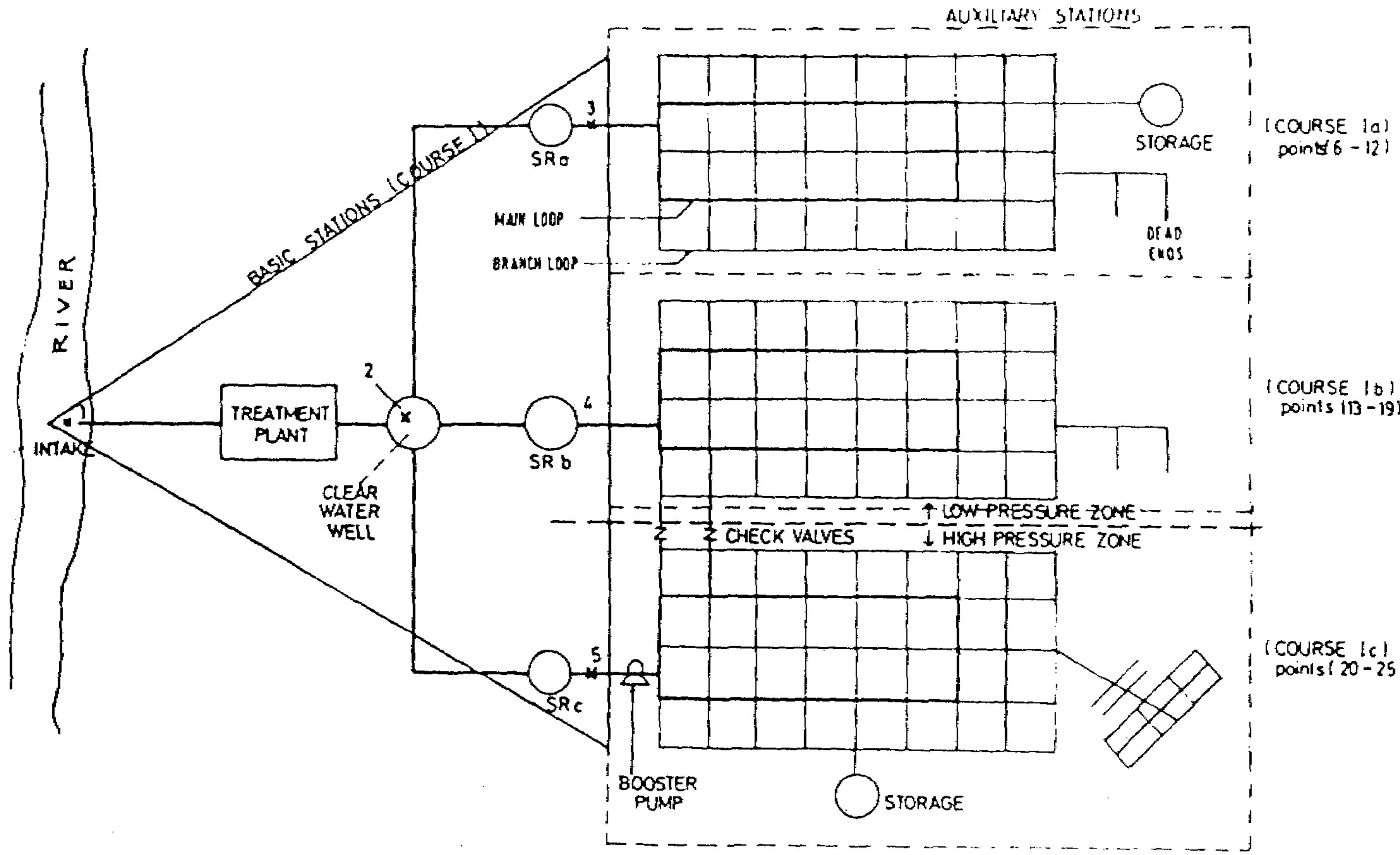
FREQUENCY OF SAMPLING

Stations / Parameters*	Source	Intake	Treatment Plant Outlet	Storage Reservoir Outlet	Distribution System
	001	002	003	004–008	009–025
GROUP I	W/M/2	W/M/2/M	W/M/2	W/M/2	M
GROUP II	M	M	M	M	M/Y/2
GROUP III	Y/2	Y/2	Y/2	Y/2/Y	Y/2/Y
GROUP IV	Y/2	Y	Y	WN	WN

W = weekly D = daily Y = yearly

WN = when necessary M = monthly Y/2 = semi-anually

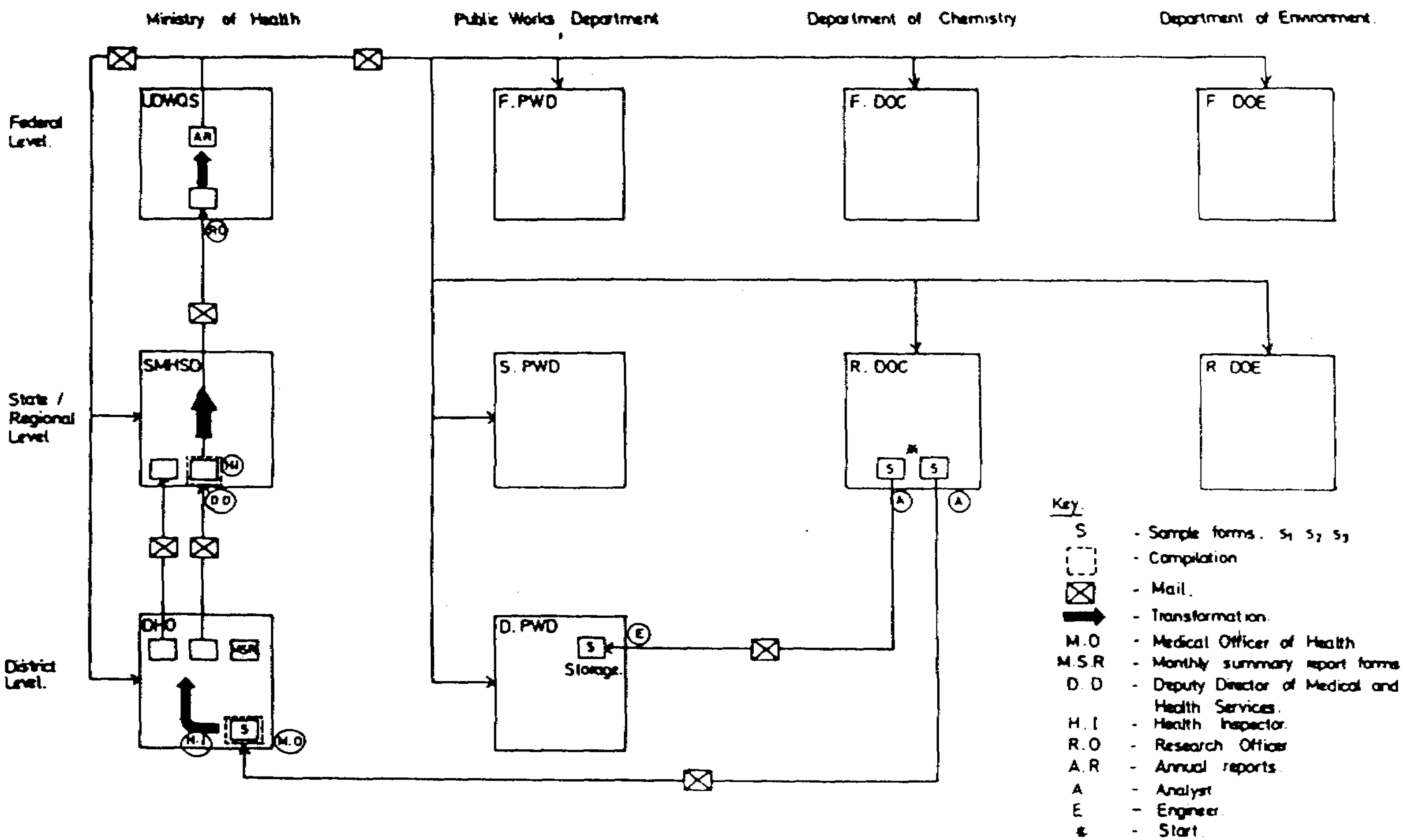
SCHEMATIC OF A MODEL URBAN PUBLIC WATER SUPPLY SYSTEM



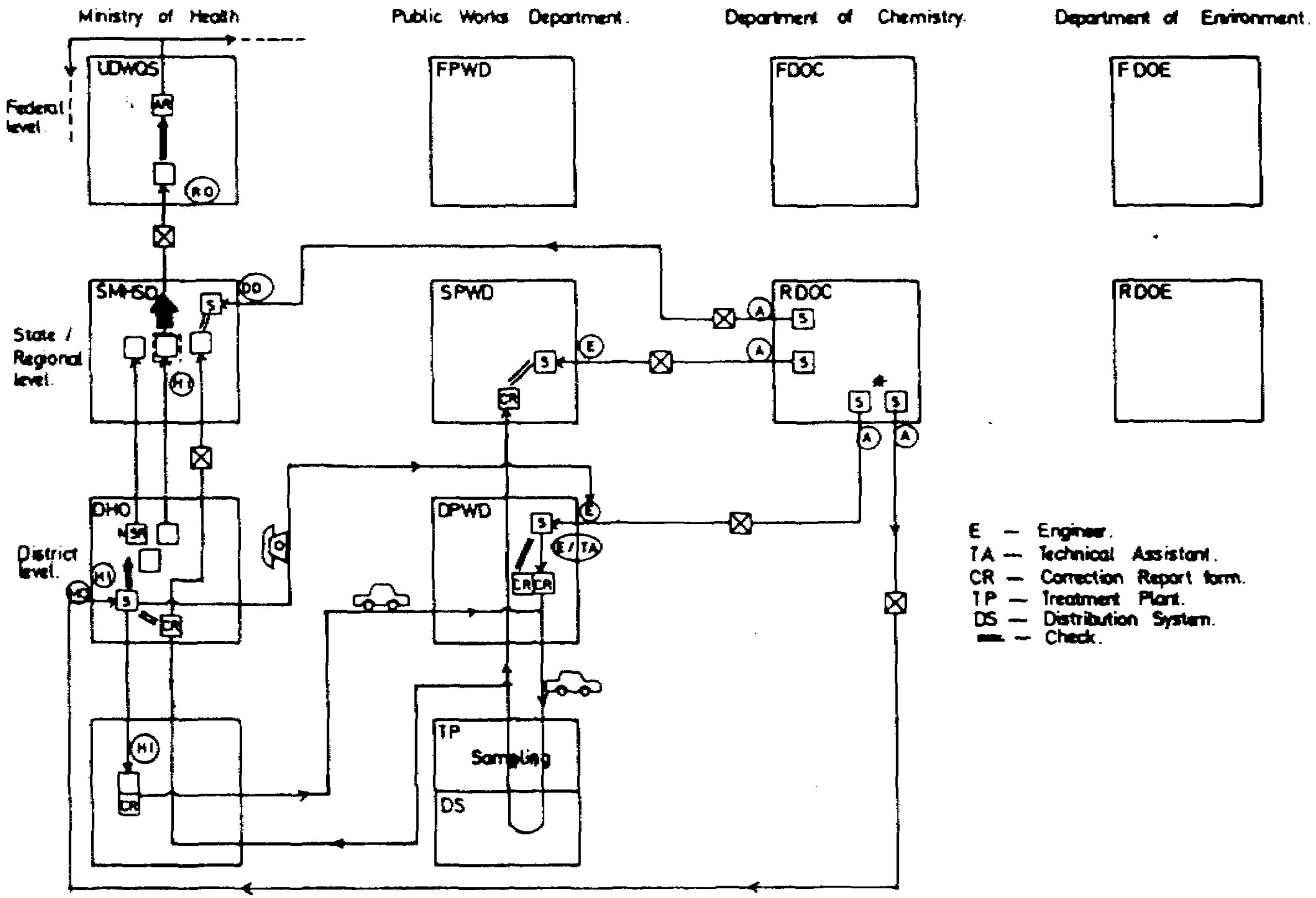
PARAMETERS GROUPING

Parameters	Group I	Group II	Group III	Group IV	Group V
Coliform E. Coli Turbidity Colour pH Residual Cl_2	X				
Total dissolved solids Carbon chloroform extract BOD COD Detergent (MBAS) Ammonia (N) Nitrate (N) Fluoride Iron Manganese Aluminium Alkalinity ($CaCo_3$) Hardness ($CaCo_3$) Chloride		X			
Mercury Cadmium Selenium Arsenic Cyanide Lead Chromium Cr^{6+} Silver Copper Magnesium			X		
Zinc Sodium Sulphate Phosphate Hydrogen sulphide Oil Phenol Chloroform			X		
Biocide				X	
Radionucleides					X

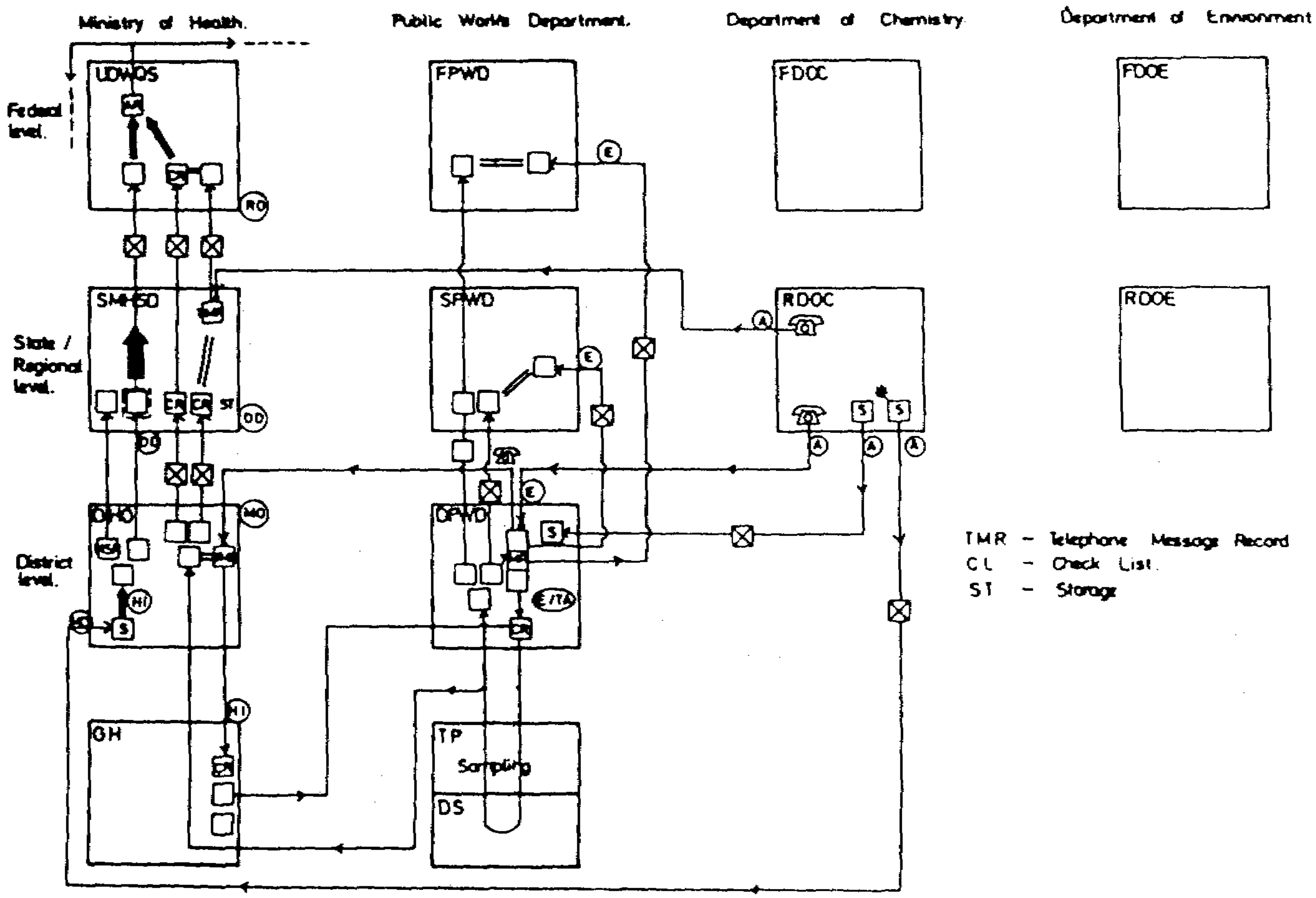
NON - VIOLATION REPORT —— DATA FLOW.



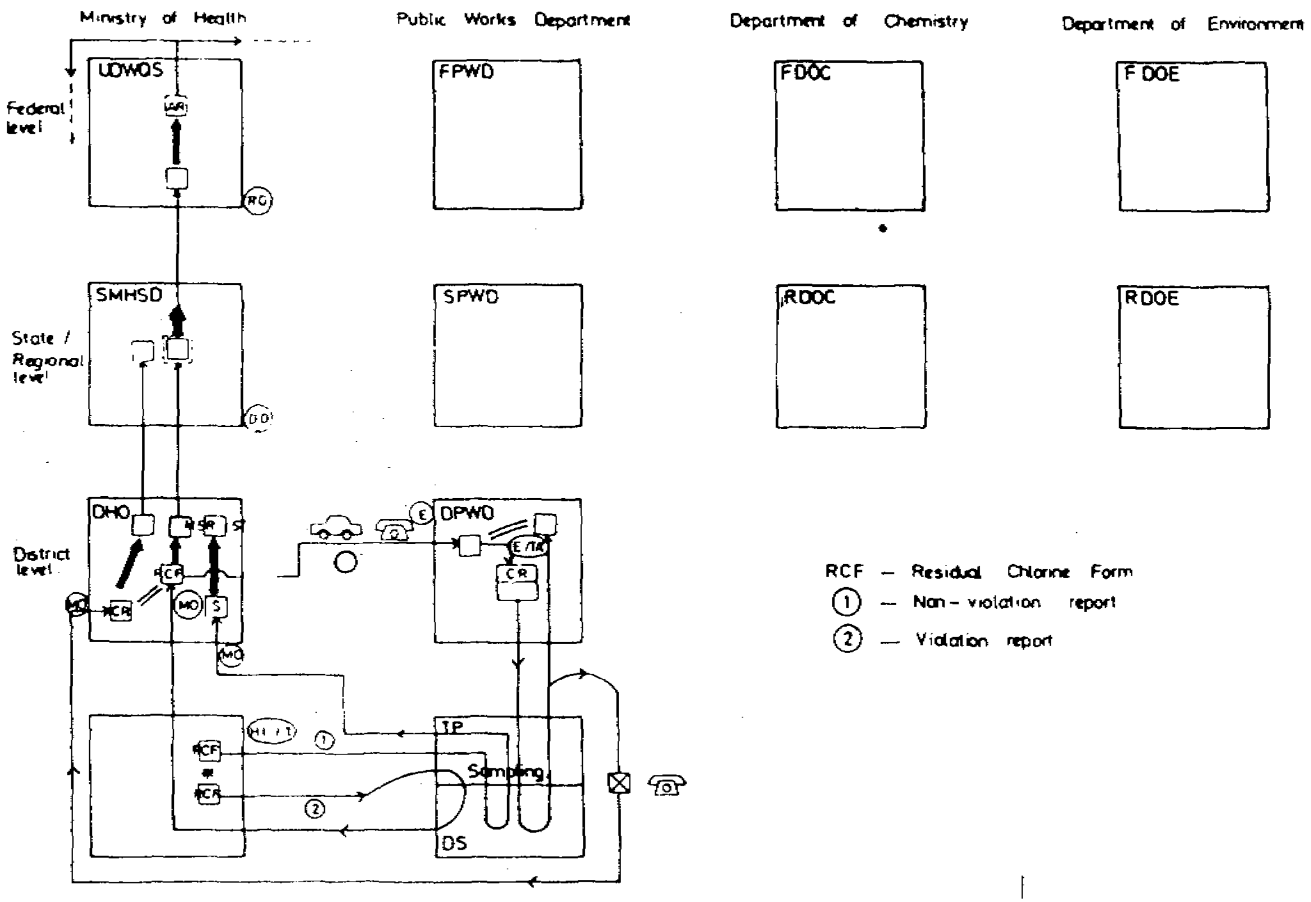
VIOLATION REPORT DATA FLOW. (Exceeding recommended levels and mandatory levels but not including those parameters described under health investigation levels.)



