EVALUATION OF THE CONNECTICUT WATER SUPPLY PROGRAM

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

SEPTEMBER 1974

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PREFACE

This report is based on the findings of field inspections of 45 water supplies, and a review of the activities of the Water Supplies Section of the Connecticut State Department of Health. The work was begun after discussions with Mr. Richard Woodhull, Chief of the Water Supplies Section and Mr. David Wiggin, Director of the Environmental Health Services Division, and covered the period May 1972 to June 1973, with some followup sampling taking place as late as December 1973.

The purpose of the report is to evaluate the Connecticut Water Supply Program and make recommendations for any needed improvement.

We would like to thank Mr. Woodhull and his staff for the cooperation they extended to us, and the Connecticut State Department of Health Laboratory for doing all the bacteriological examinations.

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SUMMARY

Approximately 2,494,000 people or 82% of the population of Connecticut are served by 329 public water supplies both municipally and investor owned. Recognizing the importance of safe and adequate supplies of drinking water, Mr. David C. Wiggin, Director, Environmental Health Services Division, Connecticut State Department of Health, agreed to cooperate with the Water Supply Branch, Environmental Protection Agency, Region I, in an evaluation of the State's water supply program.

An in depth study, with particular emphasis on water quality, was made of 45 public water supplies that serve 1.14 million persons or 45.5% of the people served by public water systems. Samples to determine chemical and bacteriological quality were taken at each supply from both source and distribution systems. The facilities were examined and, in most cases, the questionnaire in Appendix F was completed. In addition, the Surveillance program of the Connecticut Health Department, Water Supplies Section, was evaluated. The Connecticut Health Department, Division of Laboratories was evaluated by EPA personnel from the National Environmental Research Center in Cincinnati, Ohio, and the Connecticut fluoridation program was evaluated separately.

The principal findings of the survey are summarized below:

I. Status of Water Supplies Studied

A. Water Quality

1. Bacteriological Quality

Of the 45 public water supplies examined, one supply failed to meet the 1962 U. S. Public Health Service Drinking Water Standards, (hereafter referred to as the Drinking Water Standards), bacteriological requirements during at least one month during 1972. This system serves 325 persons.

2. Chemical Quality

Twenty seven systems (60% of the 45 systems sampled by EPA) failed to meet one or more chemical units in the Drinking Water Standards. These systems serve 870,570 people with water that doesn't meet the Drinking Water Standards. The recommended or aesthetic standards were exceeded most often. Seventeen systems (38%) failed to meet the recommended standard for manganese and nine systems (20% failed to meet the recommended standard for iron.

Eight (18%) systems failed to meet the recommended (aesthetic) limit for copper and one system had a chloride level of 550 mg/l. State samples in 1972 and 1973 averaged 112 mg/l, a high level, but within the recommended standard of 250 mg/l.

During the first sampling period, which lasted from June 1972 through March 1973, samples from 4 systems (9%), exceeded the Drinking Water Standards mandatory (health) limit for lead. Resamples of these supplies in March and December 1973 were negative for lead in 3 systems and the fourth had a trace amount less than the standard.

One system exceeded the proposed Federal Drinking Water Standards mandatory standard for carbon chloroform extract. A resample in December 1973 of the source showed it to be within the acceptable limit at that time.

Three of the eight fluoridated systems that were studied were fluoridating at less than the 0.8 to 1.2 mg/l range required by the State Health Department. This underfeeding could significantly reduce the dental benefits of this treatment.

B. Facilities

From the EPA visits to 45 water systems it was determined that:

a. Five supplies had inadequate source protection. Three of the five were cited because of the source vulnerability to highway accidents and possible spills.

b. Seventeen (38%) systems had inadequate distribution storage or no emergency power to provide water during power failures.

c. One system (2%) had continuous pressure problems.

d. No system had a cross connection control program that systematically looked for cross connections. Double check valves are inspected every 4 months.

e. Seventeen systems (38%) had no meter to determine water used or had records to indicate water demands.

f. Twenty-nine systems (64%) had inadequate or no records.

II. Water Supply Authority

A. Statutes

The Connecticut Department of Health is given the authority over public water supplies by the Connecticut General Statutes and contained in the Public Health Code. These statutes are further identified in a publication entitled Public Health Statutes. The legal base is generally good, but there are some weaknesses. One weakness is the lack of enabling legislation to adopt the Drinking Water Standards as regulations. At this writing, legislation has been drafted to eliminate this deficiency.

B. Regulations

The publication Public Water Supply Information contains the regulations and policy of the Connecticut

Health Department and the publication Private Water Supplies gives guidance for developing individual wells and regulations pertaining to well construction and use. The regulations are quite comprehensive especially with regard to well construction. No other New England state has such regulations. Lack of enforceable water quality standards is the weakness that needs to be eliminated, and as mentioned under "statutes", this is being corrected.

III. Water Supply Program

A. Surveillance Activities

1. Inspections. From a review of state records by EPA, it was determined that during 1972, 272 of the 319 (85.3%) systems were visited by personnel of the Water Supplies Section.

Ten (3%) systems had not been visited since 1968.

2. Chemical and Bacteriological. Only thirteen of the forty-five (29%) systems visited by EPA could meet the Drinking Water Standards requirement for frequency of bacteriological sampling.