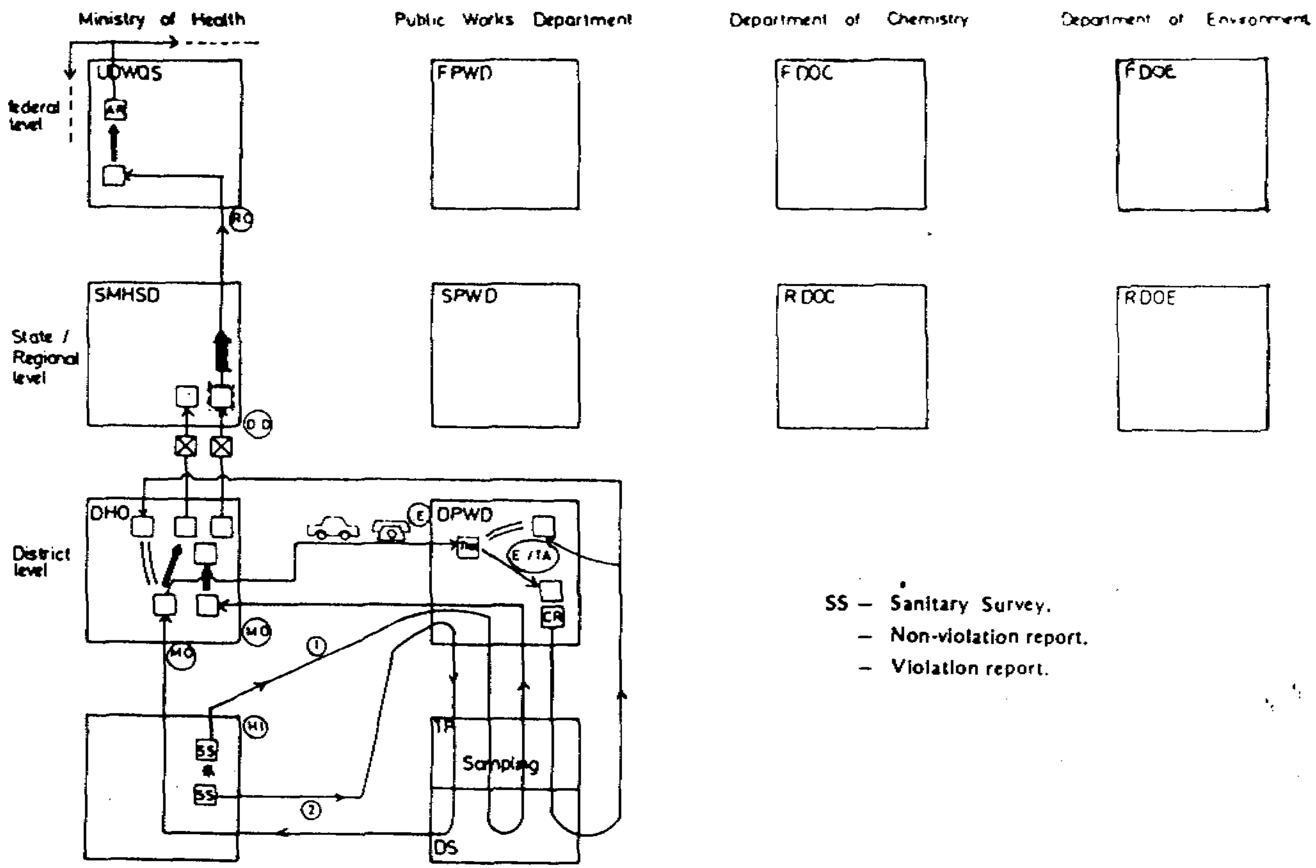
VIOLATION REPORT DATA FLOW. (Exceeding Health Investigation levels)



RESIDUAL CHLORINE DETECTION MECHANISM



DETECTION MECHANISM THROUGH SANITARY SURVEY



MAIN CATEGORIES OF STAFF OF THE
VARIOUS DEPARTMENTS INVOLVED
IN THE PROGRAMME

Department	Category of Staff
Unit of Drinking Water Quality Surveillance, Ministry of Health.	Biochemist Microbiologist Public Health Engineer
State Medical and Health Services Department.	Deputy Director of Health and Medical Services State Public Health Engineer Chief Health Inspector Senior Health Inspector (sanitation).
District Health Office	Medical Officer of Health Health Inspector
Public Works Department at Federal, State and District level.	Engineer Technical Assistant Technician
Department of Chemistry, Federal and Regional level	Chemist Biologist Laboratory technician
Department of Environment	Environmental Officer Assistant Environmental Officer

WORLD HEALTH ORGANIZATION

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REGION DU PACIFIQUE OCCIDENTAL

REGIONAL CENTRE FOR THE PROMOTION OF
ENVIRONMENTAL PLANNING AND APPLIED STUDIES (PEPAS)

REGIONAL WORKSHOP ON DRINKING WATER QUALITY MONITORING AND SURVEILLANCE

ICP/RUD/001 PROG/112/CR-006

Kuala Lumpur, Malaysia
27 February - 3 March 1989

ENGLISH ONLY

COUNTRY REPORT

MICRONESIA

by

Mr Jose Xavier

FEDERATED STATES OF MICRONESIA

COUNTRY REPORT

REGIONAL WORKSHOP ON DRINKING-WATER QUALITY MONITORING AND SURVEILLANCE

PEPAS, KUALA LUMPUR, MALAYSIA

27 FEBRUARY - 3 MARCH, 1989

I. Country Profile

A. Geography and Population

The Federated States of Micronesia (hereinafter referred to as the FSM) is an island nation comprised of 607 islands that are spread across more than 1 million square miles (2.59 square kilometers) of the Western Pacific Ocean within an east-west chain of islands known collectively as the Caroline archipelago. While the FSM is large in size, the total land area is small, 270 square miles (699 square kilometers) with an additional 2,776 square miles (7,190 square kilometers) of lagoons. The 607 islands vary from large, high mountainous islands of volcanic origin to small coral atolls. Approximately 65 of these islands are inhabited. The climate is tropical, with temperatures ranging from the low 70's to the low 90's, mean humidity is 80%, and the average annual rainfall is 162 inches (4,115 mm.).

The FSM is composed of four island states which extend from the Western Carolines to the Eastern Carolines. These states are Yap, Truk, Kosrae, and Pohnpei on which the national capital is located.

Each state is comprised of a state center, intermediate areas and with the exception of Kosrae, outer islands. The state center is generally the largest of the islands and is the center of commerce and government. Approximately 32% of the FSM population in 1988 is projected to live in the state centers.

TABLE 1
Geography of the FSM

State	Land Area Sq. Miles (% of Total)	Number of Islands Number (% of Total)	Rainfall (Inches)
Yap	46 (17%)	149 (24%)	125"
Truk	49 (18%)	290 (48%)	142"
Pohnpei	133 (49%)	163 (27%)	190"
Kosrae	42 (16%)	5 (1%)	190"
Total	270 sq. mi.	607	

TABLE 2
Population of the FSM

State	Est. Population in 1988	% of FSM Total	% in State Center	% in Intermediate/ Outer Islands
Yap	10,344	10%	23%	77%
Truk	51,098	51%	31%	69%
Pohnpei	31,750	32%	37%	63%
Kosrae	7,048	7%	34%	66%
Total	100,240			

B. Morbidity and Mortality from Waterborne Diseases
From October 1987 to October 1988, morbidity from waterborne diseases ranked second of all infectious reportable diseases (exceeded only by influenza).

TABLE 3
Morbidity From Waterborne Diseases (October 1987-October 1988)

State	Amebiasis	Diarrhea	Gastroenteritis	Hepatitis A/ Unspecified	Total Number (% of Pop)
Yap	55	0	913	70	1038 (10%)
Truk	918	677	474	5	2074 (4%)
Pohnpei	257	1134	185	93	1669 (5%)
Kosrae	6	773	94	35	908 (13%)
Total	1236	2584	1666	203	5689

Mortality figures for the same period of time show 13 deaths listed as having gastro-intestinal infections as the underlying cause of death; 1 death with an associated cause from gastro-intestinal infection, and 3 deaths from hepatitis, in the FSM. Throughout the FSM, reports of deaths are very much underreported, especially deaths of young infants and older people who are the most susceptible to these kinds of infections.

II. National Policy and Programme of Drinking-Water Quality Monitoring and Surveillance

A. Policy and Provisions

The FSM Public Water Supply Systems Regulations were amended in 1983. These regulations were developed to comply with the U.S. Environmental Protection Agency's Safe Drinking Water Act, to allow the FSM to receive U.S. EPA funds to administer the drinking water program. The purpose of these regulations is "to establish certain minimum standards and requirements as determined by the FSM Department of Human Resources to be necessary for the public health and safety to insure that public water supply systems are protected against contamination and pollution and do not constitute a health hazard."

These regulations also state "It is the responsibility of the supplier of water to assure a quality of water supply that equals or surpasses drinking water quality standards of the FSM."

The FSM National Department of Human Resources is responsible for administering and enforcing these regulations, and receives assistance from the State Environmental Health Offices.

B. National Drinking Water Quality Standards

1. Maximum Contaminant Levels for Coliform Bacteria

a. Membrane Filter Technique

The number of coliform bacteria shall not exceed any of the following:

(1) One per 100 milliliters as the arithmetic mean of all samples examined per month.
(2) Four per 100 milliliters in more than 5% of the samples when 20 or more are examined per month.

b. Fermentation Tube Method

When 10 milliliter standard portions are used, coliform bacteria shall not be present in any of the following:

(1) More than 10% of the portions in any month;
(2) Five portions in more than one sample when less than 5 samples are examined per month; or
(3) Five portions in more than 20% of the samples when five or more samples are examined per month.

When 100 milliliter standard portions are used, coliform bacteria shall not be present in any of the following:

(1) More than 60% of the portions in any month;
(2) Five portions in more than 1 sample when less than 5 samples are examined per montn; or
(3) Five portions in more than 20% of the samples when 5 or more samples are examined per month.

2. Maximum Contaminant Level for Turbidity

The maximum contaminant levels for turbidity in drinking water, measured at a representative entry point(s) to the distribution system, are:

a. One Turbidity Unit, except that 5 or fewer turbidity units may be allowed if the supplier of water can demonstrate that the higher turbidity does not do any of the following:
   (1) Interfere with disinfection;
   (2) Prevent maintenance of an effective disinfectant agent throughout the distribution system; or
   (3) Interfere with microbiological determinations.

b. Five turbidity units based on an average of 2 consecutive days.

3. Maximum Contaminant Levels for Inorganic Chemicals

Contaminant	Levels (mg/l)
Arsenic	0.05
Barium	1.0
Cadmium	0.010
Chromium	0.05
Lead	0.05
Mercury	0.002
Nitrate (as N)	10.0
Selenium	0.01
Silver	0.05
Fluoride	1.4

The following chemical substances will not be present in a drinking water supply in excess of the listed concentrations, where more suitable supplies are or can be made available:

Substance	Concentration (mg/l)
Chloride (as Cl)	400
Calcium (as Ca)	200
Total Hardness	400 mg/l as $CaCO_3$

4. Physical Standards

a. Color will preferably not exceed 5 units and in no case exceed 50 units.

b. Taste will not be objectionable.

c. Threshold odor number will not exceed 3.

5. Maximum Contaminant Levels for Organic Chemicals

Chemical	Level (mg/l)
Endrin	0.0002
Lindane	0.004
Methoxychlor	0.1
Toxaphene	0.005
2,4-D	0.1
2,4,5-TP Silvex	0.01

6. Maximum Contaminant Levels for Radium-226, Radium-228, and Gross Alpha Particle Radioactivity

a. Combined radium-226 and radium-228 = 5 pCi/l.

b. Gross alpha particle activity (including radium-226, but excluding radon and uranium) = 15 pCi/l.

7. Maximum Contaminant Levels for Beta Particle and Photon Radioactivity from Man-Made Radionuclides

a. The average annual concentration of beta particle and photon radioactivity from man-made radionuclides in drinking water shall not produce an annual dose equivalent to the total body or any internal organ greater than 4 millirem/year.

b. Except for the radionuclides listed in Table A, the concentration of man-made radionuclides causing 4 mrm total body or organ dose equivalent shall be calculated on the basis of a 2 liter per day drinking water intake using the 168 hour data listed in "Maximum Permissible Body Burdens and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure", NBS Handbook 69, as amended August, 1963, U.S. Department of Commerce. If two or more radionuclides are present, the sum of their annual dose equivalent to the total body or to any organ shall not exceed 4 millirem/year.

Table A - Average Annual Concentrations Assumed to Produce a Total Body or Organ Dose of 4 mrem/year

Radionuclide	Critical Organ	pCi: Per liter
Tritium	Total Body	20,000.0
Strontium-90	Bone Marrow	8.0

III. Implementation of Drinking-Water Quality Monitoring and Legal Enforcement

While the supplier of water is responsible for assuring the quality of the water supply, because the State Environmental Health Offices have more laboratory capabilities, the Environmental Health staff perform the routine monitoring of the public water supply systems, and notify the supplier of the test results, along with recommendations for correction if necessary.

If monitoring results indicate a regulatory violation, the public water supply system is notified of the violation and ordered to implement the necessary corrective measures. The public is also informed of the result and provided with the necessary information to make their water safe to drink or of where alternate water supplies are available.

All monitoring results are reported to the FSM Department of Human Resources on a quarterly basis.

IV. Current Practices of Drinking-Water Quality Monitoring and Sanitary Surveys

A. Monitoring Frequency

1. Coliform Analysis
According to the regulations, the supplier of water shall take coliform samples at regular time intervals, and in proportion to the population served, as follows:

Population Served	Minimum Number of Samples Per Month
25 to 1,000	1
1,001 to 2,500	2
2,501 to 3,300	3
3,301 to 4,100	4
4,101 to 4,900	5
4,901 to 5,800	6
5,801 to 6,700	7
6,701 to 7,600	8
7,601 to 8,500	9
8,501 to 9,400	10
9,401 to 10,300	11
Over 10,301	In Accordance with FSM Regulations

2. Turbidity
Turbidity samples are to be measured at least once a day, at the entry point of the water distribution system.

3. Inorganic Chemicals and Physical Standards
After initial testing, systems using surface water sources are required to analyze for inorganic chemicals and physical standards every year. Systems using ground water sources must perform the analyses every 3 years.

4. Organic Chemicals
   Analyzing for organic chemicals, after initial testing, is to be done at least every 3 years for systems using surface water sources. Systems using ground water sources are to repeat the testing at intervals specified by the FSM Department of Human Resources.

5. Radionuclides
   Radionuclide testing is to be repeated every 4 years.

B. Monitoring Techniques and Procedures
All testing is done according to the American Public Health Association's "Standard Methods for the Examination of Water and Wastewater". Bacterial testing is done using the membrane filtration technique. Turbidity testing is done with a turbidimeter. Chemical and radionuclide testing is done by private commercial laboratories in the U.S.

C. Sanitary Surveys
Sanitary surveys are carried out annually by the State Environmental Health staff, using forms developed by the FSM, and in compliance with U.S. EPA requirements. The results of these surveys are discussed with the entity in charge of the particular water system, in order that the appropriate treatment and/or protection measures can be implemented.

V. Training and Manpower Development
Each state employs one Environmental Health staff to administer the safe drinking water program, and one or two staff to perform the water analyses. These individuals have participated in both national training workshops, on-site trainings, and short-term WHO fellowships for off-island training. These training activities involve both survey and analytical techniques and interpretation of results.

VI. Monitoring and Surveillance Problems and Corrective Measures
Efforts are continuing to have the water system operators become more involved in the monitoring activities, in order that they will be more able to utilize the analysis results to adjust the treatment of the water. Training of the water system operators is also a need, to increase their understanding and capabilities in producing drinking water of potable quality.

In the area of water analysis techniques, steps are being taken to include confirmation tests of the membrane filter results, and to introduce alternate techniques in waters of high background, non-coliform, counts.

VII. Summary and Conclusions
The State Environmental Health Offices adequately monitor the quality of the major public water supply systems in the FSM. Continuing efforts need to be made to involve the system operators more closely in these efforts, so the treatment of the water can be appropriately adjusted.

Public education efforts need to be continued to make the public aware of the role of water in infectious diseases, and means to protect their health through water disinfection and protection of water supply sources.

WORLD HEALTH ORGANIZATION

WESTERN PACIFIC REGION

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REGIONAL CENTRE FOR THE PROMOTION OF
ENVIRONMENTAL PLANNING AND APPLIED STUDIES (PEPAS)

REGIONAL WORKSHOP ON DRINKING WATER QUALITY MONITORING AND SURVEILLANCE

ICP/RUD/001 PROG/112/CR-007

Kuala Lumpur, Malaysia
27 February - 3 March 1989

ENGLISH ONLY

COUNTRY REPORT

PALAU

by

Mr Lucio Abraham

Republic of Palau
Environmental Quality Protection Board
P.O. BOX 100
KOROR, REPUBLIC OF PALAU 96940
TEL NO. 1639 TLX NO. 8901

WHO COUNTRY REPORT
REGIONAL WORKSHOP IN DRINKING-WATER QUALITY MONITORING AND SURVEILLANCE
27 FEBRUARY - 3 MARCH, 1989

Mr. Lucio Abraham - Republic of Palau

1. The Republic of Palau is comprised of more than 200 islands. It lies between 2 degrees and 8 degrees north latitude and 131 degrees and 135 degrees east longitude. The islands encompass 170.4 square miles of land. There are four types of geological formation: volcanic; high limestone; low platform; and coral atoll.

   Only 9 islands are inhabited. Total population is 13,772 base on census carried out in March 1986. The annual population growth rate is 0.6 percent since 1973.

   Monthly morbidity reports (copy in attached) of the Bureau of Health Services, National Health Center, shows gastroenteritises cases as high as 758 in 1986 and 292 cases of Hepatitis type A in the same year. This was 5.5% and 2.1% respectively of the total population. Poor quality of water is believed to be one of the contributing causes of diseases mentioned.

2. Republic of Palau has recognized the following problems and issues which prevent the delivery of adequate quantity and quality of safe drinking water to the communities.

   1. Additional Sources of Water
   2. Excessive Demand for Water from Small Population
   3. Shortage of Qualified Personnel
   4. Inadequate Water Treatment
   5. Inadequacy of Public Water System in Rural Areas.
   6. Inadequate Operational Budget

   With this understanding, the National Government has developed the following objectives to be pursued in a Five Year Plan:

   1. To provide a reliable and dependable potable water system to the capital center of Koror on a continuous 24 hour basis.

   2. To provide reliable and dependable potable water systems to all the outlying states (rural areas) of the Republic of Palau.

3. To provide for necessary expansion and upgrading of each of the public water systems through proper planning and design, construction and maintenance programs.

To achieve the above objectives, the following policies and strategies will be applied:

1. Provide a adequate budget to meet the operations and maintenance requirements of the Republic's public water systems;

2. Upgrade the capital center of Koror public water system by implementing pending system modification;

3. Implement the Rural Water System project for which US$ 3.7 million is available;

4. To protect the health of citizens and prevent the possibility of waterborne diseases, appropriate water quality standards for water supply will be determined and applied in the operations, maintenance and development of public water systems;

5. Through a training programs, establish a pool of trained citizens to manage and handle the day to day operations and maintenance of the public water systems; and

6. Within the Plan period, water sources of good quality and of sufficient quantity will be identified and tapped for expansion of the public water systems.

3. Palau National Code (PNC), Title 24, Chapter 1, Subchapter II, section 129(a) stated that, "The Board shall promulgate and enforce primary drinking water regulations." This was enacted in 25 May 1983. The Board is Palau Environmental Quality Protection Board (EQPB). By the authority vested in the Board a <u>Public Water Supply Systems Regulations</u> is in the process of adoption. Currently a Trust Territory Environmental Protection Board's (TTEPB) regulations with similar context is enforce in Palau. Part IV of these regulations set Drinking Water Quality Standards and mandated the supplier of water to assure a quality of water supply that equals or exceeds drinking water quality standards. Within the same regulations a sampling requirements are prescribed. Generally it specifies frequency for routine monitoring, routine sampling points and check sampling.

frequency for routine monitoring, routine sampling points and check sampling.
Environmental Quality Protection Board, as a regulatory agency which responsible for the promulgation and enforcement of safe drinking water regulations, has ever since its creation in mid 1970 supported and operated a water analysis laboratory. The laboratory is equipped to do chlorine residual, turbidity, pH, total and fecal coliform analysis.

4. Same laws and regulations (24 PNC and Public Water Supply Systems Regulations) requires that supplier of water is responsible to monitor the quality of the water produced. At the same time EQPB does water analysis to assure the compliance with the drinking water quality standards. However, presently no facility has the capability to do their own analysis so EQPB is responsible for water quality monitoring.

In the event of non-compliance to the standards, a supplier shall report to EQPB within 48 hours and public notification through public notice media within 2 days. At such time consumers are usually instructed through public media to boil their drinking water. Disinfection of drinking water with household bleaching agent such as clorox or purex are recommended under emergency conditions.

Chlorine residual readings in distribution lines are taken daily except week-ends and holidays. A Hach chlorine residual test kit is used. Total coliform analysis of water using membrane filter method is used to determine bacterial contamination of drinking water. Samples are collected at different locations twice a month. In the event that coliform counts exceed the standard, public notification is put out and daily water sampling and analysis is pursued until the quality of the water is brought within the standard. Turbidity of the water is measured with Nephelometric Turbidity Units (NTU) at same day that total coliform testing is performed. Temperature and pH are also measured at the same time.

Other tests such as organic and inorganic chemicals are referred to more fully equipped laboratory overseas such as University of Guam, University of South Pacific in Fiji and U.S. Mainland. Samples are collected, packed and air mail by the staff of EQPB. Upgrading of the EQPB Laboratory capability to include simple inorganic analysis is anticipated by June, 1989.

Sanitary survey of all public water systems is carried out annually. A form called "Public Water System Inspection Form" is used in this activity. This survey is conducted by the staff of EQPB, who actually visit the site. Necessary inquiries for data collection are directed to state official who is responsible for the operation and maintenance of state water systems.

Another survey form is used for rain catchment tanks. This is a two page form which gather necessary data on catchment area (roof) and storage (tank). After these survey have been conducted, a written report is prepared on the findings. Recommendations are included in the report and addressed to the state whose water system was surveyed.

5. EQPB is anticipating the training and certification of supervisor of each water system. A proposed Public Water Supply System Regulations, Part V, (5.1) stated that EQPB will establish a training program which will lead to certification of water system operation. The timetable for such a program is, however, still uncertain at this time. Beside training routine monitoring, record keeping and reporting are specified in the same regulations.

   EQPB staff who run the water monitoring and surveillance had been trained overseas in East-West Center at the University of Hawaii, Guam Environmental Protection Agency (GEPA) and Division of Environmental Quality in Commonwealth of Northern Mariana Islands. Continued laboratory training in regards to monitoring and surveillance of water quality is anticipated next year with GEPA. These are two(2) EQPB staff who attend these water laboratory analysis training and who are assigned to monitor the quality of the water.

6. Problems faced in drinking-water quality monitoring and surveillance are:

   1. Lack of capabilities of each state to do self monitoring and surveillance of the quality of water produced. This is a common problem throughout rural areas of Palau. EQPB had been doing water analysis of the rural water systems and presently developing a monitoring strategies which will be undertaken in the near future. The strategy determine frequency of water sampling of rural water systems. Through this regular water sampling and analyzing, quality of water could be ascertain. Self monitoring and surveillance will be attained with state development of trained laboratory technicians.

2. Transportation, particularly by boat from Koror to outer states is sometimes interrupted due to mechanical difficulties to the office boat. This is usually a temporary setback. However, water sampling during the past year was severely hindered by the lack of the boat. These maintenance problems seem to have been corrected and no serious extended problems are now anticipated.

3. There are two laboratory technicians who do water quality monitoring and surveillance. EQPB is at present seeking necessary funding to recruit one more laboratory technician to ease to ease the workload.

7. Republic of Palau understands the inadequacies in provisions of adequate quality and quantity of drinking water to its community. For this there are policies, objectives and strategies being prescribed in a Five Year Plan. This plan has not been totally implemented due to unsettled political relationship of Republic of Palau and the United States of America under a Compact of Free Association which will give Palau necessary financial aid.

Palau Environmental Quality Protection Board (PEQPB), a National Government Agency, is running a water analysis laboratory which monitors the quality of drinking water. The same agency is also responsible for the protection of the environment: air, land and water. There are regulations being adopted and under process of adoption for the above purposes by PEQPB. Achievement of the Decade is also the goal of PEQPB and the Republic of Palau, but to meet the target year of 1990 is almost impossible due to financial constraints of the Nation. Again, U.S. financial aid through Compact of Free Association is anticipated as sources of necessary funding to alleviate the inadequacies of public water supply systems in the entire Nation. This will also provide necessary resources due required monitoring and surveillance of quality of drinking water.

Table M

[illegible]ES OF NOTIFIABLE DISEASES
Republic of Palau
1931-1987

DISEASE	Percentage	7-Year Total	1981	1982	1983	1984	1985	1986	1987*
Amoebiasis	.01	1							1
Influenza	41.30	3,7[illegible]	670	[illegible]3	[illegible]	231	[illegible]7	795	427
Gonorrhea	15.96	1,466	[illegible]3	184	[illegible]7	[illegible]2	3[illegible]1	178	131
Gastroenteritis	22.73	2,087	155	295	97	131	246	758	345
Hepatitis Type A	6.96	639	3	1	-	5	293	293	44
Hepatitis Type B	.02	2							2
Hepatitis unspec.	.02	2							2
Chickenpox	3.61	332	51	[illegible]5	27	[illegible]6	55	[illegible]3	40
Conjunctivitis	7.53	[illegible]92	692	-	-	-	-	-	
T.B. Pulmonary	1.09	100	5	[illegible]	9	19	[illegible]6	14	32
[illegible]	.[illegible]	[illegible]	5	[illegible]	[illegible]	4	1	-	3
Hansen's Disease (Leprosy)	.18	17	3	2	5	2	1	1	3
[illegible]s	.[illegible]3	[illegible]2	2	1	3	4	1	1	
[illegible], Other [illegible]	.12	11	4	2	-	-	1	3	1
[illegible]	.[illegible]1	1	1	-	-	-	-	-	
[illegible]									
([illegible])	.[illegible]1	1	-	1	-	-	-	-	
Measles	.01	1	-	-	-	1	-	-	
TOTAL	99.[illegible]5	9,183	1,694	1,[illegible]8	1,[illegible]1	[illegible]65	1,4[illegible]2	2,082	1,031

Source: Monthly Morbidity Reports. Bureau of Health Services. March 1988

* Provisional Data

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Kuala Lumpur, Malaysia
27 February - 3 March 1989

ICP/RUD/001 PROG/112/CR-008

ENGLISH ONLY

COUNTRY REPORT

PAPUA NEW GUINEA

by

Mr Kaoga Galowa

WHO REGIONAL W/SHOP on DRINKING WATER QUALITY MONITORING and SURVEILLANCE

27 Feb - 3 Mar 1989

KL Malaysia

Country Report by:

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WORLD HEALTH ORGANISATION REGIONAL WORKSHOP

ON

DRINKING WATER QUALITY MONITORING AND SURVEILLANCE

27 FEBRUARY - 3 MARCH 1989

KUALA LUMPUR - MALAYSIA

Country Report prepared by

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by 1990 c

PAPUA NEW GUINEA COUNTRY REPORT

FOR

WHO REGIONAL WORKSHOP

ON

DRINKING WATER QUALITY MONITORING AND SURVEILLANCE

KUALA LUMPUR, MALAYSIA

27TH FEBRUARY - 3RD MARCH 1989

1. INTRODUCTION AND GENERAL COUNTRY PROFILE

The country, Papua New Guinea has total area of 46 2840 square kilometers with top graph varying from flat coastal areas to high plateaus.

Western of the Island is Indonesian province of Irian Jaya. Rainfall varies from 80-450mm/year. Population 3006799 growing at annual rate of 2.4%. Port Moresby being the country's capital has 122760 people.

Morbidity & mortality - Water Borne Diseases

In Papua New Guinea Gastro-intestinal diseases is 3rd in order of priority when looking at morbidity and mortality of patterns.

Diarrhoeal diseases is the second most common reason for hospital admission in children under 5 years and accounts for about one third of all deaths in this age group. It is commonly associated with poor personel hygiene and contaminated water supplies. It presents a serious and vacious cycle with malnutrition.

About 2 years ago, typhoid cases and epidemics have increased. This is attributed to poor sanitation (mainly) and lack of adequate water supplies.

Skin diseases such as scabies, grillies and skin sepsis are commons in rural areas where there is inadequate clear water supplies.

Water related disease such as Malaria is second important disease in the country and major cause of hospitalisation.

2. POLICY AND PROGRAMME OF WATER QUALITY MONITORING AND SURVEILLANCE

National Water Supply and Sewerage Board (Water Board) came into existence in September of 1982 and was charged with the duty of co-ordinated planning, design, construction, management of, and charging for, water and sewerage facilities through out the country.

For rural areas and peri-urban settlement not served by municiple systems installations operations and quality control are responsibilities delegated to Health Departments by the Board.

Water Quality Monitoring and Surveillance of both urban and rural water supplies is the responsibility of Health Inspectors, Water Resources Inspector and those officers gazetted and authorised under certain legislations. These legislations and provision include:

2.1 National Water and Sewerage Act 1982

All persons including government authorities are bound by this act. The act is subject to the Water Resources Act 1982 and drinking water quality standards are set and monitored by the Department of Health.

The role of the Water Board in dealing Water Quality Control is to;

- Comply with and enforce all current legislation on the proper use of water and proper discharge of sewage.
- Set standards for design and construct water and sewerage works.
- Declare regulations regarding water and sewerage.
- Declare water and sewerage district.
- Arrange agencies for management of systems.

2.2 Water Resources Act 1982

This act is administered by Water Resources Board. The act provide for the protection of a natural resource and make provisions for the management of National Water Resources and responsibilities to manage it. This responsibilities include:-

examination of problems and making plans in respect of
- the allocation and quality of water.
- control of erosions on the banks of rivers and shores etc.
- the conservation of water
- needs of fisheries and wildlife and recreational use of water etc.

2.3 Environmental Contaminant Act 1978

This piece of legislation is administered by Department of Environment and Conservation.
Among other provisions, the act relates to the prevention, abatement and control of environmental contamination.

2.4 Public Health Drinking Water Regulation 1984

This is a Regulations under Public Health Act which provides
- Water quality standards
- Standard for raw water Standards for drinking water
- Sampling and analysis if raw water

This piece of legislation is administered by Health Department. Health Inspector are empowered under Public Health Act to enforce the legislation. The same officers are also gazetted persons to enforce legislations on Environmental Contaminant act and Water Resources Inspector.

2.5 Drinking Water Quality Standards

Within the Public Health (Drinking Water) Regulations, schedules have been included. This have been adopted from WHO International Standards for Drinking Water, 1971.

This include:-

(a) Micro-biological Standards for:-
- disinfected water
- non disinfected water
- raw water

(b) Toxic contaminants Standards

(c) Aesthetic Quality Standards

3. IMPLEMENTATION OF MONITORING AND SURVEILLANCE PROGRAMME

Water quality monitoring and surveillance of both urban an rural water supplies is the responsibility of Health Department, Divisions and Local Authorities. These organisation employ Health Inspectors who do sampling of water supplies.

In rural areas the sampling and analysing of water is not programmed; however the samples are taken and tested mostly for bacteriological tests when:

1. There are complaints water pollution.
2. There is rise in cases of a water borne disease.
3. There is an epidemic of water borne disease.
4. Physical surveys are done on viability of the water supply.
5. After construction and before the community have access to the water supply to determine its safety.

In urban centres, there are other treated waters. These supplies are monitored regularly according programmes and standards as set under Public Health (Drinking Water) Regulations.

4. CURRENT STATUS - QUALITY MONITORING

Water quality monitoring of both urban and rural water supplies is the responsibility of Health Inspectors who are employed by Provincial Health Divisions of Health and local authorities such as municipal and Town Council.

Bureau of Water Resources also have appoint water resources Inspectors to Moni Water Resources Act. The Department of Environment also appoint officers under Environment and contaminant act to police the same.

4.1 Sampling Procedures, Techniques and Frequency

Apart from major urban cities and Towns Frequency of sampling for water quality is iregular in rural areas. Samples are taken and sent in for analysis when:-

(a) Determinding the quality of water before and after installation of a system. This may be a well. a spring catchments or a river intake.
(b) When there is an epidemic of or a rise in cases of a water-borne disease.
(c) There is a complaint about certain water supplies.
(d) There is likely pollution to water systems because of development projects and industries.

Whether the samples are taken from a tap, river, well or spring, the techniques of sampling is standard as adopted from WHO guidelines for Drinking Water Quality.

All Towns and citys serving large populations from 4000 to 150 000 have their water systems samples taken according to schedule 3 of Public Health (Drinking Water) regulations 1984.

4.2 Equipment and Laboratory Support Services

Water Quality testing is done at the Central Public Health Laboratory for bacteriological tests. Chemical testing is done at the two institutions like a University of Papua New Guinea and University of Technology. The National Department of Health do not have such facilities to cater for the needs.

4.3 Sanitary Surveys

Sanitary surveys are included in the physical surveys viability of installing a water supply. This include the location and use of sanitary facilities, likely pollution to water sources, such as traditional burial grounds, sites for disposing of refuse etc.

In Town and cities, sanitary surveys are also carried out and that site for disposal of refuse will have to be gazetted.

4.4 Provincial Water and Sanitation Surveys

Monitoring and drinking water quality surveillance is include in the Provincial Rural Water Supplies and Sanitation surveys in that the use of H2s test are carried out to determine the safety of Public installed supplies through out the country.

The frequency of the monitoring and evaluations of the installed systems are or will be determined by the Policies of each provincial water and sanitation committees.

Eleven (11) Provinces have been covered with these surveys and the results show that about 13% of the total population have access to safe water supplies which other 87% of rural population do not.

All major towns and cities have treated water supplies which are maintained and run by municipal authorities and Water Board.

5. TRAINING IN MONITORING AND SURVEILLANCE

Number of workshops on water and sanitation have been conducted in the country. In 1985 two workshop were conducted for Health Inspectors Incharge of Water and Sanitation programmes in the country on Water Quality Monitoring and surveillance.

These workshops were conducted with reference to the programme of co-operation between WHO and the Government of Papua New Guinea.

Total of 35 people were Training during the programme.

As at December 1988, 4 out of 19 provinces have been introduced to evaluation and monitoring of the Public Drinking Water Supplies.

It is anticipated that the all provinces in the country should have full programmes of monitoring and surveillance within 3 years.

At the Provincial Water and Sanitation Surveys, all Health Inspectors and personel involved in the survey go through 5 days of briefing.

6. PROBLEMS ENCOUNTERED

6.1 High cost of analysis of water samples by local and private organisation in the country.

The Government is looking at establishing a National Laboratory for all analysis for both food and water. The anaylists will be all Government employed.

6.2 For H2s test not all chemicals are available at local markets.

6.3 It is presumed that all rural water supplies are contaminated and that persons engaged in the programmes have no set plans for the purpose.

6.4 Transportation to remote areas of the country is difficult, because of terrain and wether.

7. SUMMARY

It is anticipated that the country information will be available as soon as all province are covered with monitoring and surveillance of the existing public installed systems. This exercise will, (apart from other information) 3 basic and important data.

* The safety of the Water Supplies
* Are they (supplies) being utilized
* Are the systems functioning

The purpose of the overal survey of the country is to;

1. Identify existing water supply and excreta disposal systems.
2. Recommend appropriate improvement.
3. Estimate the cost of recommended improvements.

With the proceeding information available, it is possible to prepare a short, medium and longterm plan for the province and the country.

WHO REGIONAL WORKSHOP ON DRINKING WATER QUALITY MONITORING AND SURVEILLANCE

KUALA LUMPUR, 27 February- 3 March 1989

H_2S method to be formalised

COUNTRY REPORT

Philippines

A. Introduction

NAME OF COUNTRY : Republic of the Philippines

PREPARED BY : ELEONOR C. CORFUZ
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B. General

The Philippines is an archipelago of 7,107 islands which lie between latitude 4° and 22° North and longitude 116° and 128° East. The country has a total land area of 300,155 square kilometers from Batanes islands near Taiwan in the North to Sulu Archipelago near Borneo in the South. The major island groupings are Luzon in the North, Visayas island in the middle and Mindanao in the South.

More than two-thirds of the area of the country is within the two large islands; Luzon in the north and Mindanao in the south. The other major islands include Samar, Leyte, Negros, Panay, Cebu and Bohol. These islands which lie between Luzon and Mindanao are known as the Visayas islands. The long island of Palawan stretches south westward from Luzon

The islands of the Philippines are the higher portions of a partly submerged mountain chain and the terrain is generally mountainous. The country has a tropical climate with a mean annual temperature of 27°C and relative humidity of 81 percent. It has a wide range of precipitation which varies with time and place due to the archipelagic nature of the country's geography and local topography. The annual average rainfall is 2360 mm.

The country basically, has an agricultural economy with fishing, forest product industry, mining, tourism, and light to heavy industry, accounting for the major development areas.

Civil Administrative and Political Division

The country has thirteen (13) regions (including the National Capital Region of Metropolitan Manila (NCR), containing 75 provinces with 60 cities, 1,531 municipalities and 42 000 barangays (villages). The Philippine climatic conditions are characterized by distinct dry and wet season.

Population Profile - As of December 1988, the population of the Philippines was estimated at 58 million with an annual population growth rate of 2.70% , of this total, about 41 percent resides in urban areas while 59 percent resides in rural areas. The projected population from 1985 to 1990 indicating the rural and urban population is shown in Table 1.

Table 1. PROJECTED POPULATION FROM 1985-1990

YEAR	TOTAL POPULATION	RURAL POPULATION	PERCENT RURAL POP.	URBAN POPULATION	PERCENT URBAN POP.
1985	34,377,993	32,671,817	60.08	21,706,176	39.92
1986	55,576,197	33,083,894	59.53	22,492,303	40.42
1987	56,760,655	33,474,285	58.97	23,286,370	41.03
1988	57,926,910	33,840,708	58.42	24,086,202	41.58
1989	59,070,022	34,180,708	57.86	24,889,314	42.14
1990	60,184,894	34,491,861	57.31	25,693,033	42.69

Table 2. Morbidity, leading causes, number and rate/100,000 population

Table 3. Mortality, rate/100,000 population

Table 2 : MORBIDITY, LEADING CAUSES, NUMBER & RATE/100,000 POPULATION

P H I L I P P I N E S

5-YEAR AVERAGE (1982-1986) & 1987

CAUSES	5-YEAR AVERAGE (1982-1986)		1987	
	No	Rate	No.	Rate
1. Bronchitis	556,933	1043.48	725,818	1265.46
2. Diarrhea	528,629	990.45	722,972	1260.50
3. URTI	541,956	1015.42	620,909	1082.55
4. Influenza	444,608	833.03	578,514	1008.64
5. Pnuemonia	181,660	340.36	215,368	375.49
6. PTB, all forms	156,625	293.46	200,534	349.63
7. Malaria	89,714	168.10	135,231	235.77
8. Accidents	68,956	129.20	133,421	232.62
9. Diseases of the Heart	32,346	60.60	80,744	140.78
10. Measles	50,120	93.91	76,232	132.91

Note:
1988 data is on the process of consolidating

Table 3. MORTALITY, LEADING CAUSES, NUMBER & RATE/ 100,000 Population
PHILIPPINES
5-YEAR AVERAGE (1982-1986) & 1987

CAUSES	5-YEAR AVERAGE (1982-1986)		1987	
	No.	Rate	No.	Rate
1. Pneumonia	50,928	95.42	59,063	102.98
2. Diseases of the Heart	28,829	54.01	34,227	59.67
3. PTB, all forms	23,500	44.03	30,013	52.33
4. Diseases of the Vascular System	20,842	39,05	16,338	28.49
5. Accidents	9,716	18.20	14,996	25.15
6. Malignant Neoplasm	10,984	20.58	14,152	24.67
7. Diarhhea	7,991	14.97	7,689	13.41
8. Pre-maturity	2,245	4.21	3,605	6.29
9. Senility	3,460	6.48	3,324	5.80
10. Avitaminosis and Other Nutritional Deficiency	1,706	3.20	1,266	2.21

Note :
1988 data is in the process of consolidating

National Policy

Generally, the existing sanitation conditions in the country are below the standard deisred level. This is due to low priority given to environmental sanitation by public health authorities as well as the private sectors in the past. In the Five-Year Department of Health National Plan (1985-1990), however, the National Environmental Sanitation Programme has been emphasized and, during its implementation it became one of the three top priorities in the public health program. The diseases associated with poor environmental sanitation are still prevailing throughout the country and in a way of endangering the health of the communities specially people in the rural areas and urban slums. On the other hand, most of these can be prevented and/or controlled through improvement of environmental sanitation conditions.

Primary Health Care (PHC) as an approach to solving the health problems in the community has been adopted nationwide. The utilization of volunteer workers in the barangay called the barangay health workers (BHW) to take care of the health needs of the population at the ratio of at least one BHW to 50 households has been an effective strategy in promoting safe water supply and sanitation which is one of the elements of PHC.

In the Philippines, mortality and morbidity data show that water borne and sanitation associated diseases are still major health problems that confronts.

The provision of safe water supply of sanitary toilets decreases the morbidity and mortality rate of the country as shown in Table 2. The priority environmental sanitation programs being implemented by the DOH are water supply sanitation, sanitary toilet construction and improvement, and the food sanitation program.

By the end of 1987, diarrhea ranked number two and number seven in the country's morbidity and mortality on water supply sanitation diseases. Other diseases like Malaria, infectious Hepatitis, Schistosomiasis, Typhoid and Paratyphoid fever, H-fever, Filariasis and Diptheria are likewise prominent in ranking under these disease problem.

In 1988, about 65% Filipinos has access to a safe and adequate water supply. The service coverage includes 86% for Metro Manila, 55% in other urban areas and 63% in rural areas. Approximately, 37% people are still dependent on water from open dug wells and rainwater, lakes and streams, the majority of which are of doubtful quality.

From 1981 to 1988, a total of 94,565 level I water supply facilities were constructed as well as 2,940 level II facilities and 1,005 level III facilities. In addition, 1,303,228 sanitary toilets were constructed and 161 water districts were formed.

The IDWSSD programme is one of the important component of the National midterm and long term Development Plan and it is the government policy that the implementation of the Decade programme is the pre-requisite to the achievement of health for all by the year 2000. Based on this plan and policy, Decade programme has been implemented jointly by the related agencies through internal and external coordination and cooperation The implementation strategies are designated as follows: complimentary sanitation and water supply development, self-reliant and self-sustaining action, maximum community participation at all levels and use of appropriate technology and local resources.

An integrated health education programme has been carried out continously in coordination with health educators, primary health care (PHC) coordinators and sanitation personnel at all levels.

Community participation in the water supply and sanitation programme has made substantial improvement in the implementation of the sector programme. Active community participation has been influenced by the sanitary inspectors, primary health care coordinators (PHC), rural health midwives, the rural water service administration, approximately 350,000 barangay health workers.

IDWSSD Decade Master Plan

The Master Plan was prepared jointly in 1982 by Deaprtment of Health, the Department of Public Works and Highways and the Rural Waterworks Development Corporation, with the cooperation of related agencies and with WHO technical assistance. The Second Master Plan covering 1987-2000 has been completed and approved by the National Economic and Development Authority (NEDA) in May 1988 which was prepared in conjunction with the IDWSS Decade Consultative Meeting. Government of the Philippines has formulated a Water Supply, Sewerage and Sanitation Master Plan reaches far beyond the Decade, covering the period 1988-2000. Through its implementation, the Government expects to attain the service coverage in water supply of 97% in Metro Manila, 95% in other urban centres, and 93% in rural areas. The sanitary toilet coverage nationwide will be 93.4% and sewerage in Metro Manila 32% and 1% for other urban areas.

The National Water Resources Council was designated as the National Action Committee for the IDWSSD programme on 18 July 1980. Four Sub-Committees on Water Supply, Sanitation, Information and Technical Support were formed on 24 November 1980. The National Water Resources Council was abolished in 1987. The " National Water Resources Board" was created under the reorganized set-up of the National Government of the Philippines which took over the functions of the National Action Committee (NAC) for the IDWSSD Programme.

The Project Implementation Review Committee was created in 1982 to monitor and evaluate the overall implementation status jointly by the Department of Health, the Department of Public Works and Highways, the Rural Waterworks Development Corporation and WHO.

The Project Management Offices for the Decade Programme were created at all levels by the agencies concerned during the early part of 1982.

Formulation of the Rural Waterworks and Sanitation Association (RWSA) has been carried out by the former Rural Waterworks Development Corporation (RWDC) to undertake management of amortization, operation and maintenance of the rural water supply and sanitation facilities. As of the end of 1987, a total of 32,454 RWSAs had been formed.

Agencies/Institutions Involved

The Department of Public Works and Highways, (DPWH) is responsible for the development of integrated water supply plans and programs consistent with the national plans and policies. It performs engineering and construction functions like the drilling of wells and the development of springs. The DPWH is responsible to providing technical assistance and financial grants for the repair/rehabilitation fof these systems. It shall also be responsible for the planning and execution of sewerage projects in some cities and larger "poblaciones" in the country.

The Local Water Utilities Administration (LWUA) is an specialized lending institution, development and financing of local water utilities. The chief concern of the LWUA is the provision of loans to Water Districts for the development of water systems at concessionary terms based on their potentials for development and continued viability. In addition, its function includes the promotion of the organization of works RWS's and the provision of institutional, technical and financial assistance to the RWSA's in the construction, operation and maintenance of rural water supply system.

The Department of Health (DOH) is responsible for promoting safe water supplies and exercising surveillance of water quality. Its operational and capital expenditures come from its share of the annual budget alloted by the National Government. A network of regional and provincial laboaratories and central laboratory with technicians is used to carry out water sampling programmes that require periodic bacteriological and chemical examinations of all water supply sources. The DOH, has, a major function of sanitation programme nationwide and the administration of health education.

The Department of Local Government (DLG) undertakes the USAID assisted Barangay Water Programme which aims to develop the capability of provinces and cities to undertake waterworks projects using this strategy. Target area are rural communities with population not exceeding 10,000 which are willing to operate and provide institution building services. Local government units plan and implement waterworks projects, and the recipient communities, through users charges, finance the operation and maintenance of the water supply facilities.

The National Water Resources Board (NWRB) is organizationally attached to the DPWH, the NWRB is a high level ex-oficio body responsible for coordinating and integrating all activities related to water resources development and management. As such, it formulates policies, evaluates and coordinates water resources programmes, regulates and controls the utilization, exploitation, development, conservation and projection of the country's water resources including the regulations of water utilities operations.

The Metropolitan Waterworks and Sewerage System(MWSS) provides for the potable water supply requirements and sewerage system to four cities and thirteen municipalities comprising the Metro Manila plus one city and other municipalities, adjacent to it. It is responsible for the planning, design, construction, operation and maintenance of water supply and sewerage disposal system within its jurisdiction, the MWSS develops and operates the system out of resources, borrowed funds and government capital subscription.

Drinking Water Quality Monitoring and Surveillance

In rural areas, Rural Waterworks and Sanitation Association (RWSA) members, Barangay Health Workers (BHW's) and designated care takers for water supply facilities are disinfecting and safeguarding water supply facilities under the supervision of sanitary inspcetors and sanitary engineers. Monitoring and surveillance work has been handled by Sanitary Inspectors and Sanitary Engineers with the help of the barangay level workers.

Since the start of the new Philippine Government Administration, reorganization has been undertaken and the following are the significant changes made in the Water Supply and Sanitation Sector:

(1) The Division of Environmental Health, Department of Health, has been elevated to Environmental Health Service (Bureau level).