The procedures and equipment used by the Health Department's Division of Laboratories were found to generally conform with Standard Methods and were approved by

EPA reviewers.

Sampling frequency for both bacteriological and chemical examination varies from quarterly to monthly depending on the size of the system. Fluoride samples from all fluoridating systems are checked on a monthly basis.

Chemical and bacteriological analyses routinely include pH, turbidity, color and taste and odor. Other chemical analyses routinely done are chloride, iron, hardness, alkalinity and the nitrogen series. The laboratory can run heavy metals, pesticides, and radiochemical tests, but does so only on special request.

Chemical and bacteriological data are handled by computer and printouts are readily available, although the time lag from lab data available to printout availability should be shortened.

B. Staffing, Program and Budget

The State Water Supplies Section has done an excellent job considering that for most of the period of this review there were only 3 engineers and one secretary working on public water supplies. The turnover problem is illustrated by the fact that the Chief of the Section was the only engineer that was in the Section at both the beginning and at the end of this study.

Staffing has not increased in spite of the increase in the number of public water supplies from 145 in 1960 to 329 in 1972, and the increase in surveillance brought about by mandatory fluoridation in 1967. There are now 29 systems fluoridating using approximately 109 installations (not all are active at any one time because some installations are on standby or emergency sources of water).

The present Water Supplies Section budget (excluding laboratory support) is approximately $60,000. There is a need to increase both staff and budget to carry out a surveillance program that will provide maximum public health protection for the citizens of Connecticut. The recommendations of this report are made to help bring about some needed improvements in the Connecticut Water Supply Program.

RECOMMENDATIONS

The Connecticut Water Supply Program should continue to pursue the enforcement of existing statutes pertaining to public water supplies. To help in this matter, it is recommended that the State:

1. Adopt cross connection control regulations, to encourage and support enactment of local programs of backflow prevention and cross connection control to help get the utilities doing more in this area. In 1972, Michigan adopted regulations that required each water utility "to develop a comprehensive control program for the elimination and prevention of all cross connections". This plan was to be submitted to the Michigan Department of Public Health for review and approval by April 19, 1973. Once approved, the utility is expected to implement the program. The Connecticut Health Department should investigate this program and determine whether or not it could be used in Connecticut.

2. Adopt the Federal Drinking Water Standards as regulations, once enabling legislation is passed. If the State desires to be more stringent, they can set their own standards.

3. Increase the severity of penalties for violation of the standards. The fines now called for are minimal, allowing continued violation by any utility which can afford to pay the price.

4. Establish a bacteriological surveillance program that will meet the Drinking Water Standards sampling frequency requirements.

5. Increase the scope of the chemical analysis of samples to include all constituents of the Drinking Water Standards in order to obtain a good data base on all public water supplies in the state. Ground water sources should be examined once every three years and surface water sources should be examined annually once all above mentioned constituents have been determined at least twice to establish the data base.

6. Expand the Water Supplies Section (excluding laboratory support) in size from 3 to 7 professionals and from 1 to 2 secretaries, and increase the budget from the present estimated $60,000 to $175,000. The $175,000 annual budget is the minimum cost for an adequate program.

INTRODUCTION

Most Americans are served the finest and safest drinking water in the world. During the more than 100 years that have passed since water was first implicated in the transmission of disease, water treatment methods and practice have improved steadily. The dread water borne diseases, such as typhoid and cholera, are no longer a concern in the United States, testifying to the efficiency of modern water treatment. The result of this decline in water borne diseases has brought about a complacency about drinking water safety among many citizens. People assume their water is safe to drink. The Community Water Supply Study indicated this complacency has spread to some utilities and regulatory agencies. Many states are much less active in the regulation and surveillance of public water supplies than they once were. Public and legislative emphasis is being placed on the abatement of air and water pollution, and there has been no significant Federal Legislation related to the regulation of drinking water since 1893. In order to meet the increasing demands for the control of pollution, states have had to commit more and more of their resources to pollution abatement programs. Since funds and personnel are limited, drinking water programs have suffered. Contrary to popular belief, extensive water pollution control programs do not necessarily mean the public will receive better quality drinking water. In Connecticut, the water pollution abatement programs will have a minor impact on drinking water quality because the public water supply sources are protected and free of known pollution. However, to insure that citizens of Connecticut will continue to receive safe and reliable drinking water, there must be an active water supply program at the state level.

The present evaluation was conducted to determine the effectiveness of the Connecticut Water Supply Program and to recommend such improvements as may be needed to assure safe, wholesome, drinking water for residents of Connecticut.

This study was undertaken by the Water Supply Branch of the Environmental Protection Agency with the cooperation of the Division of Environmental Health Services, Connecticut State Department of Health.

SCOPE OF THE EVALUATION

Water Supplies in Connecticut

The first public water supply in Connecticut was developed in Durham in 1748. After 1850, the number of public water supplies increased rapidly until in 1960 there were 145 systems. Since that time, a number of water supplies have been developed, including many small supplies serving housing development, so that, excluding the small water supplies that serve less than 25 persons, public water supply systems in Connecticut, both municipally and privately owned, number 329, and supply an estimated population of 2,494,000 or approximately 82% of the 1970 population. A "water company is defined in the General Statutes - Sec. 25-32 as "any individual, partnership, association, corporation, municipality or other entity, or the lessee thereof, who or which owns, maintains, operates, manages, controls or employs any pond, lake, reservoir, well, stream or distributing plant or system for the purpose of supplying water to two or more consumers."