(2) The Rural Waterworks Development Corporation (RWDC) has been merged with the Local Water Utilities Administration (LWUA) which is under the umbrella of the Department of Public Works and Highways.

(3) The Department of Environment and Natural Resources was created and the National Pollution Control Commission and the National Environmental Protection Council have been absorbed by the Environmental Management Bureau of this Department.

(4) The Laguna Lake Development Authority (LLDA) is still under the Office of the President

THE PHILIPPINE STANDARDS FOR DRINKING WATER

Coliform group organisms shall be judged consistently not present when either of the following conditions are met:

a. When the dilution tube technique is used and 10 ml standard portions are examined, not more than 10 per cent in any month shall show the presence of the coliform group. The presence of the coliform group in three more 10 ml portions of a standard sample shall not be allowable if this occurs in:

   (a) Two consecutive samples;

   (b) More than one sample per month when less than twenty (20) samples are examined per month; and

   (c) More than 5 percent of samples when twenty (20) or more samples are examined per month

b. When the Membrane Filter Technique is used, the arithmetic mean coliform density of all standard samples, each of which shall not be less 50 ml examined per month shall not exceed one per 100 ml. Coliform colonies per standard sample shall not exceed three per 50 ml, four per 100 ml, seven per 200 ml, or thirteen per 500 ml in:

   (a) Two consecutive samples;

   (b) More than one standard sample when less than twenty (20) are examined per month; and

   (c) More than 5 percent of the standards samples when twenty (20) or more are examined per month

Water Quality: Physical, Chemical and Radiological Requirements

Parameter		Maximum Permissible level*
Turbidity	:	5 units
Color	:	5 units (s) **
Odor	:	Unobjectionable
Threshold odor Number	:	Not more than 3
Taste	:	Unobjectionable
Total Solids	:	500 (s)
pH	:	6.5 - 8.5
Phenolic Substances	:	0.001
Radioactive Subs.		
Gross Alpha	:	3 pCi/l
Gross Beta	:	30 pCi/l
Trace Elements		
Arsenic	:	0.05
Barium	:	1.0
Copper	:	1.0
Cyanide	:	0.05
Fluoride	:	0.6
Iron	:	1.0 (s)
Lead	:	0.05
Manganese	:	0.5 (s)
Mercury	:	0.002
Zinc	:	5.0 (s)
Persistent Pesticides		
Aldrin	:	0.001
DDT	:	0.05
Dieldrin	:	0.001
Chlordane	:	0.003
Endrin	:	0.0002
Heptachlor	:	0.0001
Other Chemicals		
Calcium	:	75
Chloride	:	200 (s)
Magnesium	:	50 (s)
Nitrate (NO_3)	:	30
Sulfate	:	200 (s)
Hydrogen sulfide	:	0.05 (s)

* All units are in mg/l unless, otherwise stated

** (s) - Secondary standards; compliance with the standard and analysis are not obligatory

From 1984-1988, a total of about 119,400 kgms. of HTH (Chlorine disinfectant) was procured and distributed nationwide to disinfect contaminated or doubtful water supply sources, with special emphasis on the localities which are flooded and endemic areas for the water -borne and water related diseases.

Since 1981, the Department of Health has improved 12 regional water laboratories and trained 12 regional chemists to enable them to conduct bacteriological, chemical, physcial and biological water analysis. A total of 57 provincial water laboratories were established, one for each province, with UNICEF financial assistance. Prior to the establishment of provincial water laboratory network, a total of 93 laboratory technicians were trained at regional and national level.

The water supply and sanitary toilet construction improvement activities in the Philippines started long before the launching of the IDWSSD programme in 1981. However, the decade programme accelerated the water supply and sanitation program. Priority was placed on the rural areas where sanitary conditions are extremely poor and associated diseases.

Monitoring of Potability of Water Supply:

1. Various kinds of drinking water sources

   a. Level I - point source of facilities like pump wells and improved springs.

   b. Level II - point source supply with limited piped water to communal faucets in the community being served by the system.

   c. Level III - standard waterworks system with piped water connection to individual homes served by the system.

2. Frequency of testing for these various kinds of drinking water source :

   a. Frequency of sampling for bactriological analysis for levels I, II, III at least once a month.

   b. Frequency of smapling for physical and chemical analysis for levels I, II and III - once a year.

3. Disinfection done:

Disinfection of water supply sources is required under the following:

a. Newly-constructed water supply facilities

b. Water supply facility being used for domestic drinking water source found positive bacteriologically by laboratory analysis

c. Water supply facility that has been repaired and improved

d. Container disinfection of drinking water collected from a water facility that is subject to recontamination like open dug wells, unimproved springs and surface water and doubtful sources

Monitoring System :

a. Sampling of sources/frequency

b. Selection of method;

Primary Health Care method (with the use of PHC bottles), and conventional method

c. Transport to Water Analysis Laboratory

d. Resources of laboratory; personnel, equipment and supplies

e. Reporting to local health office

f. Action taken

g. Evaluation/Monitoring

Frequencies in the guidelines:

The minimum frequency for a sanitary survey is twice yearly. Additional visits should be made when abonormal conditions exists, e.g. epidemics, floods, negative analysis.

The minimum frequency for sampling drinking water systems for bacteriological analysis is :

Population	Minimum No. of Samples/Month
Less than 5,000	1
Over 5,000	1 per 5,000

However, for unpiped and untreated supplies, no specific recommendations are made in the guidelines. The frequency is largely dependent on the capacity of the appropriate control agency and will reflect local circumstances in particular the frequency and results of sanitary surveys.

Chemical analysis should be carried out once per system and then as requested by consumers' adverse reports.

How it is implemented

1. Collect water samples at least once a month for level I

2. Collect water samples at least onee a month for level II

3. Collect water samples at least once a month for level III

4. Conduct sanitary surveys:

   a) when new sources of water are being developed .

b. when laboratory analysis indicate a potential hazard to health.

c. when an outbreak of diseases, which could be water-borne, occurs in or near the area served

d. when any significant change or event occurs that could affect water quality (e.g. beginning of the rainy season, agricultural patterns, near industrial construction on the watershed)

e. collect water samples by the use of PHC bottles .

PROBLEMS/CONSTRAINTS :

1. Inadequate supervision and monitoring by Sanitary Engineers (SEs) and Chief/Assistant Provincial Sanitary Inspectors (SIs) due to some intervening functions assigned.
2. EHS Provincial Management Staff like SEs, Chiefs SIs and District Sanitary Inspectors need training for supervising and monitoring skills.
3. Checklist for monitoring and supervision of program activities have not been fully developed.
4. Current program forms for reporting is inadequate in terms of data and information needed for program review/program planning.
5. Poor enforcement of rules on environmental sanitation by field units.
6. Accuracy and promptness of reporting as required has not been complied.
7. Some SIs due to their low education qualification and many duties assigned have not been capable of giving optimum service delivery and compliance to submission of reports.
8. Frequent typhoons and floods, peace and order problem and socio-economic problems, i.e. low income families cannot construct toilet facilities per DOH standards.
9. Country's difficult geographical condition resulting in inaccessibility, lack of road network, rough terrain, etc.
10. Cultural habits and practices in certain regions like Southern Mindanao and Mountain Provinces in Northern Luzon particularly on toilet construction.
11. High population growth rate of 2.4 to 2.7% and inmigration due to urbanization has created additional requirements for sanitary facilities.
12. Inadequate coordination by concerned agencies (government and non-government agencies) with DOH escially at the barangay level.
13. Present provincial laboratories cannot cope up with the demand for water samples to be examined and they are only accepting limited number.

RECOMMENDATIONS:

1. Professionalization of SI positions. Sanitarians and Chief Sanitary Inspectors. At the same time, higher educational qualification instead of just a mere high school graduate is recommended. Training of Sanitarians to further develop their technical skills and in supervision and monitoring.

2. Improvement of Environmental Health Program reporting through a strengthened supervisory system, regular monitoring and evaluation and computerization of data and information.

3. Strengthened enforcement of sanitary laws, rules and regulations through training of SIs on legal interpretation and procedures as well as provision of legal staff support at the provincial level.

4. Work and financial program including preparation of annual procurement plan shall be strictly required at all administrative levels of Environmental Health Program.

5. All DOH water analysis laboratories at the regional and provincial levels shall have to be made functional and their service capabilities strengthened and be expanded to district levels.

6. Closer coordination on the different agencies involved and plan together to improved existing giving priority to the construction of water supply facilities to prevent water-borne diseases.

7. Utilization of Primary Health Care (PHC) approach to program implementation which includes the use of PHC Media in the bacteriological analysis of water samples.

8. Regular schedule on consultative conferences on all agencies involved and implementors.

WORLD HEALTH ORGANIZATION

WESTERN PACIFIC REGION

ORGANISATION MONDIALE DE LA SANTE

REGION DU PACIFIQUE OCCIDENTAL

REGIONAL CENTRE FOR THE PROMOTION OF
ENVIRONMENTAL PLANNING AND APPLIED STUDIES (PEPAS)

REGIONAL WORKSHOP ON DRINKING WATER QUALITY MONITORING AND SURVEILLANCE

ICP/RUD/001 PROG/112/CR-010

Kuala Lumpur, Malaysia
27 February - 3 March 1989

ENGLISH ONLY

COUNTRY REPORT

SOLOMON ISLANDS

by

Mr Samuel Kafukese

SOLOMON ISLANDS
MINISTRY OF HEALTH AND MEDICAL SERVICES
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HONIARA.

A REPORT ON WATER QUALITY MONITORING AND SURVEILLANCE IN SOLOMON ISLANDS.

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SOLOMON ISLANDS
FEBRUARY 1989

CONTENTS

1.0. GENERAL

1.1. SOLOMON ISLANDS

Solomon Islands comprises of a scattered archipelago of mountainous Islands and hundreds of coral atolls stretching over 1,500km in a generally south easterly direction from Boungainville (Papua New Guinea) to Tikopia Island in the Temotu Province.

Australia is approximately 1,860km to the west and New Zealand 2,400km to the South.

The six main Islands and cluster are arranged in a double chain, with Choiseul, Isabel and Malaita to the North, and the New Georgia Group, Guadalcanal and Makira to the South. Together with numerous small Island groups at either of the chain, the archipelago covers a land and sea area of approximately 650,000 Sq.km. of which only approximately 30,000 Sq.km is land. The land is 90% dense tropical Forest.

The main Islands have thickly Forested mount ranges, deep narrow valleys, rivers that are subject to sudden and heavy floodings and nearly navigable for any length, coastal swamps as well as extensive coral reefs and lagoons. The only large coastal plain of any size is the North-east of Guadalcanal. The small outlying Islands are either typical coral atolls or raised atolls with rather limited vegetation. Solomon Islands lies in the Centre of an area of seismic activity, and there are several extinct or dormant Volcanos.

1.2. CLIMATE

Solomon Islands has a tropical climate with slight variations from Island to Island. There are no clearly defined seasons, but between November and May the North-West winds bring squalls, and cyclones may occur. For the remainder of the year, the South-East trade winds blow steadily, mainly during the day. The Temperature at noon in Honiara the capital, is normally around 30c with a high level of humidity.

The average annual rainfall in Honiara is around 2,230mm. This is much lower than other parts of the country, where annual rainfall often exceeds 7,500mm.

1.3. POPULATION OF SOLOMON ISLANDS

Solomon Islands is a multi-cultural, multi-racial Society. The most dominant racial group, the melanesians generally inhabit the larger Islands, while the polynesians tend to live on small outlying Islands and atolls. There are some Pacific Islanders resettling in some parts of the Solomon Islands. Europeans Chinese and other Foreigners lives mostly in urban areas.

Total population	1970	-	160,998
	1976	-	196,823
6	1986	-	285,176

Annual Rate of increase 1976 - 1986 = 3.5%
Solomon Islands population ethnic component: (1986 census)

A) Melanesia - 94.2%

B) Polynesia - 3.70%

C) Kiribati - 1.4%

D) All other - 0.7%

90% of Solomon Islands population lives in Rural areas and 10% lives in urban areas.

1.4 ECONOMY

Solomon Islands become more diversified and more self-reliant, both in terms of trade and aid. However like many other developing countries dependent on commodity exports, Solomon Islands experienced economic difficulties. These are not unmanageable and in the longer term the outlook is quite favourable.

The market economy is dominated by the production of Fish, Copra, Cocoa, Timber and Palm oil for exports.

The country is still dependent on other Countries for manufactures, experties, and developmental finance.

With about 90% of all our people lives in rural areas and 10% lives in urban areas. Solomon Islands is and willremain an agricultural nation. Most of the people in Solomon Islands are subsistence farmers but an increasing number of small holders are involved in growing Coconuts, Cocoa, spices and cattle raising.

1.5 LANGUAGE

Solomon Islands have English as an official language, and Pidgin English the Lingua Franca for the majority of people in Solomon Islands.

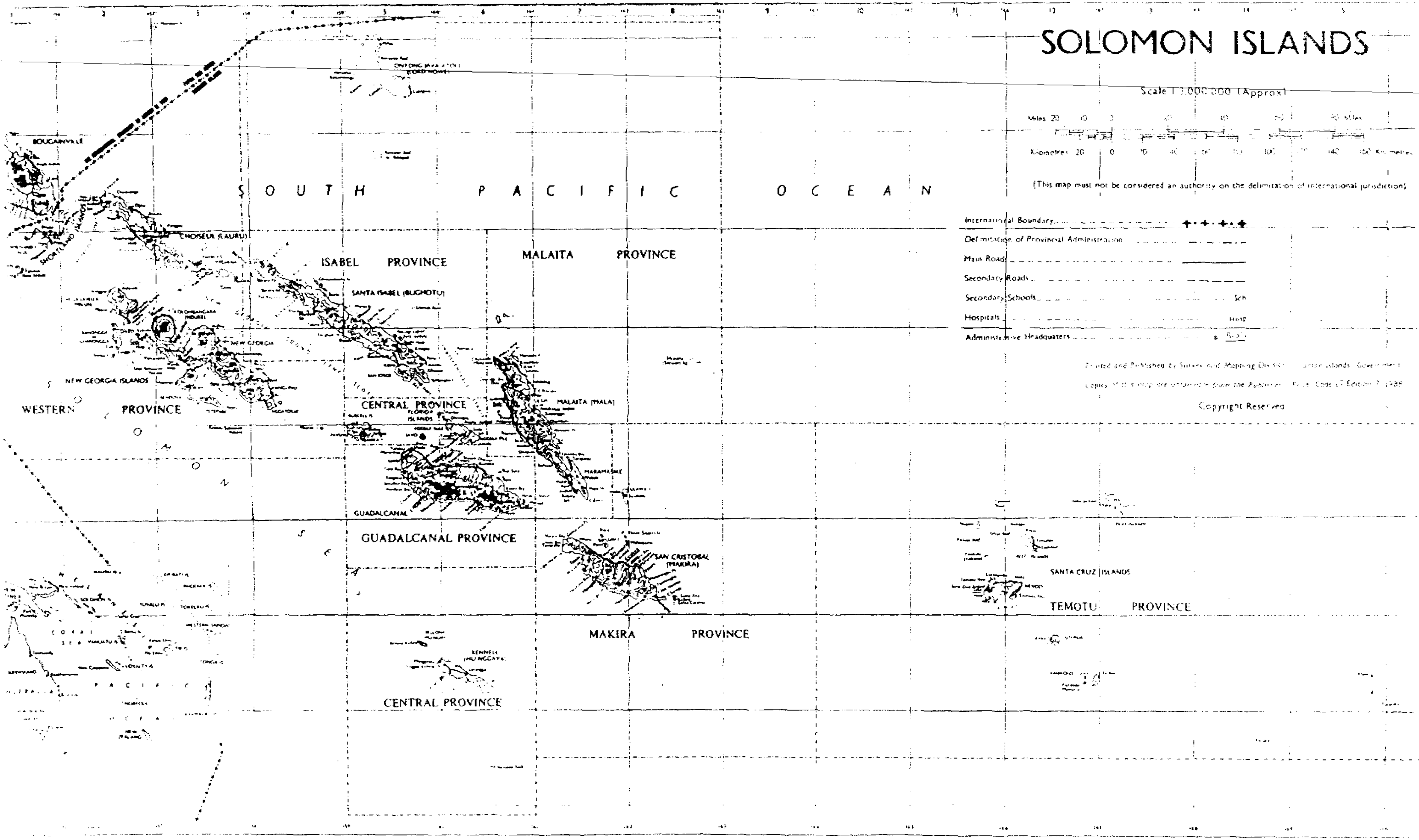
There are approximately more than 100 different local dialects but no one dialect is spoken by all the people of Solomon Islands.

1.6. SOLOMON ISLANDS GOVERNMENT

Solomon Islands is a constitutional monarchy with Queen Elizabeth II as head of state, represented locally by a Governor General. The country gained independence from Britain in 1978. The 1978 constitution was built on existing Political institutions and practices. It provides for a Single Chamber National Parliament, composed of not less than 30 and not more than 50 members elected every four years, and a Cabinet type of executive headed by a Prime Minister chosen by the National Parliament. He in turn chooses up to 14 Ministers.

In line with a decision taken in early 1970's to devolve certain Central responsibilities, provincial assemblies and administrators have assumed responsibilities for certain functions that use to be the domain of the Central government.

At present there are 8 provinces including Honiara City Council which they administer their own affairs.


SOLOMON ISLANDS
(This map must not be considered an authority on the delimitation of international jurisdiction)
International Boundary
Delimitation of Provincial Administration
Main Roads
Secondary Roads
Secondary Schools
Sch
Hospitals
Hosp
Administrative Headquarters
Copyright Reserved
SOUTH PACIFIC OCEAN
BOUGAINVILLE
CHOISEUL (LAURU)
ISABEL PROVINCE
SANTA ISABEL (BUGHOTU)
MALAITA PROVINCE
MALAITA (MALA)
MARAMASIKE
NEW GEORGIA ISLANDS
WESTERN PROVINCE
CENTRAL PROVINCE
FLORIDA ISLANDS
GUADALCANAL
GUADALCANAL PROVINCE
SAN CRISTOBAL (MAKIRA)
MAKIRA PROVINCE
SANTA CRUZ ISLANDS
TEMOTU PROVINCE
RENNELL (MU NGGAVA)
CENTRAL PROVINCE

2.0 RURAL WATER SUPPLY AND SANITATION PROJECT

2.1 INTRODUCTION

It is an aim targeted by World Health Organisation for better health to the World by year 2000.

Therefore the Solomon Islands Government with World Health Organisation, United Nations Development Program, Australian Development Assistance Bureau and USAID decided to put their priorities on rural water supply and sanitation project to be implemented in Solomon Islands.
The Project which effectively carried out in 1978 although it slowly started before 1978 after Solomon Islands Government and World Health organisation realises that better water and Sanitation will greatly contributes to better health in Solomon Islands is jointly funded by the Solomon Islands Government, WHO, ADAB, USAID and other Foreign aid donors.

The project is implemented by the Environmental Health Division of the Ministry of Health and Medical Services and manpower on Sanitary engineering is provided by WHO and WASH (Projec) of the United States Agency for international Development.

There are 33 Health Inspectors and more than 200 Health Workers who carry out the implementations of the project.

These officers are permanently posted out in the 8 Provinces of Solomon Islands. They carryout Survey, Plannings, Constructions and Superivisions to water supply and Sanitation projects in their own provinces.

At the end of 1978, 24% of the rural population in Solomon Islands had an adequate water supply system. By the end of 1986, the project (RWSS) program has reached 60% of the rural population with improved water systems.

The water systems have proven to be very popular and the government is aggresively pursuing the goal of providing satisfactory water systems to the entire rural population.

The Environmental Health Division of the Ministry of Health and Medical Services is responsible for carrying out the RWSS project and has been constructing four types of water supply systems.

These are:

- gravity -fed systems piped from springs or streams.
- Rainwater catchments
- Handpumps
- Hydraulic Rams and
- Solar powered

These water systems are relatively easy to maintain in proper operating condition and to repair when breakdowns occur compared to more technically complex systems.

The Environmental Health Division cannot by itself maintain the water systems built under RWSS Program. The Communities themselves must accept major responsibility for water system maintenance.

The Government of Solomon Islands has established procedures covering the implementations of the RWSS Programme which give general guidelines *regarding community responsibilities towards the improved water systems.*

These are:-

1) The community, not the government, is the owner *of the improved water system.*

2) *The* Community must contribute, at a minimum, local materials and labour towards the construction of the water system

3) The community is reponsible for the operational and minor maintenance of the water system.

2.2 MAINTENANCE POLICY FOR RURAL WATER SUPPLY SYSTEMS

A National maintenance Policy have a purpose of establishing a consistent approach to water system maintenance that can be followed by each of the provinces.

The policy is based on the concept of community responsibility for the maintenance of its water system.

The policy is divided into 5 sections consiting of:-

1) Introduction

2) The method used by the Environmental Health Division personnel to present the concept of community responsibility for the water system prior to construction.

3) The concept of community management of water supply projects and an explanation of Village responsibilities with respect to the design, construction and maintenance of the water system.

4) The technical requirements for the maintenance of water system.

5) The responsibilities of government in the process of constructing and maintaining rural water supplies.

This policy has been adopted by the Environmental Health Division inorder that the water supply systems we are constructing now or have constructed will still be providing water to villages in Solomon Islands for many years in the future.

Inorder for the RWSS program to have future success, each provincial government must take the steps necessary to adopt and implement the maintenance policy.

2.3. ADAPTATIONS OF MAINTENANCE POLICY TO PROVINCES.

The policy is based on village management of their project.

The provisions are:-

a) Village responsibilities must be explained to them and the Village must agree to carry them out before the province agrees to construct or rehabiliates the water system. Village responsibilities include setting up a water committee collecting funds for maintenance, providing local materials and labour and selecting caretakers. In general, villages will be expected to be responsible for the management of their water system.

b) The water system project cycle adopted by each province should include at least two visits to the village in where their responsibilities are told to them and for the environmental Health Division to varify that the village is fulfilling their responsibilities.

c) Provision for the villages to buy tools or have access to tools must be included.

d) The province must establish a method for the villages to obtain spare parts and inform villages of this method.

2.3. FINANCIAL RESPONSIBILITY FOR MAINTENANCE.

At present villagers pay very little, if at all, to have their water system repaired. This policy requires that villagers purchase tools and spare parts to carry out minor maintenance, however, major maintenance work remains as the responsibility of the environmental Health Division.

3.0. WATER PROJECT DEVELOPMENT CYCLE - (RURAL WATER PROJECT)

3.1 GENERAL

The water project development Cycle describes a water project from the time the village first requests an improved water supply system through follow up visits by an Environmental Health Division representative, after the water system is constructed. It is not possible to give 100% assurance that a village will carry out its responsibilities towards the maintenance of their water systems. However, it is possible to introduce the new water system to the village in such a way that they are fully aware of and agree to carry out, their duties with respect to caring for the water supply system before its construction actually begins.