Surface water sources are used by 75 water utilities, drawing from 107 separate reservoirs or streams. Seventy-nine of these sources, serving about 1,060,000 persons, are unfiltered but chlorinated. The remaining 28 sources, serving 850,000 persons, are filtered and chlorinated. A total of 584,000 people are supplied with ground water from 647 wells. Eighty-eight percent of the water systems are privately owned, although these companies service only 52 percent of the population supplied by public water systems.

Connecticut's mandatory fluoridation law affects approximately 2,112,000 persons presently served by public water supplies. This comprises 69 percent of the state population and 85 percent of those on public water systems.

WATER SUPPLIES STUDIED

In order to select a representative number of water supplies for study, all public water supplies in Connecticut were divided into groups according to population served as shown in Table 1. Supplies selected in the three groups serving 20,000 persons or more were interstate carrier water supplies and were selected for that reason alone. Those selected in the groups serving from 500 to 20,000 were selected primarily because of geographic location, but with some emphasis on source, treatment, and ownership. Those supplies serving less than 500 persons were selected by numbering all the supplies and using a table of random numbers. The supplies actually studied are listed in Table 2, and approximately located as shown on Figure 1. Three originally selected were not studied. One was connected to a municipal system during the study and it was impossible to schedule visits to the other two.

In addition to this selection of supplies to be evaluated, a completely independent selection of fluoridation installations to be surveyed was made. Eight water supplies were selected using as criteria, (1) geographic location, (2) population served, and (3) fluoride compound used.

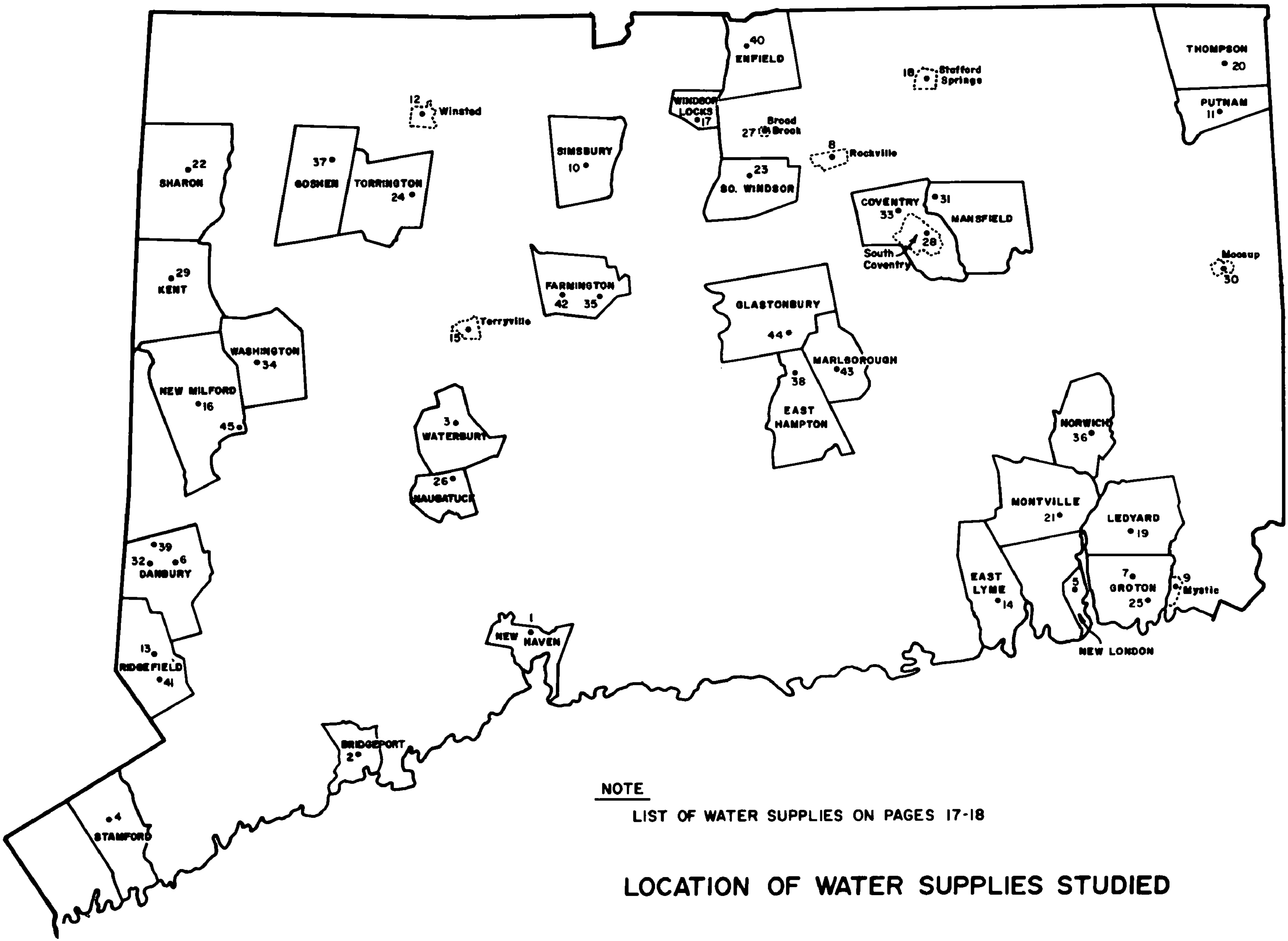
The 45 supplies evaluated represent 13.8% of the 314 public water supplies listed in the 7th edition of "Analyses of Connecticut Public Water Supplies", a publication of the Connecticut State Department of Health. These 45 supplies serve 1.14 million (45.5%) of the 2.49 million people served by public water systems. Fifteen of the 45 systems surveyed use primarily surface water sources and the remaining 30 are exclusively using ground water. Two of these 30 have surface water available but have taken these sources out of service.