3.2 CURRENT METHOD

While the technique for providing improved water systems for rural Solomon Islands differs somewhat from provinces to provinces, the basic approaches are similar, and can be described in the following steps.

1. A village requests an improved water system.

2. The health inspector/Sanitary officer assigned to the province does an initial screening of the proposed project.

3. Those not deleted will be surveyed by the provincial Environmental Health Division staff. This includes on-site evaluations and preparations of a design plan. Some projects may be rejected at this stage due to technical problems.

4. The Senior Health Inspector/Sanitarian officer in the Provinces prepares a final list of projects and a master list of materials needed. The master list is submitted to the Director of the Rural water supply and sanitation project at the Headquarter (Honiara)

5. After determining the amounts of funds and materials available, the Director , will inform the provincial Environmental Health Division office.

6. The Senior Health Inspector in the provinces prepares a list of projects that, can be completed during that fiscal year and plans the construction schedule.

7. If a village is required to provide labour and local materials, they are advised of their construction.

8. When materials are received from Honiara and the village has gathered its contribution in local materials, the construction of the water systems begins.

The primary difficulties with this method are two-fold. One, the village still percives, in most cases, that the water system is owned by the government and that the village is not responsible for maintenance, and two, in instances where the village accepts their responsibility the villagers do not possess the skills, tools and spare parts needed to take care of their water system.

3.3 PROPOSED MODEL CYCLE

The proposed cycle requires that the provincial Environmental Health Division personnel spend more time before construction to make the village people aware of their responsibilities and for the village people to take steps including the formation of a water Committee and and the collection of funds to demonstrate their committment to the project. Two pre-construction visits to the village are required. These visits serve two purposes. The first is to determine if the proposed water system is technically feasible and to carry out the survey of the system. The second and equally important purpose is to carryout community preparation activities.

This method also includes the use of written agreements between the Environmental Health Division and the village. The agreements help to define the role of Environmental Health Division and to insure that the water system is a village project, not a government one.

The first step is a request from a village for improved water system. The next step is the first visit to the village by Environmental Health Division staff.

The purpose of this visit are to:-

1) Describe the RWSS program
2) Insure that the village understands that the water project and systems is theirs.
3) Inform the village of their responsibilities towards the system.
4) Describe and leave with the village a copy of the request for assistance (RFA) form for the village people to read and sign.
5) Carryout the technical survey of the water system.
6) Instruct the village to form a water committee before the second meeting and advise them of the composition and duties of the committee.

After the village notifies the Environmental Health Division staff that they have decided to continue with the project, have signed the RFA form and formed a water committee, the Environmental Health Division schedules the second visit with the village.

The purpose of the visit is to:-

1) Insure that the village has signed the RFA form and formed a water committee.

2) Prepare the construction agreement for signature by the village water committee and the Environmental Health Division representatives.

3) With respect to community preparation activities inform the committee of the steps they must take, before construction is scheduleed and advise them on methods for carrying out these tasks. The tasks include:

   - raising funds for maintenance
   - selecting caretakers
   - arranging for tools

4) Instruct the committee to inform the Environmental Health Division when they have completed the required tasks.

Upon receiving notice from the village that they have completed their pre-construction task, the Environmental health Division schedules construction and arranges for delivery of government provided material to the construction site.

Construction is then carried out. During construction, the water system caretakers identified by the water committee are trained by the environmental Health Division construction crew. When construction is completed, a dedication ceremony is held and the ownership certificate is signed and presented to the water committee.

A followup visit to insure that the village is properly carrying out their responsibilities should also be scheduled during the ceremony.

4.0. URBAN WATER SUPPLIES

In Solomon Islands there are 2 water Units, one deals with planning and constructions of urban water supplies the other deals with rural water supplies.

The management of urban water supplies maintenance and construction is carried out by the Water Unit of the Ministry of Transport Works & Utilities, while the Rural water supplies, management, maintenance and construction is carried out by the Rural water supply project of the Ministry of Health and medical Services (Health Inspectorate Division).

The Health inspectorate Sanitary Engineer can also assist the Ministry of works and utilities on plannings of the urban water supplies but other works on urban water supplies is entirely the responsibilities of the Water Unit-

5.0. TYPES OF WATER SUPPLIES IN SOLOMON ISLANDS

In general terms there are only 3 possible sources of water in Solomon Islands, and each will have to be investigated and the feasibility established.

a) Ground water

This is the most frequently used source. It has many disadvantages and advantages which should be weighed and considered prior to utilization. The advantages and disadvantages of ground water are valid for hand dug wells boreholes and infiltration gallaries.

If disadvantages can be eliminated, the use of ground water appears to be preferable to any other Sources.

Therefore the disadvantages will be examined and procedures set forth to deal with the problems. Commonly used in atolls, isolated villages away from the nearest water source (streams rivers)

b) SURFACE WATER

Water orginating from the run-off of precipitation is to be considered (River, streams etc).

In Solomon Islands this type of water is usually common in mountianous Islands.

c) RAIN CATCHMENT

Roof catchment however can be easily assesed by the Health Inspector. In the possession of the maximum/minimum and mean annual rainfall. This can easily be calculated inorder to find out the size of storage tanks.

This type of water supply is commonly used in atolls and isolated villages away from the nearest water sources.

6.0. WATER QUALITY CONTROL IN SOLOMON ISLANDS.

6.1 GROUND WATER

Two things can go wrong with water quality in a well in Solomon Islands. One is the entry of undersireable Micro-organisms which can be estbalished by a bacteriological examination (coliform Tests), or the salinity may increase beyond tolerance level thus rendering the water unfit for human consumption. The former could be called bacterial contamination and the latter chemical contamination.

1) Bacterial contaimination

The indicators of bacterial contaimination are two groups of bacteria detected by exmination in a lab, they are:-

- Total coliforms

  This is an indicator of faecal pollution and the most commonly used bacteriological indicator of water quality.

- Faecal Coliforms

  This is an indication of faecal pollution where the detection process is based on higher incubation temperatures permitting the differentiation from other coliforms widely distributed in the environment. Table 1.1 shows the permissable levels of both indicators. Samples should be negative for E.Coli in Principle. But in almost all small community water supply systems faecal bacteria are likely to be found. It would be pointless on Solomon Islands situations to condemn all supplies that contain some faecal contamination especially when the alternative source of water is more polluted. When pollution is found a sanitary survey is indicated to correct the situation.

II) Corrective measures

Should the indicators exeed the values shown in table 1.1 an investigation and corrective measures are required. The investigation does not require special equipment just a little bit of common sense.

1) Establish the distance of the well from pit latrines or solid waste disposal pits in the vicinity.

2) To observe the activities around the well and establish possibility of reinfiltration.

   On basis of these observations the following steps could be taken.

   a) If pit latrine or solid disposal are found within 15m of the well these should be eliminated.

   b) Handpump is usually installed.

c) Conrete apron should be constructed around the well or alternatively full reconstruction of the well could be done.

3) To observe the means of extraction of water from the well.

4) Chlorinated well

iii) WELL CHLORINATION

Equipment Required.

- 1 - Tape measure or calibrated rod
- 1 - c12 comparator and DPD tablets No.4
- 1 - Sample bottle
- 1 - Chlorine

iv) CHEMICAL POLLUTION/SALINITY

The above term may not be the most descriptive but it is intended to differentiate between the causes of water quality deterioration. There could be several types of chemicals which could contaminate water supplies in Solomon Islands. Since most of them are due to industrial wastes therefore their appearance in Solomon Islands is very rare.

6.2. SURFACE WATER

Under this category water originating from the run off of precipitation will be considered (Rivers/Streams). etc.

a) Quality check
Similarly to ground water level of:

1) Bacteriological pollution must be established. However when dealing with surface water are adequated.(Refer to Table 1.1). If the level of pollution is higher than shown thereof etc treatment of the water is necessary.

ii) Physical pollution

Really there is only one test that is needed to rectify the extent of treatment required. The turbidity must be established. Turbidity is the quantity of suspended matter in the water. These particles could be organic or inorganic.

Simple Field test kit for measuring turbidity. On the basis of this analysis it is possible to establish the degree of treatment required.

6.3. RAIN CATCHMENT

Roof catchment can be easily assessed by Health Inspectors. This type of water supply which consists of a storage tank, catchment roofs can only be calculated for sizes due to the following informations.

a) Annually available water in m3

b) Mean annual rainfall in mm.

c) Horizontal roof area in m2

This have been found to be the most safest water supply in Solomon Islands but control measures such as Bacteriological monitorings is frequently carried out.

Solomon Islands annual rainfall is approx more than 8000mm.

6.4. FIELD KIT FOR TESTING SALINITY.

1. EQUIPMENT

- Syringe, plastic, 50ml x 2 ml
- Bottle, wide mouth with screw cap.
  500ml mark (For use in storage of silver nitrate titrant).
- Dropping Bottle with pippette, 40ml.
  Mark with 1ml mark on the Dropper (For use in storage of indicator solution).
- Bottle wide mouth screw cap with 50ml mark (For water sample)

2. REAGENTS

Two Reagents are required, they are to be prepared by dilution in distilled water. The chemical could be weighed on a sensitive balance or if pre-weighed in plastic sachets.

One such sachet could be used in preparing reagent. The silver nitrate (N Ag. No3) sachet should contain 2.396 grams and the potassium chromate sachet should contain (K 2 Cro4) 2 grams.

SILVER NITRATE TITRANT . 028N.

a) Carefully dissolve one sachet of silver nitrate in distilled water in the number bottle.

b) Fill up to 50ml mark with distilled water water

c) Mix well by shaking the bottle

POTASSIUM CHROMATE INDICATOR SOLUTION

a) Dissolve on sachet of potassium chromate in distilled water in the dropping bottle.

b) Fill up to the 40ml mark with distilled water and mix well.

3. PROCEDURE

a) Fill the sample bottle to the 50ml mark.

b) Add 1 ml of potassium chromate solution using the small medicine dropper.

c) Fill the syringe with silver nitrate solution to the 50ml mark and drop by drop the solution into the sample bottle until an orange red colour start to appear.

d) Read the level of solution in the syringe and subtract this from 50 to find out the quantity used.

4. CALCULATIONS

a) FOREMULA

$$\frac{\text{No. ml. of Silver nitrate added} \times \text{N. Ag } NO_3 \times 35450}{50 \text{ ml}}$$

= mg/L of CL.

b) Prepared table - already calculated

Silver Nitrate added ML	Chloride in water MG/L
1	100
5	100
10	200
15	300
20	400
25	500
30	600
35	700
40	800
45	900
50	1000

5. Solomon Island Standards for drinking water (Chloride)

In Solomon Islands we are still using the W.H.O standards which is:-

- Maximum desirable level of chloride =200mg/L
- Maximum permissable level of chloride =600 mg/L

6.5. FIELD KIT FOR TESTING TURBIDITY.

1. EQUIPMENT

We use the easiest way of testing turbidity by preparing with the use of distilled water and clean inorganic (Sterilized) silt a set standards of 100ml, volume each, Then seal the test tubes. Shake up the standards and compare with the sample to find out turbidity.

2. ESTABLISHING SETTLING VELOCITY

In establishing settling velocity, the standards must be shaken well before the readings, but the sample should not, contrary to the normal Establishment of turbidity when both the sample and the standards must be well shaken.

1. Fill one test tube with the sample water.
2. Compare the upper half of the sample with the standards in 10, 15, 30, 60, 90, 120, 240 intervals.
3. Repeat the test and average Results.

For example

A stream which has a turbidity reading 250 degrees is to be utilized for drinking.

Then the duration of detention in this case is:

Reading after minutes	1st Test	2nd Test	Average Turbidity
10	200	180	190
15	180	160	170
30	150	135	142½
60	120	110	115
90	80	70	75
120	45	30	37½
140	15	10	18½

A detention time of 4 hours is required so that the turbidity could reach less than 20 degrees and thus possibly filter through a slow sand filter.

7.0. WATER TREATMENT

7.1. FILTRATION

When the quality of surface water is doubt (due to high turbidity or risk of contamination), therefore the following provisions have been included in the design of water works in Solomon Islands.

The provision includes either filtering the water or drawing the water from an infiltration gallery.

A) FILTRATION

Filtration of water requires elaborate concrete works which consists of sedimentation tanks and filter boxes.

B) INFILTRATION GALLERIES

As stated before when surface water is doubtful it was found a very good practice to have the design provisions to draw water from infiltration galleries.

In Solomon Islands the type most suitable for a locality depends on the findings during the Pre-construction survey. There are factors which are always considered before the latter is constructed, these includes soil formation and head of water.

If the ground water is not permeable enough for sufficient water to be extracted from a well, it is possible to build an "infiltration gallery" under the bed of the body of surface water. This is basically a horizontal tube well. Instead of the tube, a collector pipe is laid with its joints open so that water can drain into them. Gravel and sand must be carefully placed around it in layers, so that each layer is a little finer than the one inside it. This is to prevent the fine sand from running into the pipe and blocking it. The collector pipe is closed at one end, and the other end leads the water into a collecting well, from which it can be pumped in the usual way.

Alternating, a gallery could be built beside a stream by raising the water level by a dam. This has the additional advantage that water is stored behind the dam. The sand and gravel are deposited behind the dam. The stored water will be partially purified by seeping through the sand, and will not be lost by evaporation.

7.2 CHLORINATION

Chlorine have been found to be the most useful disinfectant in Solomon Islands for its water works and is effective against the bacteria commonly associated with water-borne disease.

The ability of maintaining Chlorine in the distribution network makes the use of chlorine the more sought disinfectant since this added characteristic in chlorine makes it as a useful chemical since it safeguards the consumer against contaimination which might occur during main repairs, leakage or through faulty plumbing installations etc -

Many Factors generally affect the concentration of chlorine in water, such as the contract period, the temperature of water, and the presence of organic matter. Chlorine enters almost instantneously into chemical combination with organic matter found in water and in water and in such a "combined form" is only of limited use for disinfectant.

Three forms of chlorine (that is the chlorinated lime, the HTH and the sodium hypochlorite solution), a stock solution containing 1% chlorine or as desired is made and applied to the water as a concentrate by means of mechanical devices know as hypochlorinators.

The required dosage of chlorine varies with the degree of organic pollution and the minerals or gases process which are subject to oxidation. The dosage should be sufficient not only to meet the "Chlorine Demand" of the water but also to maintain a dectable chlorine residual in the water at distance points of the water distribution system.

The application of chlorine in Solomon Islands to water works varies from one type of water to another. Thus each type of water requires different dosages due to increased turbidity after heavy rain etc .

8.0. OTHER MEASURES IN MONITORING, SURVEILLANCE OF WATER in SOLOMON ISLANDS.

8.1 REGULATIONS TO CONTROL WATER SOURCES AND QUALITY IN SOLOMON ISLANDS.

This is a legal method enforce by the Ministry of Health and Medical Services through her environmental Health Staff to safeguard the water sources in Solomon Islands.

This has been long introduced due to facts that water sources in Solomon Islands especially those at the rural areas have been found faecally polluted either from animals, human beings etc or water quality sometimes been adultrated.

This also have been found most effective in Solomon Islands.

8.2 REGULAR BACTERIOLOGICAL SAMPLING.

The need to control water quality is an essential fact since it is as food, it should be under sanitary control. It has been found a good practice to sample both rural and urban water supplies from time to time but as it is expensive to rural isolated areas therefore in rural water supply situations the emphasis have been placed on "Sanitary Surveys". If a sanitary Survey is carried out around the source it is possible to tell even before bacteriological results are available whether the water is polluted or not.

After "Sanitary Survey" is carried out remedial measures be taken to correct the situation. This does not mean banning the taking of samples from rural water supplies, it is quite the contrary, it is meant to emphasis the need to take samples when pollution persists even after remedial measures are taken.

Samples are usually collected in sterile bottles and must be taken properly and packed in ice boxes and delivered to the Laboratory for analysis. This must be done as quick as possible.
The following method is used in Solomon Islands:-
EQUIPMENTS:-

a) sterile bottles
b) labels
c) gas burner
d) match
e) pen
f) ice
g) box
h) bacteriological forms

If sample is taken from the source, the sterile bottle is dipped down below the surface and water is collected, labelled with time, date, and the source

If samples are taken from taps then the tap have to be heated first for 5 mins before turning on and sample is collected.

On the Bacteriological forms should be filled in immediately with time, date, serial number, the location of smapling point and officer taking sample and on delivering to the Lab. it should accompany the samples.

In Urban areas Bacteriological samples are usually taken every week and in rural areas it is taken monthly. There is another type of sterile bottle used, this is mainly for isolated areas from the Lab. and this is called field screening bacteriological sampling bottles.

This consists of sterile bottle, sterile paper containing chemicals and same method as above, is applied when sample of water is taken. This samples are not send to the lab. but retain in a cool place for 24 hrs. If the water is polluted the reaction will take place in the bottle between the bacteria and the chemical which produces hydrogen sulphide which gives out nasty smell and sample turning black. But this does not tell you what type of bacteria is present in the water untill the bacteriological samples results are received from the lab.

These two types of sampling are usually carried out together, one for Bacteriological sample and one for field screening test to each point of sampling.

On receiving the sampling Test results the Health Inspectors will make his move in remedying the situations if it is polluted.

8.3. REGULAR MONITORING OF CHLORINE LEVEL IN WATER SUPPLY SYSTEMS

In urban water supplies in Solomon islands the amount of chlorine added to water systems is carried out by the water unit of the Ministry of works and utilities and Environmental Health staff of the Ministry of Health and Medical Services is carrying out the monitoring of the chlorine level in the urban water systems.

In urban water supplies systems are fitted with hypochlorinators and therefore the level of chlorine whether of free chlorine or Residual chlorine must be monitored.

Our permissible level is 0.4. mg/l on chlorine reading scale and can be adjusted higher depending on the bacteriological results (For drinking water).

In rural water supplies chlorine might not be possible for some water supplies, this also depends on bacteriological resutls.

Monitoring of chlorine level in water supply systems in Solomon Islands is very important due to fact that chlorine sometimes are added into water systems in large quantities by the water Unit especially urban water supply system disregarding the permissible amount of chlorine of each urban water supply system.

In Solomon Islands we use the following reagents/DISCS.

a) REAGENTS

Reagents for determining	DPD Tabet No.
- Total REsidual chlorine	4 or (No. 1 & 3)
- Free and combined chlorine	1 & 3
- Free chlorine & Monochlorine	1, 2 & 3

b) Standard disc. used in Solomon Islands

STANDARD DISCS	RANGE
- 3/40A (for drinking water)	0.1 to 1.0 mg/l
- 3/404 (for sterilizing well etc)	1 to 10 mg/L

NOTE: Information on Hydrogen sulphide Field screening Test

Equipments

- Sterile Bottle
- Sterile Tissue Paper

- Ingredients added to the Tissue
  - Peptone - 20g
  - Potassium hydrogen phosphate - 1.5g
  - ferric ammonium ~~syndrate~~ citrate - .75g
  - Sodium thiosulphate - 1g.
  - Tepol - 1ml
  - Water - 50ml.

1 ml to each bottle and a total of 50ml produced =50 bottles.

9.0. PRESENT QUALITY OF WATER IN SOLOMON ISLANDS

The quality of water in Solomon Islands since 1986 was fairly good. The very bad results were in early 1986 when cyclone Namu striked the Solomon Islands.

We have the following permissible levels of Bacterial pollution.

Table 1.1

Sampling Frequency	TOTAL COLIFORMS PER 100 ML	FAECEL COLIFORMS PER 100ml
- Weekly	1-10	0
- Monthly	1-10	0
- Three monthly	10	0 but 1.5 permissible
- Every 6 months	10	0 but 2.5 permissble

The quality mentioned above exludes turbidity, organic suspended matters. It is alway's the aim of the Health inspectors in Solomon Islands to keep bacterial level at permissible levels as well as permissible chlorine level.

10. CONCLUSION

Solomon Islands is one of the highest rainfall receiver per year therefore it is always the aim of the government to provide the people with better quality of water as the Country is experiencing pollution to water sources from floodings and other sources of pollution.

There are no proper water treatment plants to larger water works in urban areas this is due to financial difficulties and our government is working on the project to remedy the situation on turbidity and other pollutions (Sources).

In our rural water supply systems it has been found that poor maintenance leads to contaimination of water quality and therefore policies on maintenance have been implemented and used to remedy the situation.

Other measures in controlling water quality have also been looked into and this consists of regulations mainly to safeguard the water sources as well as protecting the quality of water in Solomon Islands, Sanitary surveys, regular Bacteriological sampling, regular chlorine level monitorings and rarely testing for salinity and turbidity.

REPORT ON WATER BORN DISEASE 1988 - HONIARA

CITY COUNCIL ONLY.

				CASES
Jan	-	Diarrhoea (Infants)	-	61
	-	Diarrhoea (Child & Adults)	-	131
Feb.	-	Diarrhoea (Infants)	-	95
	-	Diarrhoea (Child & Adults	-	125

		Under 1 yr	1-4yrs	5 yrs & Over
March -	Diarrhoea	29	33	81
-	Jaundice	1	0	3
-	Trachoma	0	0	0
April -	Diarrhoea	16	59	127
-	Jaundice	1	1	5
-	Trachoma	12	36	175
May -	Diarrhoea	25	62	125
-	Jaundice	1	2	2
-	Trachoma	0	0	2
June-	Diarrhoea	33	47	139
-	Jaundice	1	0	0
-	Trachoma	0	0	0
Aug -	Diarrhoea	32	75	118
-	Jaundice	0	2	2
-	Trachoma	0	0	0
Oct -	Diarrhoea	15	75	111
-	Jaundice	2	3	2
-	Trachoma	0	0	0
Nov -	Diarrhoea	24	68	125
-	Jaundice	0	0	1
-	Trachoma	0	0	0

Note: High cases of Diarrhoea recorded is not due to water alone but also include diarrhoeal cases from others.
There are no proper defined cases of mortality to water borne diseases recorded during the above period for Honiara city Council.

SUMMARY OF RESULTS OF MORBIDITY/MORTALITY

SURVEY - DIARRHOEAL DISEASES

1. Under five mortality rate:

$$\frac{d}{a} \times 1000 = \frac{41}{2757} \times 1000 = 14.9 \text{ per } 1{,}000$$

2. Under five diarrhoea associated mortality rate:

$$\frac{e}{a} \times 1000 = \frac{18}{2757} \times 1000 = 6.5 \text{ per } 1{,}000$$

3. Under five diarrhoeal death rate:

$$\frac{e}{d} \times 100 = \frac{18}{14} \times 100 = 43.9$$

4. Annual Under five diarrhoeal incidence

$$\frac{b}{a} \times 26 = \frac{293}{2757} \times 26 = 2.76 \text{ episodes per child/year}$$

5. Under five ORT Usage rate:

$$\frac{c}{b} \times 100 = \frac{219}{293} \times 100 = 74.7\%$$

6. Under five ORS Usage rate:

$$\frac{f}{b} \times 100 = \frac{83}{293} = 28.3\%$$

7. Under five custom medicine usage rate: *

$$\frac{g}{b} \times 100 = \frac{25}{293} = 8.5\%$$

* This figure No. 7 should be regarded with some caution as data may not be complete. It is included to point out significant role custom medicine may play in treatment of diarrhoeal diseases.

WORLD HEALTH ORGANIZATION
WESTERN PACIFIC REGION

ORGANISATION MONDIALE DE LA SANTE
REGION DU PACIFIQUE OCCIDENTAL

REGIONAL CENTRE FOR THE PROMOTION OF
ENVIRONMENTAL PLANNING AND APPLIED STUDIES (PEPAS)

REGIONAL WORKSHOP ON DRINKING WATER QUALITY MONITORING AND SURVEILLANCE

Kuala Lumpur, Malaysia
27 February - 3 March 1989

ICP/RUD/001 PROG/112/CR-011

ENGLISH ONLY

COUNTRY REPORT

TONGA

by

Mr Lelea Tuitupou

Mr Filipe Fatongia Koloi

COUNTRY - PAPER

REGIONAL WORKSHOP ON DRINKING - WATER

QUALITY MONITORING AND SURVEILLANCE

KUALA LUMPUR, MALAYSIA

27 FEBURARY 1989 - 3 MARCH 1989

COUNTRY: KINGDOM OF TONGA

PATICIPANT 1: FILIPE F. KOLOI
MANAGER - ENGINEER
TONGA WATER BOARD
NUKU'ALOFA.

2: LELEA TU'ITUPOU
A/SENIOR HEALTH INSPECTOR
MINISTRY OF HEALTH
NUKU'ALOFA.

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LOCATION: The Kingdom of Tonga is at South of equator between 15^{o}s and 23^{o}s and just west of the International Dateline. Consist of 170 islands with total area of 260 square miles. Main groups of islands are Tongatapu, Vava'u, Ha'apai, 'Eua and the two Niuas. Total population about 100,000 and annual rainfall at 72 - inches.

SOURCE OF WATER SUPPLY: Groundwater is the main source of supply except 'Eua. Rain water catchment at Ha'apai and Niua plus of course private ownership. Groundwater safe yield in Tongatapu at 14 imgd but current abstraction for Nuku'alofa at jsut over 1 imgd.

COMMUNITY WATER SUPPLIES:- About 82% of the population of Tonga has access Community Water Supplies, with piped distribution systems. Tonga Water Board operates Nuku'alofa Water Scheme (main urban centre, Tongatapu), Neiafu Water Scheme (main urban centre for Vava'u), Pangai - Hihifo Water Scheme (main urban centre for Ha'apai) and 'Eua Water Scheme. The Ministry of Health supervise the village water scheme with a village water committee. Continous chlorination practised for the Water Board piped system.

"WATER - BORN" DISEASE:

See table

DRINKING WATER QUALITY STANDARDS:-

W.H.O. "International Standard for Drinking Water" is being used as guidelines. Two major considerations here: this standard would need another New Department to be operational just to satisfy this standard and only standardiz the water inside the pipeline and up to the tap, not the health benefits to the humanbody.

FREQUENCY OF SAMPLING:-

Frequency of sampling been improved by the need to report at each Board monthly meeting, resulting in Neiafu (Vava'u) 'Eua and Pangai (Ha'apai) being 3 - 4 week and Tongatapu fortnightly. Resources that control sampling were the availability of independent sampler (M.O.H. Health Inspector instead of Board's employee) and air transport to reach the Tongatapu Laboratory, same date. This system were somewhat continous because Minister of Health was also Chairman of Tonga Water Board.

If the analysis showed E - Coli present then chlorination could be carried out because its the Board manpower but Re - sampling might be difficult because the Independent sampler might not be available.

LABORATORY AND MANPOWER:

The present Laboratory in the Ministry of Health could handle 20 water samples per week for Bacteriological tests. There is only one technician attending to the Water Samples; but the testing of water samples is a extra burden to the Ministry of Health Laboratory. There are Field Kit for chemical analysis but no field kit for Bacteriological tests.

Technicians could be trained in this Laboratory for a period of 12-months. Existing Health Inspectors could "sample" the water for testing.

The Tonga Water Board is currently designing a new Laboratory as perhaps national water laboratory. A scholar being trained at an overseas university to be chemist failed last year. One qualified chemist plus local trained technicians could operate this new laboratory.

COST INVOLVED IN MONITORING:-

Costs are hard to estimate as health benefits for water are not easily quantified. direct diseases from polluted water not easily separated. Typhoid outbreak was not initiated from the reticulated water supply. Diarrhoeal disease more likely to come from a dirty cup than polluted water.

For each sample:-

Sampler takes 5 minutes, driver to/from Airport takes 10 - minutes, Lab technician 24 hours but effective work in 2 hours and typist and others takes 5 - minutes:-

Therefore: Mainpower of 2 hours 20 minutes @ $30 per 40 hour = $7-00
provision cost for electricity, reject samples airfreight etc. = $3-00
$10-00

Number of samples per month:

3 - 4 weeks:

Neiafu - 10, 'Eua - 10, Pangai - 6

Therefore averaged for 30 samples per month.

2 - weekly:

Tongatapu - 30

Therfore: cost per month = 60 X $10-00 = $600
or Annual cost = 12 X $600 = T$7200 p.a.

So a good approximation be T$10-00 p.a.

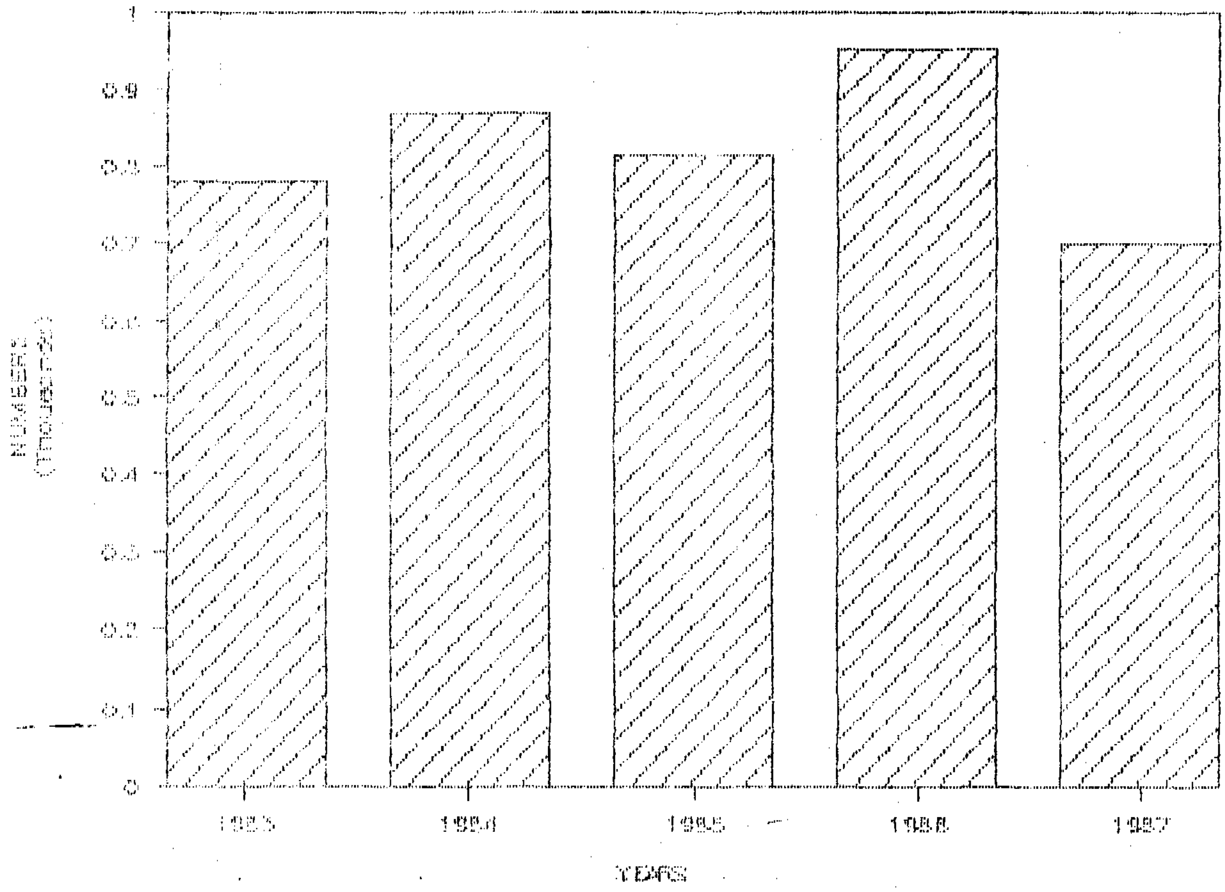
Thus this is urban water supply monitoring and only few rural villages in Tongatapu; it does not include rural villages of Ha'apai, Vava'u, rest of Tongatapu, 3 - villages of Niuatoputapu and rainwater in Niuafo'ou, Tafahi and other islands.

REPORTED CASES OF WATER-BORN DISEASE
IN TONGA 1983 TO 1987

YEARS	TYPHOID	GASTRO	INF-DIAR	ADULT-DIAR
1983	8	2051	780	522
1984	3	2057	869	772
1985	28	2180	814	571
1986	38	1918	951	492
1987	18	1765	698	356

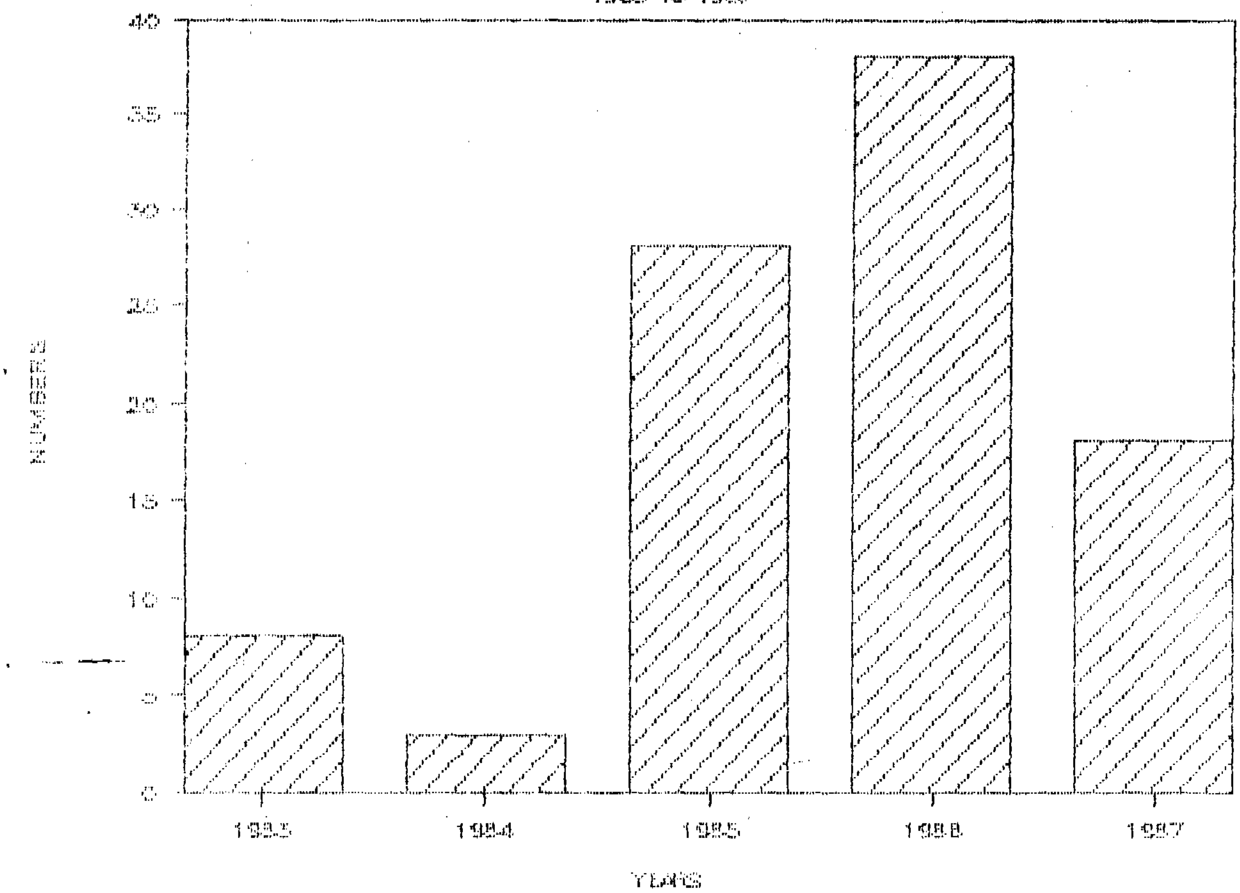
REPORTED CASES OF INF-DIARRHOEA IN TONG

1983 TO 1987



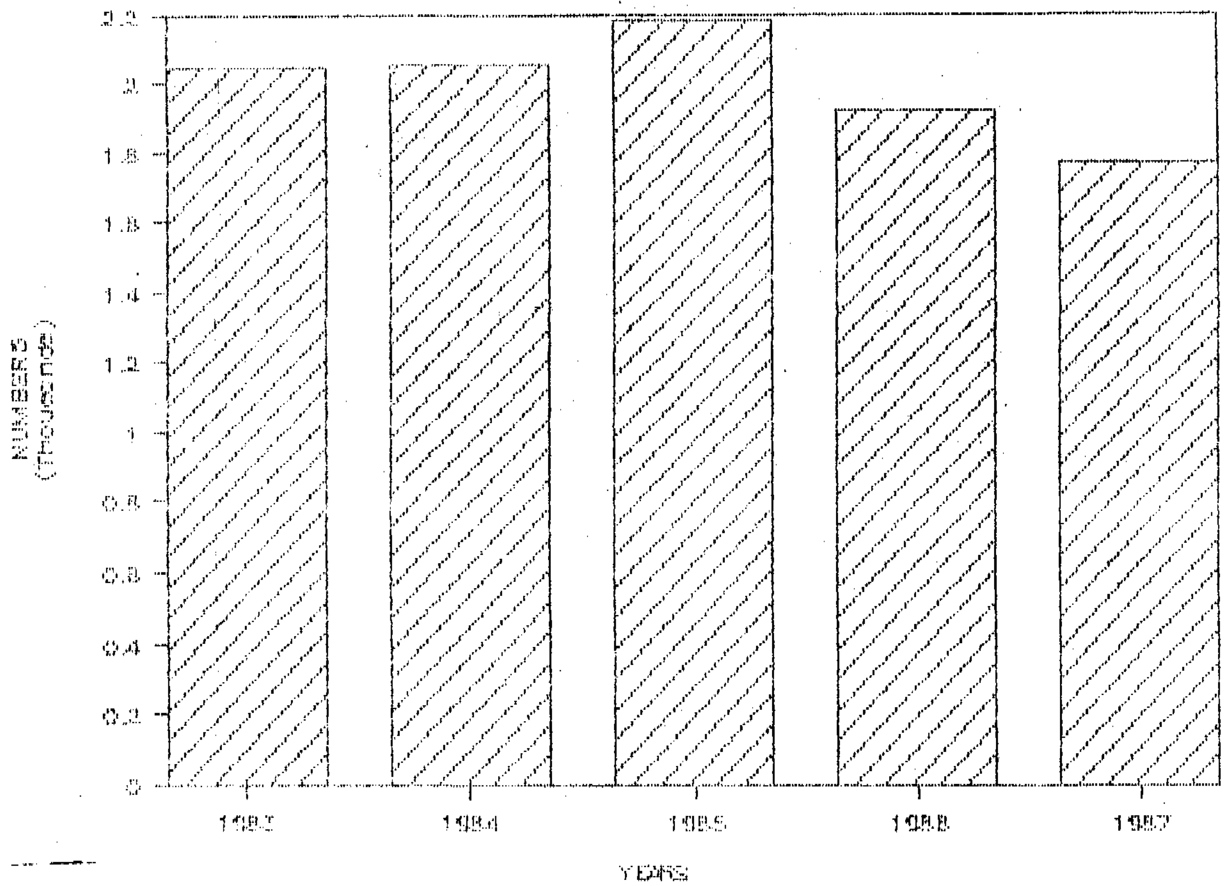
REPORTED CASES OF TYPHOID IN TONGA

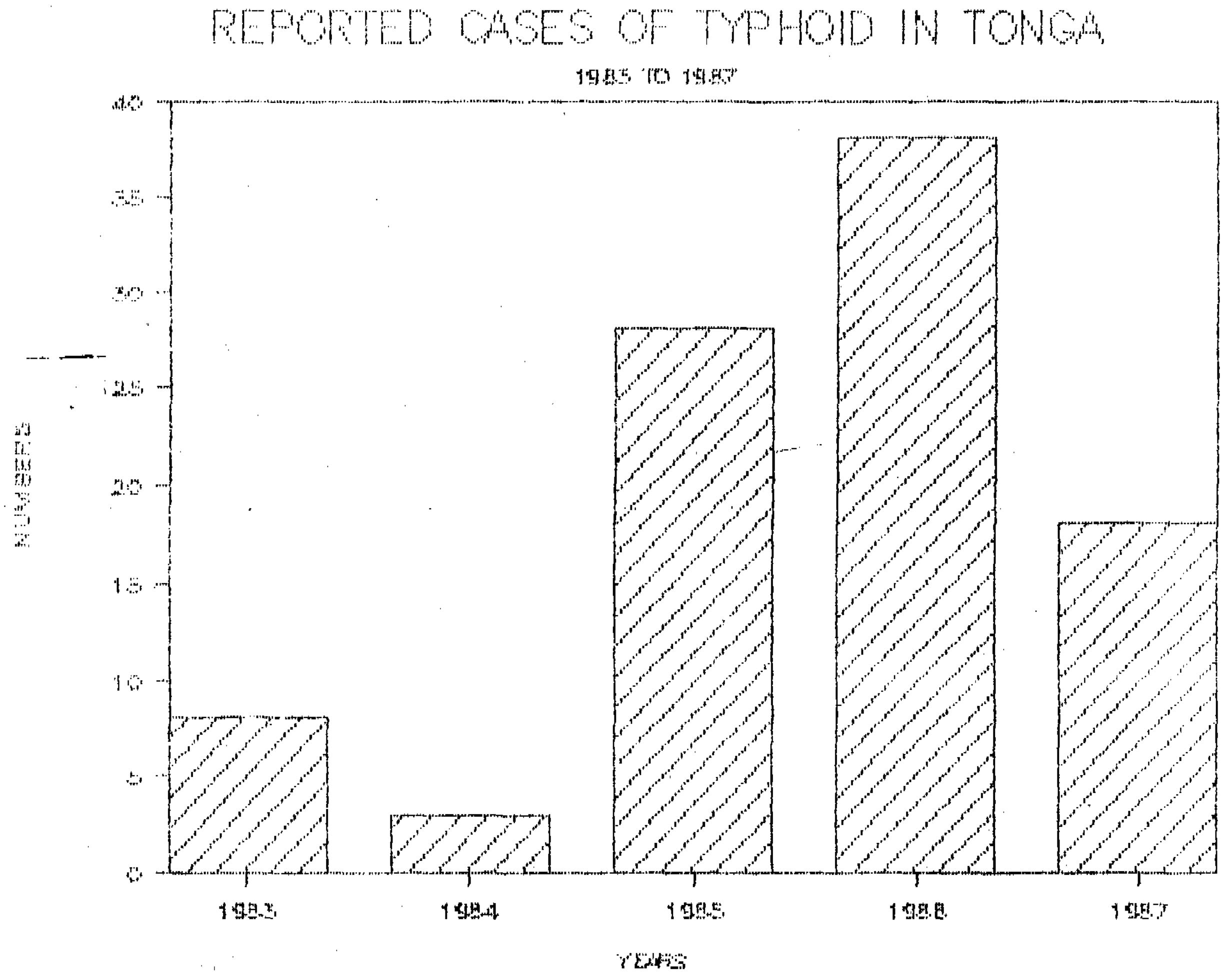
1983 TO 1987

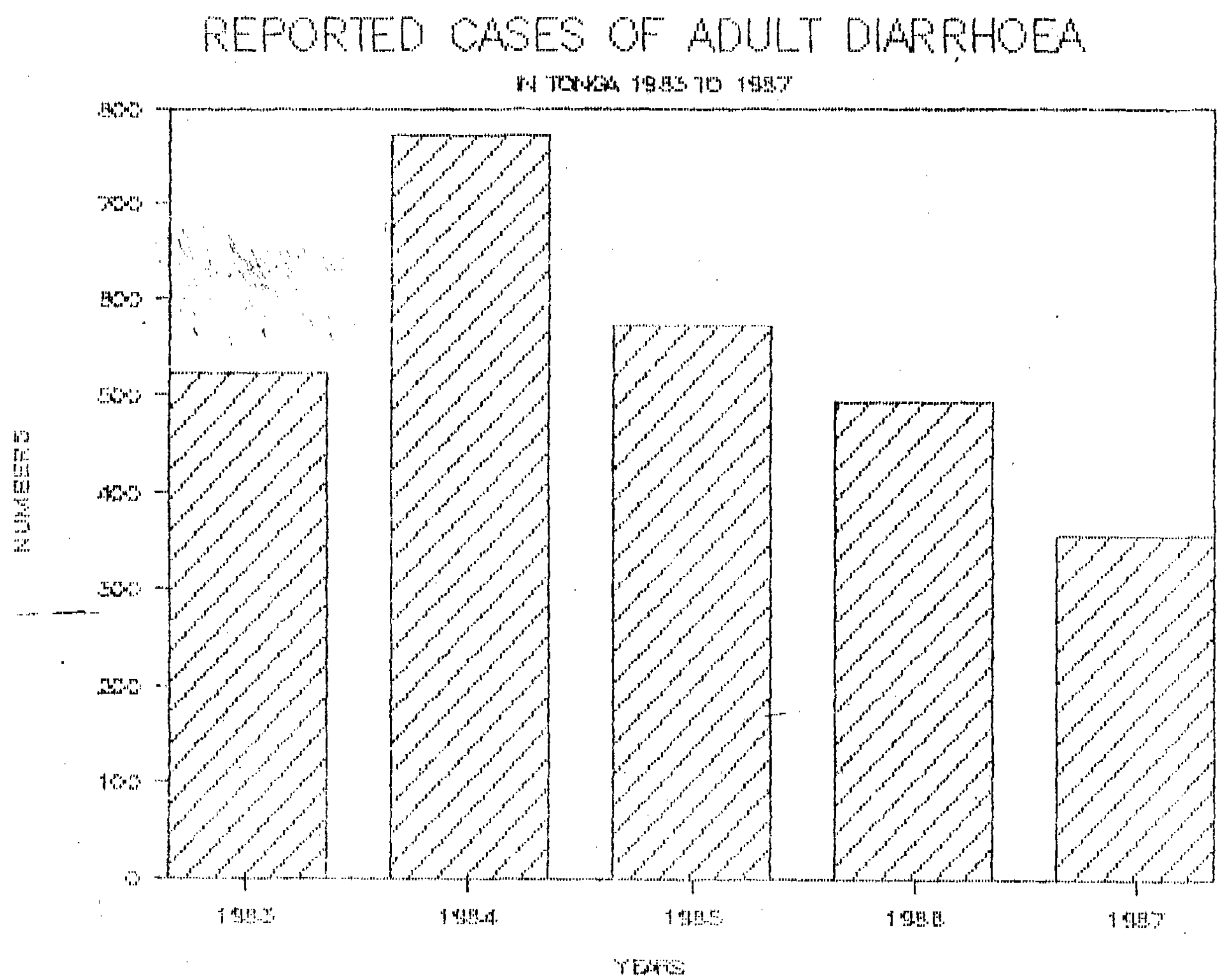


REPORTED CASES OF GASTROENTERITIS

IN TONGA 1983 TO 1987




REPORTED CASES OF TYPHOID IN TONGA
1983 TO 1987
NUMBERS
40
35
30
25
20
15
10
5
0
1983
1984
1985
1986
1987
YEARS



REPORTED CASES OF ADULT DIARRHOEA
IN TONGA 1983 TO 1987
800
700
600
500
400
300
200
100
0
NUMBERS
1983
1984
1985
1986
1987
YEARS

CENTRAL PUBLIC HEALTH LABORATORY

VAIOLA HOSPITAL

Date: 6/2/89

Result of Bacteriological Analysis of Water

		Coliform/100mls	Faecal Coliform/100mls
1.	Popua	Nil	Nil
2.	Queen Salote Wharf	Nil	Nil
3.	Dateline Hotel	Nil	Nil
4.	Kiteau Topui Bakery	Nil	Nil
5.	Halavave 1	Nil	Nil
6.	Halavave 2	Nil	Nil
7.	Desicated Factory	Nil	Nil
8.	Hospital	Nil	Nil
9.	Fua'amotu Airport	Nil	Nil
10.	Pelehake	460	150
11.	Malapo	460	21
12.	Vaini	15	4
13.	Veitongo	240	15
14.	Ha'ateiho	7	7
15.	Pea	43	23

Performed by:...........