Table 1

Connecticut Water Supply Evaluation

Population Served	No. of Water Supplies*	No. Selected for Evaluation	% of Number of Supplies	No. Actually Evaluated
500	186	18	9.7%	16
500 - 1000	40	8	20%	7
1001 - 5000	39	8	20.5%	8
5001 - 10,000	15	4	26.6%	4
10,001 - 20,000	12	3	25%	3
20,001 - 50,000	13	3	23%	3
50,001 - 100,000	5	1	20%	1
100,000	4	3	75%	3
Totals	314	48		45

FIGURE I



NOTE

LIST OF WATER SUPPLIES ON PAGES 17-18

LOCATION OF WATER SUPPLIES STUDIED

Table 2

WATER SUPPLIES STUDIED

	Water Supply	Ownership*	Pop. Served	Source of Supply	Treatment**
1.	New Haven Water Co.	I	393,905	8 Surface, 3 well fields	Cl, Cc, Fl F (1)
2.	Bridgeport Hydraulic Co.	I	338,500	3 Surface, 8 well sites	Cl, Cc Fl
3.	Waterbury Water Dept.	M	120,000	2 Surface (Wigwam & Morris	Cl, Cc, Fl
4.	Stamford Water Co.	I	84,000	N. Stamford Reservoir, Laurel Res.	Cl, Cc, Fl
5.	New London Water Dept.	M	36,000	Lake Konomoc	Cl, Cc, Fl
6.	Danbury Water Dept.	M	35,000	Margerie & West Lake Res.	Cl, Cc, Fl, F, T
7.	Groton Water Dept.	M	29,315	Groton Reservoir	Cl, Cc, Fl, F, T
8.	Rockville Water & Aqueduct Co.	I	13,280	Shenipsit Lake	Cl, Cc, Fl, F, T
9.	Mystic Valley Water Co.	I	7,398	Palmer Reservoir & G.P. well	Cl, Cc, Fl, F, T (reservoir only)
10.	Village Water Co., Simsbury	I	11,416	4 Gravel packed wells	Cl
11.	Putnam Water Dept.	M	8,400	Little River	Cl, Cc, F, T
12.	Winsted Water Dept.	M	8,300	Crystal Lake	Cl
13.	Ridgefield Water Co.	I	8,256	Round Pond Res., 2 well fields	Cl, Cc
14.	E. Lyme Water Commission	M	6,000	2 Gravel Packed Wells	None
15.	Terryville Water Co.	I	4,780	2 Gravel packed wells	Cl, Cc
16.	New Milford Water Co.	I	4,600	2 Reservoirs, 1 G.P. Well	Cl Cc (Softening on well)
17.	Bradley Int. Airport	S	3,000 PE	4 Gravel Packed wells	Cl, Cc
18.	Stafford (Conn. Water Co.)	I	2,600	2 Reservoirs, 2 Caisson-wells	Cl
19,	The Highlands, Ledyard	I	2,590	2 Gravel Packed Wells	Cl
20.	Thompson Water Co.	I	2,100	4 Wells	Cl
21.	Montville Water Works	I	1,630	8 Drilled Wells	None
22.	Sharon Water & Sewer Commission	M	1,500	Beardsley Reservoir	Cl
23.	Avery Heights Water Co. S. Windsor	I	1,000	Gravel Packed Well	Cl, Cc
24.	Doolittle Heights, Torrington	I	1,000	1 Drilled Well used	None
25.	S. E. Conn. Water Auth., Est. Div.	M	875	2 Gravel Packed Wells	Cl
26.	Indian Field Water Co. Naugatuck	I	800	2 Gravel Packed Wells	None
27.	Broadbrook Water Co., E. Windsor	I	784	3 Drilled Wells	Cl

Table 2 (Continued)

WATER SUPPLIES STUDIED

	Water Supply	Ownership*	Pop. Served	Source of Supply	Treatment**
28.	S. Coventry Water Supply Co.	I	600	3 Drilled Wells	None
29.	Kent Water Co.	I	500	Kent Reservoir (2 Wells Feed Res.)	Cl
30.	Moosup Water Works	I	428	2 Drilled Wells	Cl
31.	Rolling Hills Mobile Home Park, Mansfield	I	400	2 Drilled Wells	None
32.	Lakeview Mobile Home Park, Danbury	I	382	1 " "	None
33.	Coventry Hills, Coventry	I	368	2 Drilled Wells	None
34.	Judea Water Co., Washington	I	325	3 Driven Wells	None
35.	Well Acres, Farmington	I	300	1 Drilled Well	None
36.	Lambert Drive Assoc., Norwich	I	250	2 Drilled Wells	None
37.	Tyler Lake Water Co., Goshen	I	250	2 Drilled Wells	Cl of Well #2
38.	Lakewood Road Water Co., E. Hampton	I	180	2 Drilled Wells	None
39.	Sherwood Forest, Danbury	I	176	2 Drilled Wells	None
40.	Shaker Heights, Enfield	I	170	1 Drilled Well	None
41.	Soundview, Ridgefield	I	150	1 Drilled Well	None
42.	Maple Ridge Farms, Farmington	I	1255	1 Drilled Well	Cl
43.	Forest Property Owners Assoc., Marlborough	I	125	1 Drilled Well	Iron & Mn Removal
44.	Oakwood, Inc., Glastonbury	I	116	2 Driven Wells	None
45.	Lillinoah Park Estates, New Milford	I	80	1 Drilled Well	None

* I = investor owned; M = municipal ownership; S = State owned

** Cl - Chlorination; Ce = corrosion control; F = filtration; Fl = fluoridatio

T = taste/odor control (1) filtration at Lake Whitney

STUDY METHODOLOGY

The evaluation was carried out by visiting each of the 45 supplies, inspecting facilities, and operation, and taking samples. An 8 page questionnaire (See Appendix F) was filled out for the supplies serving more than 3,000 persons. On surface water supplies, 14 day composite samples were collected at the source and examined for trace elements, pesticides, radionuclides and a routine wet chemistry analysis. A minimum of 2 samples for chemical analysis were collected from each distribution system and in most cases bacteriological samples were collected at the same time. The new mini-sampler developed at the National Environmental Research Center in Cincinnati, Ohio was set up at all the surface supplies to provide carbon chloroform extract (CCE) results. Ground waters were not examined for organics or pesticides since it was felt that ground water would not be as likely to be contaminated by these constituents as surface waters. Only grab samples were taken for the other analyses since the quality of ground water is not as variable as surface water.

There were four EPA laboratories involved in analysis; NERC, Cincinnati, Ohio, (trace metals and CCE), Narragansett, R.I. (wet chemistry), Montgomery, Ala. (radiochemistry), and Dauphin Island, Alabama (pesticides). The State Health Department laboratory in Hartford did the bacteriological examinations.

EVALUATION CRITERIA

BACTERIOLOGICAL WATER QUALITY

Samples were taken at 44 of the 45 supplies visited and delivered to the State Health Department laboratory for bacteriological examination. Results were compared with the 1962 Public Health Service Drinking Water Standards to see if each water supply was in compliance. Also, a review of the past bacteriological record of these 45 water supplies was made at the State Health Department.

CHEMICAL WATER QUALITY

Available chemical records of the State Department of Health were reviewed and in addition, the chemical tests listed in Table 3 were performed on water samples collected during visits to the water utilities. The number of samples analyzed for each listed parameter is also summarized in Table 3.

Chemical results for each supply were compared with the Drinking Water Standards and rated as either:

1. Meeting all the standards.
2. Failing to meet one or more of the

"recommended" limits (aesthetic) but meeting all "mandatory" limits (health).

3. Failing to meet one or more of the "mandatory" limits.

FACILITIES EVALUATION

A facilities evaluation was conducted on each water supply. The adequacy of sources, treatment, operation, distribution, storage, record keeping and quality control was judged on the basis of the Manual for Evaluating Public Water Supplies and the Drinking Water Standards. A copy of the survey form is included in Appendix F.

The source of each supply was evaluated for the adequacy of its quality and if possible, its quantity. Actual quantity available was not always known by those responsible for the small well supplies.

The treatment being provided was judged on the adequacy of the facilities, including standby equipment, as well as operation and maintenance.

Each distribution system was rated on the basis of available storage. Storage was considered adequate if the elevated or non-pumped storage equalled or exceeded the systems' average daily demand, or emergency power was available to run the pumps. Pressure problems were noted and random chlorine residuals were checked.

STUDY FINDINGS

BACTERIOLOGICAL QUALITY

Forty-four supplies were sampled and bacteriological examinations were made by the State Health Department Laboratory. One sample of 46 untreated wells, and five of 145 samples from distribution systems had coliform densities greater than 4/100 ml. using the membrane filter technique. The Drinking Water Standards, section 3.23, says:

> "When the membrane filter technique is used, the arithmetic mean coliform density of all standard samples examined per month shall not exceed one per 100 ml. Coliform colonies per standard sample shall not exceed 3/50 ml, 4/100 ml, 8/200 ml, or 13/500 ml in:
>
> (a) Two consecutive samples;
> (b) More than one standard sample when less than 20 are examined per month; or
> (c) More than five percent of the standard samples when 20 or more are examined per month.
>
> When coliform colonies in a single standard sample exceed the above values, daily samples from the same sampling point shall be collected promptly and examined until the results obtained from at least two consecutive samples show the water to be of satisfactory quality."