Sitino Maka
Assistant Lab. Technician

WORLD HEALTH ORGANIZATION
WESTERN PACIFIC REGION

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REGIONAL WORKSHOP ON DRINKING WATER
QUALITY MONITORING AND SURVEILLANCE

ICP/RUD/001 PROG/112/CR-012

Kuala Lumpur, Malaysia
27 February - 3 March 1989

ENGLISH ONLY

COUNTRY REPORT

VANUATU

by

Mr Elison Sese Bovu

THE GOVERNMENT OF THE REPUBLIC OF VANUATU
GOUVERNEMENT DE LA REPUBLIQUE DE VANUATU

MINISTERE DE LA SANTE
MEDECINE PREVENTIVE
BPXXXX
Port-Vila

MINISTRY OF HEALTH
PREVENTIVE MEDECINE
Private Mail Bag
Port Vila

Our Ref :

Date : 13/02/89

**REGIONAL WORKSHOP ON DRINKING WATER
QUALITY MONITORING AND SURVEILLANCE
KUALA LUMPUR (MALAYSIA)**

27 February - 3 March 1989

COUNTRY REPORT

REPUBLIC OF VANUATU

by

ELISON.S.BOVU

VANUATU 1979 - (1986)

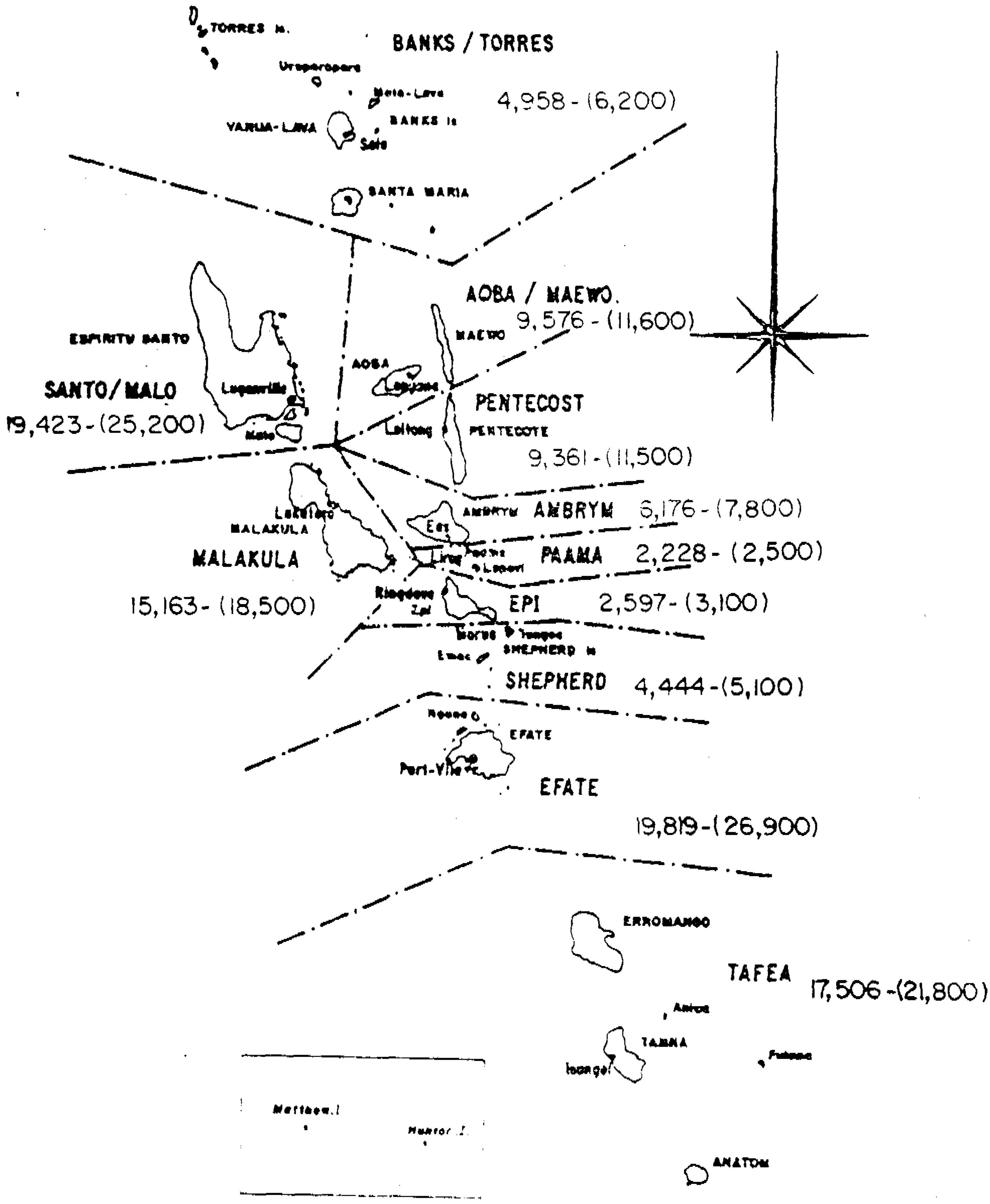
TOTAL POPULATION

111,251 - (140,154)

VANUATU

Local Government Regions

• Sola .... Local Government Councils



GEOGRAPHY AND CLIMATE

Name :Republic of Vanuatu

Location : south-west Pacific,latitudes 13 and 22 south,longitudes 166 and 172 east. approx. 80 islands.

Total Area :12,200 square kilometers

Total Population: 140000

National Capital: Port Vila

Annual Growth Rate:2.8%

Date of Independence: 30 July,1980

Climate From tropical in the north to a sub-tropical in the south.

Average Temperature: maximum 88°F

minimum 72°F

Precipitation: average rainfall is about 2300 mm.

Wind : south-east prevailing

Seasons : November to April-rain,warm(cyclone season)

May to October -cool,dry

Hydrography : considerable number of streams decend to the sea in all the islands but only few major rivers.

sometimes lakes are maintained in volcanic depressions.

Introduction

The importance of an adequate and safe drinking water supply for the people of Vanuatu has been realised and programmes in this sector are being fully supported by the government.
Its commitment to this led to the adoption of the UN International Drinking Water Supply and Sanitation Decade programmes(IDWSSD).
Therefor,the planned activities underthis two sectors(Water & Sanitation) have been included in the First National Development Plan (NDP1) and again in the current NDP2.
At the end of 1987,about 61.4 % of the country's population had access to an adequate water supply.

Idealy,water supplies in rural areas are taken to be safe for direct consumption however,it would be noted that our rural communities tend to be concious and selective in what type and state of water they would drink.
There are no reported and confirmed cases of a waterborne disease in the country however,the incidence of diarrhoeal diseases is prevalent through out the country and mostly so for some smaller islands. Such cases are mostly suspected in connection with poor hygiene in homes and also in areas having no water supply or an inadequate supply of water.
It is believed by health officials that a number of water supply sources especially those serving larger communities, are susceptable to feacal contamination but it does not show due to the fact that people tend to prefer drinking rain water than that from communual standpipes.

Development Ojectives

The government objectives for the Water Supply development during the NDP2 period are to:

- increase the coverage of piped and rural watersupply schemes through out the Republic;
- upgrade existing rural water schemes which do not meet basic specifications and standards of reliability;
- increase the distribution of Urban domestic watersupply schemes and improve the quality of supply where necessary.

Strategy and Policy

The strategies pursued inorder to achieve water supply ojectives are:

- provide sufficient funding to expand the capacity of water supply facilities;
- expand data compilation and investigative resources necessary for water resource development;
- continue to provide appropriate programmes to train LGCs personnel in the maintenance of rural watersupply schemes;
- enact appropriate water resources legislation;

...2/

-reduce wastage of water through improved leakage detection procedures in Port Vila and Luganville.

Water Quality Standards

For Public standpipe supplies: WHO standards have been adopted however ,it is not followed or rather applied to rural water supplies schemes due to lack of equipments and the necessary supplies. Taste and visual appreance acceptable to the consumer.

For wells with Handpump, a same quality standards is desired and a protected zoning of 30m minimum from possible sorces of contamination. Again the rainwater catchments/storage desired the same quality standards especially the absence of faecal coliforms. Raincatchments are built to a standard that they are protected from possible means of contamination.

The Health Department is in principle responsible for monitoring the water quality but to date very little is being done in this area. Concerning watersupply for the two urban centres,Port Vila supply is treated(chlorine gas) and the chlorine level is being reqularly monitored by the responsible health staffs and as for Luganville town,only the field screening test(FST) which was introduced by theWHO Technical Officer attached to the Health Ministry) is being periodicly done as a measure to detect any possible contamination.

WHO,through its Technical Officer again has provided alot of assistanc especially,in technical and training areas and finance to increase the service levels in both the water supply programme and the Basic sanitation programme. This is being greatly appreciated by the Government,for this two sector programme must progress if possible, at the same rate to ensure achieving the commom desired objective as stated in the IDWSSD programmes for Vanuatu.

Implementing Agency.

Public Works Department(PWD)under ministry of Transport is reponsible for construction,maintenance and operation of the two urban watersupply systems and the supply system of the other three semi urban centres of Norsup,Isangel and Lakatoro.
Rural water supply Unit under the Dept. of Mines & Geology is responsible for the planning,designing and construction of rural water supplies in the country. Other local authorities, community groups and NGOs also play or contribute in funding smaller water schemes,especially rainwater catchments.(tanks).
In both rural and Urban water supply systems, the Health Dept. as earlier stated is in principle resposible for monitoring the quality of these schemes.

Humanresource Development

Perhaps the important aspect to mention here is in the area of local training courses conducted by both the Health Dept. for its field officers(Village Sanitarians) and by Rural Water supply unit for its project officers as well as for village sanitarians. Both departments benefit from technical assistance and financial assistance from WHO and Australian aid/grants respectivly.

A local programme of training in Basic Plumbing and Inter-midiate plumbing had started in 1986 and over 22 personnels from throughout the eleven Local government Councils(LGC) regions have undertaken this courses. This includes EH staffs(village sanitarians) who are employed by the LGCs ,thus enabling them among their respective duties,to also able to carryout maintenance and minor repairs to the water schemes in their areas.
Thirty-four(34) village sanitarians are currently working throughout the 11 LGC regions in the country. It will be these catergory of health workers who will greatly assist in executing the future monitoring and survellance programme of Drinking-water in the country

Future Projects.

The governmentofVanuatu has forworded a request to SPREP and WHO for the establishment of a Monitoring and Survellance Project of Drinking -Water for the country. This project to be started as a pilot project has several componets,eg.training,equipment purchasing etc. and is to commence this year 1989 and hoped to be in full operation after 1990/91 when appropriate formal consultation by WHO and other appropriate bodies on the subject have been made.

References: NDP2 Document by NPSO-VanuatU.

: 198 Rural Water Supply Programme-By RWS Engineer.

: Village Sanitarians Monthly Reports.

: Water & Sanitation Consultation Report by WHO Technical Officer,Vila.

: Minutes of meeting on Vanuatu Government request for the Establishment of M&S pilot project of Drinking water quality -13 October 1988.(by Govt.Officers and Dr.R.Helmer,WHO consultant.)

WORLD HEALTH ORGANIZATION

WESTERN PACIFIC REGION

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REGIONAL WORKSHOP ON DRINKING WATER
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ICP/RUD/001 PROG/112/CR-014

Kuala Lumpur, Malaysia
27 February - 3 March 1989

ENGLISH ONLY

COUNTRY REPORT

WESTERN SAMOA

by

Mr Ainini Tiumalu Apia

Electricity
springs
wells

Sanitary Survey is
costly will gain fair eyes
No testing
excellent village cooperation

NATIONAL REPORT : WESTERN SAMOA

WORKSHOP ON DRINKING WATER QUALITY MONITORING AND SURVEILLANCE PEPAS : 27 FEBRUARY-3 MARCH 1989

1. PREFACE - GENERAL COUNTRY PROFILE:

The island of Western Samoa lies between latitudes 13 degrees and 15 degrees south, 168 degrees and 173 degrees west, close to the International Dateline. The Western Samoa group is located 4160 km southeast of Hawaii, 2880 km from New Zealand and 4320 km from Sydney Australia. Its nearest neighbour is American Samoa. The Independent State of Western Samoa consists of two main islands, namely Savaii and Upolu with smaller islands Apolima, Manono, Fanuatapu, Nuutele, Nuulua and Nuusafee. The total land area is 2830.8 sq. km. Savaii is the largest island of 1700 sq. km; the second largest island is Upolu of 1110 sq. km where the capital Apia is located.

The total population of Western Samoa is just over 160,000 people which include the largest concentration of full-blooded Polynesians in the world. The climate of Western Samoa is tropical with abundant rainfall. Humidity averages 80%. The average monthly temperature ranges from 22 to 30 degrees Celsius with very limited seasonal variations. There are two major distinguishable seasons. The rainy season extends to November through April, the dry season from May through October. The annual rainfall is 2880 mm, although there is great variation with latitude and location.

2. NATIONAL PROGRAMME AND POLICY OF DRINKING WATER QUALITY MONITORING AND SURVEILLANCE:

(a) The Departments of Health, Public Works and Observatory, a section of Agriculture are Government authorities responsible for monitoring and surveillance of drinking water quality, but to date, not much has been done to it except when public crises arise.

(b) Only when someone polluted a source, then actions are to be taken against the offenders but not for quality monitoring and surveillance.

(c) There is no national drinking water quality standard in Western Samoa. We are only using the WHO standards as guidelines for our drinking water quality.

(d) There are 3 Government bodies involved in drinking water quality monitoring and surveillance.

 (i) Observatory Section - testing of water prior to use of such for a source of water supply and also ad hoc sampling.

Department of Health

Ten Leading Causes of Morbidity for 1988

	Disease	Number	Incidence (/10,000)	Percent of All Known Cases
1.	Influenza	7,428	467.3	40.2%
2.	Gastroenteritis/ Diarrhoea	1,356	85.3	7.3%
3.	Pneumonia	1,251	78.7	6.7%
4.	Bronchitis/Emphysema	542	34.1	2.9%
5.	Conjunctivitis	280	17.6	1.5%
6.	Unspecified Diseases of the Digestive System	233	14.7	1.3%
7.	Infection of the Skin & Subcutaneous Tissue	226	14.2	1.2%
8.	Obstetrical Diseases/ Reasons	193	12.1	1.0%
9.	Hypertensive Disease	174	10.9	0.9%
10.	Congestive Heart Failure	152	9.6	0.8%
	All Known Cases of Morbidity	18,469	1,162.0	100.0%

DEPARTMENT OF HEALTH

TEN LEADING CAUSES OF MORTALITY 1986

Disease	Number	Incidence (/10,000)	Percentage All Deaths
1. Congestive Heart Failure	54	3.4	18.7%
2. Cerebrovascular Disease	32	2.0	11.0%
3. Pneumonia	30	1.9	10.4%
4. Suicide	19	1.2	6.6%
5. Chronic Liver Diseases and Cirrhosis	17	0.9	5.9%
6. Acute Myocardial Infarction	13	0.8	4.5%
7. Septicemia	12	0.8	4.2%
8. Diabetes Mellitus	10	0.6	3.5%
9. Intestinal Infectious Diseases	10	0.6	3.5%
10. Symptoms, Signs and Ill-defined conditions	8	0.5	2.8%
All Cases of Mortality/ Registered Deaths	322	18.2	100.0%

(ii) Public Works Department - survey, sampling and maintenance of Government water supply systems only.

(iii) Health Department - survey, sampling and analysis of all water systems, usually upon complaints from the public. Consultations and advising the public for proper measures of maintaining good quality water supplies, for both Government water supply systems and *community water supply system.

3. WATER QUALITY MONITORING AND SURVEILLANCE PROGRAMMES AND RELEVANT LAWS:

(a) In Western Samoa, there is no current programme of drinking water quality monitoring and surveillance. The only means of maintaining a potable water supply is by general sanitary inspections and sampling but not on a regular basis. Health Department, Observatory Section and Public Works Department, have just proposed a drinking water quality monitoring and surveillance programme in January this year. Likewise there is no national standard of drinking water quality in Western Samoa but we are trying to follow the WHO standards even though we are far behind of such standards.

(b) Also there is no law in Western Samoa which spell out drinking water quality monitoring and surveillance. We are only using general powers given under some Acts and Regulations for general inspections and sampling.

4. CURRENT PRACTICES OF DRINKING WATER QUALITY MONITORING AND SURVEILLANCE:

(a) As I previously mentioned, water sampling in Western Samoa is not regular. Most of the sampling has been done by inspectors of the Health Department, during their general sanitary inspections. There is only about one sample per month from five water supply systems out of more than 80 water supply systems in the country. If water sampling is to be carried out, it is necessary to obtain sampling bottles from the Health Department Laboratory then proceed to the proposed sampling point. Taps are flamed by any means possible, if the sample is to be taken from a tap. After flaming, the tap is run to waste for 5 minutes before taking the water sample. Ample space is left in the sampling container if the sample is for bacteriological analysis otherwise it is filled and sealed immediately. Complete the lable on the sample indicating the required analysis, date, time, weather and place of sampling. The sample is put in a cooler and delivered as soon as possible to the Health

*Some water supplies have been installed privately by village/community groups.

Department Laboratory for analysis. At present, the foresaid laboratory is only carrying out Bacteriological analysis using Membrane Filtration method. The Observatory Section has just received their equipment for Bacteriological and Chemical analysis early January 1989.

(b) There is very little work done on water surveillance in Western Samoa. The three Government authorities as I previously mentioned are the ones to be involved in such surveys.

5. TRAINING AND DEVELOPMENT OF MANPOWER FOR DRINKING WATER QUALITY MONITORING AND SURVEILLANCE:

(a) Speaking from the Health Department's point of view, the only training we received is the aid from WHO which conducts an Assistant Health Inspector course of one year locally and also Health Inspector Diploma courses overseas. This is the only training which helps to gain knowledge of the public health work including water quality monitoring and surveillance.

(b) It is not known how many people are engaged in water supply monitoring and surveillance. Only some officers are partially engaged in drinking water quality monitoring and surveillance.

6. CONSTRAINTS IN DRINKING WATER QUALITY MONITORING AND SURVEILLANCE:

(a) Lack of communication between involved Government authorities;

(b) Lack of adequate enforceable legislation;

(c) Shortage of manpower and lack of skill in existing manpower;

(d) Lack of funds for sampling, testing and recurring cost of testing media. (this is not a Government priority)

(e) Shortage of transportation.

7. SUMMARY AND CONCLUSIONS:

(a) Lack of appreciation by Government authorities of importance of surveillance and monitoring.

(b) Lack of communication by relevant Government authorities.

(c) Lack of demand from the communities for proper surveillance and monitoring.

WORLD HEALTH ORGANIZATION
WESTERN PACIFIC REGION

ORGANISATION MONDIALE DE LA SANTE
REGION DU PACIFIQUE OCCIDENTAL

REGIONAL CENTRE FOR THE PROMOTION OF
ENVIRONMENTAL PLANNING AND APPLIED STUDIES (PEPAS)

REGIONAL WORKSHOP ON DRINKING WATER
QUALITY MONITORING AND SURVEILLANCE

ICP/RUD/001 PROG/112/CR-013

Kuala Lumpur, Malaysia
27 February - 3 March 1989

ENGLISH ONLY

COUNTRY REPORT

VIET NAM

by

Dr Hoang Thi Nghia

COUNTRY REPORT

DRINKING WATER QUALITY MONITORING AND SURVEILLANCE IN VIETNAM

Dr. HOÀNG THỊ NGHĨA
National Institute of Hygiene
and Epidemiology , Hanoi

I. GENERAL COUNTRY PROFILE

The Socialist Republic of Vietnam is situated between 6°50´and 23°22´ parallels ; 102°07´and 117°20´longitudes in South East Asia , with a total area of 330,000 km² and a total population of 62 millions ,80% of them live in the rural areas . There are plenty of natural water supply sources . The average density of rivers , streams ... is about 1 km / 1 km² and the average rainfall is about 1900mm/year . But their distribution is not regular , so the shortage of water may occur during the dry season from April to September .