Comparing the bacteriological results to the requirements of this section, the following is noted. In four cases, the resample was negative so part (a) was met and also parts (b) and (c) were met. The average coliform density in samples from these supplies was less than 1 per 100 ml. during the month the study samples were collected and bacteriological records indicated satisfactory water quality the remainder of the year. The fifth case was a small supply serving 325 persons untreated well water that is pumped from the wells to two small, covered, reservoirs. A sample from the pipe delivering water from two wells had a coliform density of 58 per 100 ml. and the two distribution system samples had coliform densities of 7 and 1 per 100 ml. Resamples of water from the pipe showed 3 per 100 ml and a resample of the distribution system at the point where the 7 per 100 ml sample was taken showed 3 per 100 ml this time. This record with other data from the system suggest that the system wouldn't meet the Drinking Water Standards and that continuous disinfection is needed. The source of the coliforms was not determined, but the fact that the samples from the pipes that come directly from the well were positive for coliforms could mean that there was some ground water contamination.

CHEMICAL QUALITY

Tables 3 and 4 summarize the results of chemical

Table 3

I. Chemical	Number of samples which were analyzed for this constituent	Number of water systems sampled for this constituent	Number of samples exceeding the constituent unit	Number of water systems which had one or more samples exceeding constituent limit
Mandatory Standards				
Arsenic (0.05)	94	45	0	0
Barium (1.0)	241	45	0	0
Cadmium (0.01)	241	45	0	0
Lead (0.05)	241	45	4	4
Chromium (0.05) (Hexavalent)	241	45	0	0
Selenium (0.01)	94	45	0	0
Silver (0.05)	241	45	0	0
Recommended Standards				
MBAS (0.5)	94	45	0	0
Chloride (250)	94	45	1	1
Copper (1.0)	241	45	9	8
Cyanide (0.01)	94	45	0	0
Iron (0.3)	241	45	13	9
Manganese (0.05)	241	45	65	18
Nitrate (10)	94	45	0	0
Sulfate (250)	94	45	0	0
TDS (500)	94	45	0	0
Zinc (5.0)	241	45	0	0
CCE (0.7)*	27	15	1	1
Mercury (0.005)**	241	45	0	0

Table 3 (Continued)

II. Physical	Number of samples which were analyzed for this constituent	Number of water systems sampled for this constituent	Number of samples exceeding the constituent unit	Number of water systems which had one or more samples exceeding constituent limit
Color (15)	145	45	23	6
Turbidity (5)	145	45	0	0
III. Pesticides**	28	16	0	0
IV. Radioactivity				
Gross Alpha (1 pCi/l)**	81	44	0	0
Gross Beta (10 pCi/l)**	81	44	0	0
V. Bacteriological (exceeding 4/100 ml)				
Distribution System (treated & untreated)	145	44	5	5
Wells - untreated	46	-	1	1

Notes

1. Numbers in parenthesis are from USPHS Drinking Water Standards - 1962, except as indicated below.

* Proposed Federal standard with use of new mini-sampler.

** From Manual for Evaluating Public Water Supplies, EPA - 1971.

TABLE 4

CHEMICAL STANDARDS NOT MET BY PUBLIC WATER SUPPLIES

Public Water Supply	Recommended				Mandatory			
		Concentration mg/l				Concentration mg/l		
	Constituent	Source	Dist. Syst.	DWS[1] mg/l	Constituent	Source	Dist. Syst.	DWS[1] mg/l
New Haven Lake Saltonstall	Manganese	0.057[2]		0.05				
Lake Bethany	"	0.054[2]		"				
Lake Maltby #2	"	0.069[2]		"				
Lake Gaillard	"	0.180[2]		"				
Lake Watrous	"	0.190[2]		"				
Lake Watrous	Iron	0.50[2]		0.3				
	Manganese		0.092[3]	0.05				
	Iron		0.37[3]	0.3				
Bridgeport Hyd. Co.	Manganese		0.116[3]	0.05				
Stamford Water Co.	Manganese Iron	0.20[2] (Laurel)	0.068[3] 0.86	0.05 0.3				
Rockville Water & Aqueduct Co.					Lead		0.420 0.000[4]	0.05
Mystic Valley Water Co.	Manganese Copper	0.17 1.40 (Well)	0.06	0.05 1.0				
Village Water Co. Simsbury					Lead	0.130 0.000[4]		0.05

1. Federal Drinking Water Standards
2. 14-day composite sample
3. Average of values not meeting the standard
4. Resample

TABLE 4 (Continued)

CHEMICAL STANDARDS NOT MET BY PUBLIC WATER SUPPLIES

Public Water Supply	Recommended				Mandatory			
	Constituent	Concentration mg/l Source	Dist. Syst.	DWS[1] mg/l	Constituent	Concentration mg/l Source	Dist. Syst.	DWS[1] mg/l
E. Lyme Water Comm.	Iron	0.85		0.3				
	Manganese	0.087	0.07	0.05				
Terryville Water Co.	Copper		4.1	1.0				
Ridgefield Water Supply Co.	Iron	0.62		0.3				
	Manganese	0.10 (Wells 2&3)		0.05				
New Milford Water Co.	Manganese	0.065[2]	1.5	0.05	Lead		0.090 0.022[4]	0.05
	Copper			1.0				
	Iron		0.5[3]	0.30				
The Highlands, Ledyard	Manganese	0.31[3]	0.30[3]	0.05				
	Copper		1.65	1.0				
Thompson Water Co.	Manganese	0.13	0.10[3]	0.05				
Montville Water Wks.	Manganese	0.18[3]	0.075[3]	0.05				
Avery Hghts. Water S. Windsor	Copper		1.66	1.0				