According to the data obtained from 43 surveys throughout the country the average diarrhoeal morbidity in children under five years of age is 2.2 episodes / child / year . The mortality rate ranges from 1 to 2 per thousand of hospitalized patients having acute gastro-intestinal infections . And the morbidity and mortality of main waterborne diseases are following :

Main waterborne diseases	Morbidity ($1/10^5$)		Mortality ($1/10^5$)	
Year:	1979	1987	1979	1987
- Dysenteric syndrom	178.6	242.2	1.2	0.58
- Acute diarrhoea	980.1	623.8	2.94	0.96
- Cholera	1.2	0.3	0.04	0.01
- Typhoid fever	4.6	11.5	0.3	0.09

2. NATIONAL POLICY

With the guideline that " Prevention is better than cure " , the adequate and safe water supply for every household is considered as a very important component of health care by the Government . Therefore since 1964 , the Government of Democratic Republic of Vietnam has promulgated the Regulation of Hygiene and Health Care which had been recommended by the Ministry of Health , in which the national standards and control of drinking water quality were determined (table 1). This Regulation was amended in 1977 . Recently the Health Code has been submitted to National Assembly for approval. The responsible bodies for implementing the control of drinking water quality as well as providing guidance to local people in water supply in rural areas are the Department of Hygiene and Environment of the Ministry of Health and the National Institute of Hygiene and Epidemiology (NIHE) .

At the NIHE the Department of Hygiene and Environment is responsible for control of drinking water quality . This Department has the duty to control , train and support the Units of Hygiene and environment in each provincial station of Hygiene and Epidemiology.

The provicial station of Hygiene and Epidemiology with their Unit of Hygiene and Environment is responsible for the situation of hygiene and environment in their province , and supervise all hygiene and environmental activities in all districs and communes in their province .

The Ministry of Construction with the Water-supply Companies are responsible for drinking water supply (tap water) for urban population and control the quality of the water . Ofcourse , the provincial stations of Hygiene and Epidemiology has the duty to control the quality of water supplied by water companies and has the right to fine the respective water companies if they violate water-hygiene regulations .

3. NATIONAL PROGRAMME AND RESULTS

With the guidance of the Government and the technical support of the World Organizations, our people have been carrying out some programmes successfully .

- " The movement of 3 achievements in Hygiene " namely water well, latrine and bathroom , has resulted in 3,897,000 wells (39.3%) for the country side in 1985 . There were only 17,000 wells in 1955 (2% of total households) , figures changed from 50 households/ well (1955) to 3 households/well (1985) .
- The National Programme of Drinking-water Supply and Sanitation Decade with the UNICEF 's support has been bringing thousands water wells to the people every year . And now , the well water quality is being determined .
- With the WHO's support , 300 households in Thai-binh province have got the good hygienic works with large rain water storage tanks and good latrines .
- With Finland's support , the water supply system in Hanoi has been improved .

The study and selection of the most suitable measures for preventing and controlling the environmental pollution is one of the main objectives of the National Programme of Control and Prevention of infectious diseases . Now most of the water sources are being rewiewed systematically .

The results of these activities are presented in table 2 and 3 :

The UNICEF well water quality on microbiology is very good . It meets the standard about 70% of total samples , which is similar to the quality of underground water in Hanoi (table 2) . However its chemical and physical water quality is not satisfying ,firstly on limpidity and iron content (table 3) .

The tap water quality on microbiology is not very well : only one fifth to one third meet the standard .

The well water quality at the countryside : only one out of 60 samples meets the standard on microbiology (< 20 fecal-coliforms/l). The chemical and physical water quality is better . But the number of water samples meeting the standard are still low . However it is better than the surface water on limpidity and total coliforms.

The rain water quality from the WHO's tanks in Thai-binh province on chemicals and physics is very good . On microbiology, 10% of total samples meet the standard. The remains are slightly polluted.

4. TRAINING AND MANPOWER DEVELOPMENT

In the Department of Hygiene and Environment of the Ministry of Health , of Hanoi Medical School and of NIHE . There are many cardres with the diploma of Candidate of Science at work .

In each provincial station of Hygiene and Epidemiology , there are at least 4 cardres : 2 of them have got university diploma and the others are technicians and workers working in 2 laboratories of microbiology and physico- chemistry. Once a month about 30 samples of all water sources from their provinces are tested at these laboratories for drinking water quality monitoring and surveillance . And at the laboratories of water-supply companies, the quality of water is determined everyday .

Every year , a special refreshing course is hold by NIHE to train doctors and technicians from all provincial stations of Hygiene and Epidemiology new knowledges and skills on hygiene and environment .

With the World Health Organization's support , a special course was organized by the Ministry of Health of Vietnam on Microbiology of Environment in Ho Chi Minh-City in 1985 for doctors and technicians in southern provinces and some doctors have also attended workshops , training courses sponsored by WHO in the Western Pacific Region as well as in other Regions . The knowledge acquired from these workshops and training courses were very useful to our work at home .

5. PROBLEMS AND SOLUTIONS

Problems

. The information is always late and not enough

. Shortage of the reagents , chemicals and equipments

. Financial constraints

. There are very few persons who like to be in this work

. The management and organization have not unified yet . So the activities and cooperations between institutions were not highly effective .

Solutions

. Regularly exchange and look for informations

. Fully utilize financial funds , supplied by the Government

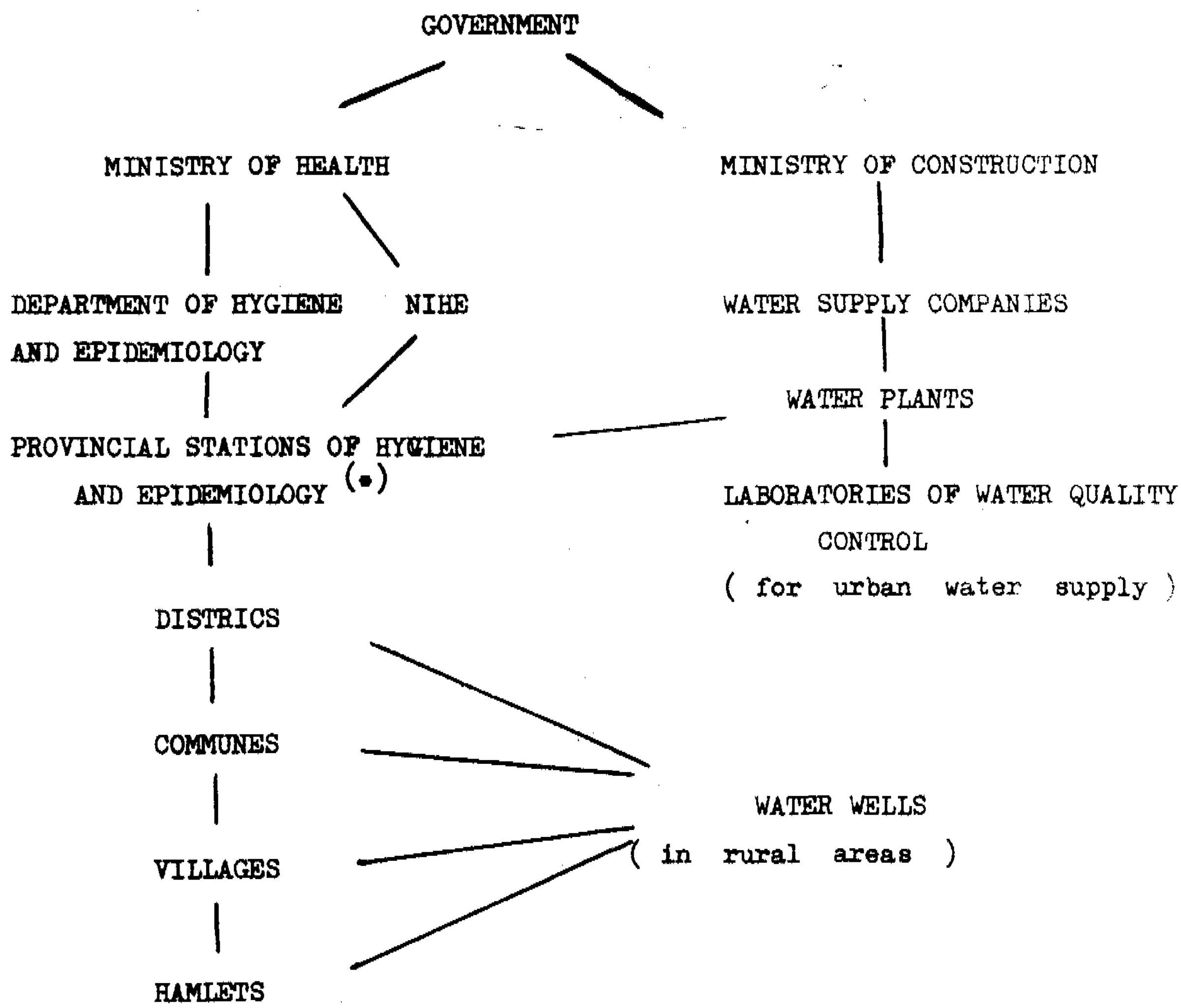
. Closely cooperate with the world organizations and the other nongovernmental organizations and governmental organizations and the other national health programmes in the country such as : The National CDD Programme ...

6. CONCLUSION

. National policies , programmes and the achievements for drinking water quality monitoring need to be improved . The measures for correcting water-polluted situations and for drinking water supply however have got some successes but have not reached the targets yet .

. The difficulties are not easy to overcome but with the devotion of our health workers and Government inputs and cooperation with and assistance from international community , the objectives of the drinking water supply and control can be achieved .

Figure 1 : The relationship between the offices for supply and control of drinking water



(*) For Southern provinces ; the Institute of Hygiene and Epidemiology, Ho Chi Minh - City
For Central provinces ; the Institute of Hygiene and Epidemiology in Nha Trang - City .

Table 1 . The National Standard for drinking water quality

Parameter (mg/l)	Vietnam	WHO
Colour	10 Cobalt's units	15 TCU
Limpidity	100 cm Dienert	5 NTU
Nitrite	0.05	
Nitrate	5	10
Ammonia	1	
Iron	0.3	0.3
Oxydation	7	
Chloride	100	250
Hardness	15 ° German	
Soluble minerals	2	
Organic and metallic toxins	0	
Pathogenic microorganisms	0	
Cl. perfringens	0	
Fecal - coliforms	20 cells	0

Table 2 . Water quality : bacteriological examinations

Sample	Total	Total fecal - coliforms/L (%)		
		Meet the standard	Don't meet the standard	
		< 20	≤ 100	>100
Rain water in WHO's tanks	30	10.00	23.33	66.67
UNICEF well water	174	71.84	25.86	2.30
Underground water sources in Hanoi	15	60.00	26.67	13.33
Tap water in Hanoi	814	28.30	20.10	51.60
Well water at the countryside	60	3.33	11.67	85.00
Red river water	48			100.00

Table 3 . Water quality:chemical and physical examinations

Parameter	Meet the standard (%)		
	Well water at the countryside	Rain water in WHOś tanks	UNICEF well water
Total	60	30	90
Nitrite-Nitrogen	58.30	96.67	-
Nitrate-Nitrogen	100.00	100.00	-
Ammonia-Nitrogen	68.33	100.00	85.56
Oxydation	16.67	100.00	83.33
Iron	15.00	100.00	28.89
Chloride	26.67	100.00	35.56
Limpidity	10.00*	100.00	28.89
Hardness **	20.00	100.00	64.44

* German degree

**For well water , the standard is ≥ 66 cm Dienert

Abstract 3rd Symposium On Our Environment

FORM B

Title: Urbanization and It's Effect on Water Quality (1982/83)

Author(s): Mohammad Ismail Yaziz and Aziz Jaapar

Institution/Affiliation: Dept. of Environmental Sciences, Universiti Pertanian Malaysia.

Urbanization is a phased process which normally starts with the clearing of vegetation, construction of dwellings and progressing with subsequent changing of behavior pattern to becoming cities. This process contributes dramatic changes particularly to the streamflow and water quality characteristics of a watershed. This study was designed to examine the changes in water quality in the Sg. Langat as it flows seawards from a protected catchment through several human settlements and townships with variations in landuse patterns along the river stretch. Nine parameters were selected to observe the changes in water quality and its impact on treatment requirements for the production of potable water.

The results showed a rapid deterioration in the river water quality as it flowed downstream especially after passing through human settlements and townships. This is reflected in increases in the concentration of various pollutants in the water samples obtained from selected sampling stations along the river. Certain pollutants were attributable to human industrial and agricultural activities while some were the result of geologic formations and human domestic activity. The implications on potable water treatment requirements justifies further research for the future.

An abstract will be accepted only when typed within this frame space

ABSTRACT GUIDELINES

- An electric typewriter with black ribbon and Elite typeface should preferably be used. Type single-spaced. Do not make carbon copies.
- Submit two copies — original and photocopy.
- The entire text (**without** title, author(s) and address) must fit in the box provided. LEAVE NO MARGIN at Top and sides. Do not use paragraphs or subheadings (Methods, Results, etc). Leave 3 spaces before starting the first line of text.
- Graphs, tables and references cannot be included in the abstract. Avoid abbreviations and formulae. Avoid erasures, strike-overs and editorial errors.
- The abstract should contain:
  - a) A statement of the main purpose of the study
  - b) A statement of the methods used
  - c) A summary of the results presented clearly and in sufficient detail to support the conclusions.
  - d) A statement of the conclusions reached (it is not satisfactory to state: "the results will be discussed").

Name of Registered Full Delegate presenting paper:

DR.MOHAMMAD ISMAIL YAZIZ

(please type)

Mailing Address:

DEPT. OF ENVIRONMENTAL SCIENCES
UNIVERSITI PERTANIAN MALAYSIA
SERDANG,
SELANGOR,
MALAYSIA.

FIGURE 1 : Map of the study area (Ulu Langat District)

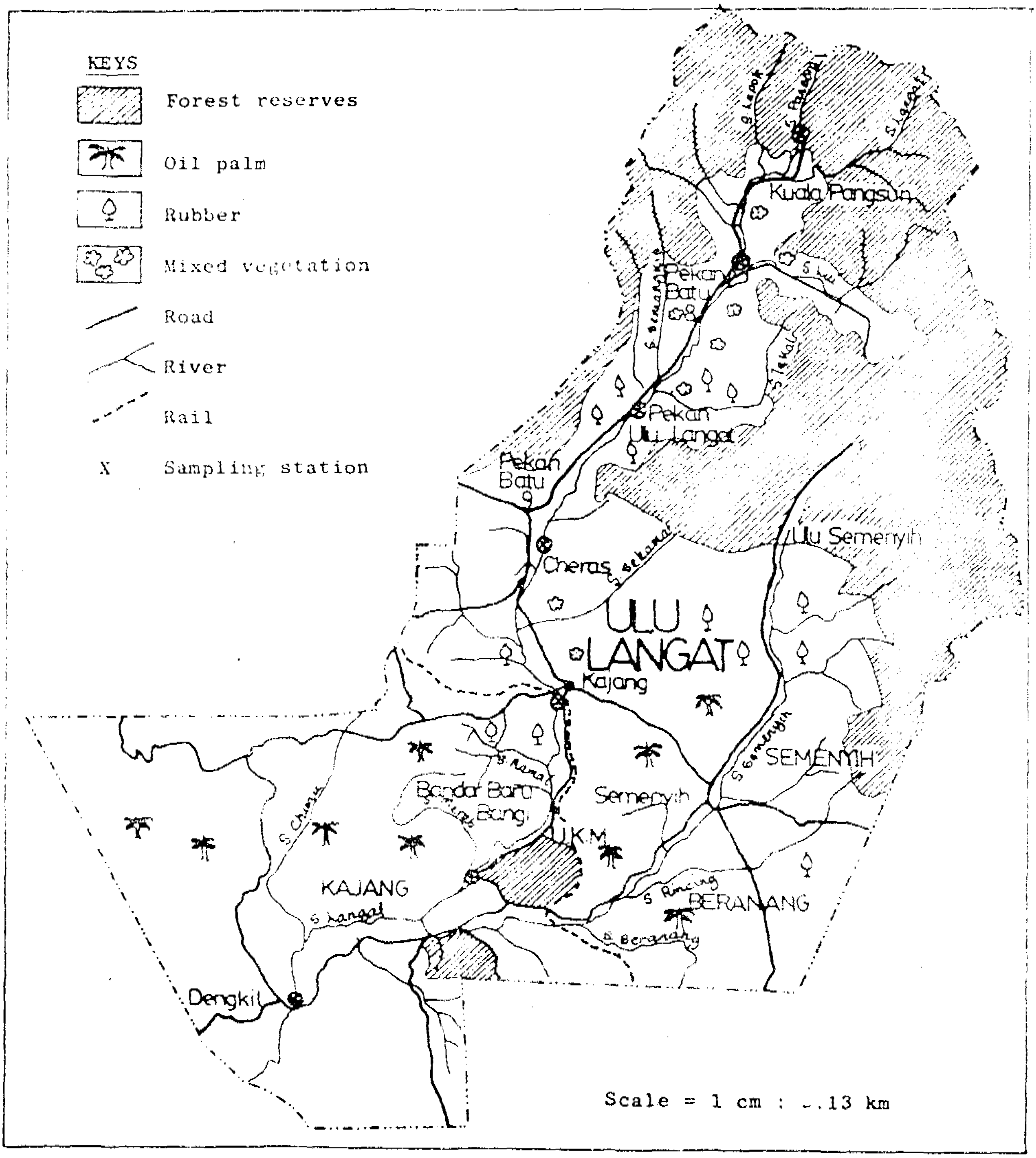


Table 2 : Summary of results of analyses of water samples taken from the Sg. Langat (from Ulu Pongsun to Dengkil)

Stations	Parameters*									
	BOD mg/l	DO mg/l	Cl mg/l	NO_3 mg/lx10^{-3}	TS mg/l	TSS mg/l	pH	Temp. °C	Elect. Conduct. µ Hos/cm	F. Coliforms Nos./100ml.
1	0.37	8.17	1.42	12.5	64.2	19.5	5.93	27.88	46.4	20
2	0.88	8.04	1.25	25.0	95.3	26.0	5.58	25.80	39.0	31
3	1.73	7.74	1.08	55.8	168.0	48.0	5.51	26.00	32.8	41
4	3.25	7.35	1.50	171.7	224.3	60.7	5.42	26.30	32.7	49
5	3.34	6.71	2.83	222.5	331.8	113.2	5.48	27.17	38.2	75
6	4.10	6.52	2.33	272.5	426.7	167.0	5.54	27.71	47.5	94
7	4.63	6.33	2.50	338.3	599.0	272.3	5.42	28.88	49.3	134
Dengkil WTP	0.03	8.36	4.83	0.4	9.33	2.33	6.96	28.04	82.8	0.15
Langat WTP	0.006	8.06	2.42	0.3	4.5	1.91	6.83	27.9	74.82	0

* All values for each parameter represent the mean of 36 samples taken over a period of 4 months.

Table 3 : Effect of water treatment on the removal of specific parameters from raw water

Nos.	Parameter	Langat WTP		% increase(+) or removal	Dengkil WTP		% increase(+) or removal
		Raw	Treated		Raw	Treated	
1.	BOD (mg/l)	1.60	0.006	99.63	4.63	0.03	99.35
2.	DO (mg/l)	8.01	8.06	0.62(+)	6.33	8.36	32.07(+)
3.	Chloride(mg/l)	1.22	2.42	98.36(+)	2.50	4.83	93.20(+)
4.	Nitrate(mg/l)	0.062	0.0003	99.52	0.338	0.0004	99.88
5.	TS (mg/l)	138	2.3	98.33	599	9.3	98.45
6.	TSS(mg/l)	157	0.91	99.42	272.3	2.3	99.14
7.	pH	5.50	6.83	24.18(+)	5.42	6.96	28.41(+)
8.	Temp (°C)	26.0	27.9	1.9(+)	28.88	28.04	2.91
9.	Conduct. (µ Hos/cm)	34.4	64.81	88.4(+)	49.33	82.83	67.90(+)
10.	F.coliforms (nos/100 ml)	44.0	0	100	134	0.15	99.88
11.	Odour	+	-		++	-	
12.	Colour	+	-		+	-	
13.	Organics	+(?)	?	-	+(?)	?	-

OPENING ADDRESS BY THE WHO REPRESENTATIVE
ON BEHALF OF THE REGIONAL DIRECTOR FOR THE WESTERN PACIFIC
FOR THE REGIONAL WORKSHOP ON
DRINKING WATER QUALITY MONITORING AND SURVEILLANCE
27 FEBRUARY - 3 MARCH 1989

On behalf of Dr Han, WHO Regional Director for the Western Pacific, I have pleasure in welcoming you to PEPAS for this Regional Workshop on Drinking Water Quality Monitoring and Surveillance.

It is estimated that approximately 80% of all illnesses in the world are due to unsafe and insufficient water supplies and sanitation, and that about 25 000 people die daily because adequate safe drinking water is not available. Epidemiological studies indicate that unsafe water is the major cause of waterborne diseases, such as cholera, typhoid, paratyphoid, diarrhoea and hepatitis. Also, many chronic heart and kidney problems are associated with the long-term consumption of water of poor chemical quality.

In recognition of these problems, the United Nations inaugurated the International Drinking Water Supply and Sanitation Decade on 10 November 1980 with the goal that all people should have access to safe drinking water and adequate sanitation by 1990. WHO considers water supply and sanitation to be critical components of primary health care; the availability of clean water and adequate sanitation are essential to achievement of WHO's goal of "Health for All by the Year 2000".

Since the inauguration of the Decade programme, many countries have made special efforts to construct safe water supply systems. Yet statistics show that the incidence of waterborne-related illnesses is still very high. While a water supply system may be considered safe when initially constructed, there are many factors which can make the water unsafe while it is in operation. It is therefore extremely important to monitor the water quality of a system regularly, to ensure that it remains safe and protects the health of consumers.

Drinking water is considered safe if it is free of harmful microorganisms, and if it does not contain chemicals in concentrations which are harmful to the consumers. In order to ensure that there is always good quality drinking water, an effective water quality monitoring and surveillance programme must be instituted and rigorously carried out.

The two major components of such a programme are monitoring and sanitary surveys. Monitoring involves regular sampling of water supplies to determine their physical, chemical and bacteriological quality and sanitary surveys involves on-site inspection and evaluation of equipment, facilities and practices associated with water supply systems. These two components complement each other and will be the focus of discussions throughout the workshop

While some Member States in the Western Pacific Region have already formulated comprehensive national programmes on drinking water quality monitoring and surveillance, there are still some which have not done so. Additionally, some of those which have established programmes are facing difficulties in implementing them, particularly in the rural areas where there is a lack of trained manpower and adequate laboratory support.

Since financial resources are very limited in most developing countries, it is important to make every effort to maximize the output and benefit of the existing water supply systems, and to minimize the health risks associated with the consumption of water. In this regard, the implementation of an effective national drinking water quality monitoring and surveillance programme is essential.

One of the main objectives of this workshop is to familiarize you with procedures and methodologies which will enable you to carry out all the necessary monitoring and surveillance activities yourselves, and to train the environmental health personnel in your own country to do the same. This workshop will also serve as a forum for the exchange of ideas and experiences gained in various countries. It will provide you with a good opportunity to discuss the problems and constraints associated with drinking water quality monitoring and surveillance, and to find ways of overcoming these problems

I wish you a successful meeting and trust that your deliberations will be productive. Thank you.