1. Federal Drinking Water Standards
2. 14-day composite sample
3. Average of values not meeting the standard
4. Resample

TABLE 4 (Continued)

CHEMICAL STANDARDS NOT MET BY PUBLIC WATER SUPPLIES

Public Water Supply	Recommended				Mandatory			
		Concentration mg/l				Concentration mg/l		
	Constituent	Source	Dist. Syst.	DWS[1] mg/l	Constituent	Source	Dist. Syst.	DWS[1] mg/l
SE Conn. Water Auth. Est Div., Groton	Manganese Iron	0.19	0.073[3] 0.58	0.05 0.3				
Indian Field Water Co. Naugatuck	Copper		1.19	1.0				
S. Coventry Water Supply Co.					Lead	0.34 0.000[4]		
Moosup Water Wks.	Manganese		0.06	0.05				
Rolling Hills Mobile Home Park Mansfield	Manganese	0.095	0.063	0.05				
Coventry Hills	Iron Manganese	1.0 0.063	0.72[3]	0.3 0.05				
Lambert Drive Assoc., Norwich	Manganese	0.18[3]	0.06[3]	0.05				
Tyler Lake Water Co., Goshen	Manganese Iron	0.11 0.87		0.05 0.3				
Lakewood Road Water Co., E. Hampton	Copper		1.23 1.60	1.0				

1. Federal Drinking Water Standards
2. 14-day composite sample
3. Average of values not meeting the standard
4. Resample

TABLE 4 (Continued)

CHEMICAL STANDARDS NOT MET BY PUBLIC WATER SUPPLIES

Public Water Supply	Recommended				Mandatory			
		Concentration mg/l				Concentration mg/l		
	Constituent	Source	Dist. Syst.	DWS[1] mg/l	Constituent	Source	Dist. Syst.	DWS[1] mg/l
Sherwood Forest Danbury	Manganese	0.16		0.05				
Maple Ridge Farms, Farmington	Iron		0.54	0.3				
Forest Prop. Owners Assoc. Marlborough	Manganese	1.52	1.68[3]	0.05				
Soundview, Ridgefield	Copper		1.27	1.0				
Oakwood Inc. Glastonbury	Chloride	550		250				

1. Federal Drinking Water Standards
2. 14-day composite sample
3. Average of values not meeting the standard
4. Resample

analyses carried out on samples collected during visits to the 45 water supplies studied.

Twenty-nine of the 45 supplies (64%) visited failed to meet one or more of the chemical standards (mandatory or recommended). No surface water supply exceeded the limit for turbidity, but 23 samples from 6 supplies exceeded the color standard of 15 units.

Manganese was the element most frequently found in quantities exceeding a chemical standard with sixty-five samples from 18 supplies exceeding the manganese standard of 0.05 mg/l.

Iron concentrations exceeding 0.3 mg/l in 13 samples taken from 9 supplies.

One well supply had a chloride problem in addition to over adjusting the pH. At the time the well was sampled, the chloride concentration was 550 mg/l and the pH at the well was 12. A commercial water conditioning company had set the rate for feeding the chemical to adjust the pH and they were contacted to make the changes. The pH in the distribution system was 8.9. Since it was reported that soda ash was being used for pH adjustment, the high chloride value wouldn't be from that source. State Health Department records showed the following:

	Chloride (Mg/l)	Sodium Mg/l)
1972	95	60
	140	63
	120	62
1973	96	150

Since the well is located near a major highway, the deicing salt might be responsible for the elevated chloride levels.

Nine samples from eight different supplies exceeded the limit for copper. Eight results were from distribution system samples and one was from a well, but the sample was taken from a sink tap in the well house. The pH range of the water was 6.4 to 7.0, the alkalinity 10 to 46 mg/l (carbonate as $CaCO_3$) and the chloride range was 6 to 29 mg/l. The low alkalinity to chloride ratio and the pH values support the theory of corrosive water being responsible for the elevated copper levels. The raw waters used by these systems have very low copper concentrations.

Only one system had two elevated copper concentrations, and the pH was 6.7, chloride 17 mg/l and alkalinity 10 mg/l. This system had the lowest alkalinity to chloride ratio.

The sample with 4.1 mg/l copper was taken from a tap in the building where chlorine is added and the corrosiveness of the chlorine might account for the high concentration.

Other variables in all distribution system samples are the amount of water used before arrival and the length of time the water was run prior to taking the sample.

Four samples failed to meet the mandatory standard of 0.05 mg/l for lead. Two of the samples were from wells, although one was taken from a sink tap in the well house. The other two were distribution system samples. Resamples at the same collection point were satisfactory. The only sampling point to show trace amounts of lead in two samples was at a lab sink in a new school which is on a dead end. It is possible the plumbing in the laboratory combined with the aggressive water could have produced the elevated lead results. No explanation is available for the results at the other three locations. One would not expect to find lead at any of the three sampling locations.

Another supply failed to meet the proposed Federal health standard of 0.7 mg/l for carbon chloroform extract (CCE). A resample was satisfactory and because surface water quality varies, this could be expected. More samples would be needed before any firm conclusion about the water quality could be made.

Facilities

Sanitary surveys of the 45 public water supplies revealed that 89% of the supplies had adequate source protection.

There were some surface water systems that could run into problems in the future unless land use is carefully controlled. It is conceivable that in the future, developers could exert much pressure on such private utilities with surface water supplies as Stamford, Bridgeport, and New Haven, and because of high taxes on the land or the need for capital, they might sell off parts of their watersheds. Uncontrolled development on the watersheds and the fact that most of these surface waters are not filtered, could result in a very undesirable situation, with a potential threat to public health.

All sources surveyed had satisfactory raw water quality when related to the degree of treatment provided. For exaple, one supply had 92 standard units of color in the raw water on the day EPA sampled (this was immediately after heavy rains), but with complete treatment the water in the distribution system had a maximum color of 1 standard unit. Without treatment the raw water quality would not be satisfactory.

Seventeen (38%) systems had inadequate distribution storage or no emergency power available. Thirteen of these systems served less than 500 people and the only storage available is in the pressure tank at the well.

During December 1973 much of Connecticut was without power for several days following an ice storm and water supplies without any emergency power were unable to deliver water to their customers.

One supply that serves 250 persons reported continuous pressure problems and stated that its efforts to correct the problem have been hampered by a lack of funds. At least five supplies in the group serving less than 500 people reported pressure problems resulting from the filling of private swimming pools or making backyard ice rinks in the winter. This water use has been prohibited by these utilities.

No system had a cross connection control program that systematically looked for cross connections, but one utility started a program during the study. A 25 to 50 home subdivision does not need as active a program as a utility serving 30,000 persons and providing water to industry, hospitals, and other users with high potential for cross connections, but such subdivision systems should at least have an initial plumbing inspection for cross connections.

Seventeen systems (38%), each serving less than 1000 persons, and one system serving 1630 persons had no master meter. Two systems (4%) had meters but kept no records.

Twenty-two systems (49%) had no full time operator and

and there were various arrangements for maintenance of these systems. The small systems can't economically afford or justify a full time operator, but using a professional manager to oversee a number of small systems in an area should be considered in more cases than now exist. Those small supplies that do have this kind of arrangement were generally the systems with the best maintenance.

Fluoridation

The State of Connecticut requires by law (enacted in May 1965) the fluoridation of all public water supplies serving twenty thousand or more persons. This law became effective January 1, 1967 for water utilities serving populations of 50,000 or more and on October 1, 1967, all water utilities serving 20,000 or more persons were required to fluoridate.

As part of this study 8 public systems were surveyed out of the 29 systems that fluoridate. Since that time, all 29 systems have been surveyed by EPA and the results forwarded to the Environmental Health Services Division of the Connecticut State Department of Health. Criteria used to select the original 8 utilities were described in the study methodology section of this report and Appendix A contains a complete discussion of the findings.

The actual level of fluoride in the distribution system is the single most important factor in evaluating the adequacy of a community fluoridation effort as well as the benefits that can be expected. Of the eight systems sampled 5 (62%), were fluoridating within the 0.8 - 1.2 mg/l range recommended by the State Department of Health. The other 3 systems were underfeeding and not reaching 0.8 mg/l. When analytic procedures were checked, 6 (75%) were within ± 0.1 mg/l of the duplicate sample analysis performed by EPA. One operator did not use a method conforming to Standard Methods. Daily finished water fluoride analysis, required by the state, was being conducted at 4 (50%) of the 8 installations. Analytic equipment and facilities and care of equipment was satisfactory at all eight systems 100%. Records of operation were acceptable at 6 (75%) systems.

At 6 systems (75%), the feeding arrangements were rated acceptable but 3 systems (37%), had unsatisfactory maintenance. Fluoride chemical storage arrangements were satisfactory at seven (80%) of the systems surveyed, but 4 (50%) did not have suitable safety equipment available and two (29%) were permitting unsafe reuse of chemical shipping containers.

A trained operator with genuine interest in feeding fluoride is essential to the satisfactory operation of a fluoridation installation. One (12%) of the facilities surveyed was operated by an individual not completely familiar with the fluoride chemical feed equipment at his plant. Two operators (25%) were not adequately trained in the use of analytical equipment, and 3 (37%) did not favor feeding fluorides to public water supply systems.

In the area of surveillance, six (75%) of the surveyed systems did not submit the required number of fluoride check samples during 1971. Three (37%) of the installations had not been visited in the past 12 months by a representative of the Environmental Health Services Division.

WATER SUPPLY PROGRAM

Authority, Statutes, and Regulations

The Connecticut General Statutes give the Connecticut Department of Health primary jurisdiction over public water supply sources and systems. They have statutory jurisdiction "over all matters concerning the purity and adequacy of any source of water or ice supply used by any municipality, public institution or water or ice company for obtaining water or ice, the safety of any distributing plant and system for public health purposes, the adequacy of methods used to assure water purity, and such other matters relating to the construction and operation of such distributing plant and system as may affect public health."
(Ch. 474, Sec. 25-32).

Section 25-33 further provides that "no system of water supply ... shall be constructed or expanded or a new additional source of water supply utilized until the plans therefor have been submitted to and approved" by the Health Department.

In addition to the foregoing specific statutory grants of regulatory authority, the Department is also directed to prepare a public health code "for the preservation and improvement of the public health" (Ch. 333, Sec. 19-13). The Department is given power to investigate and issue appropriate orders to protect water supply sources or systems (Sec. 25-34). Judicial review of such orders is provided for (Sec. 25-36). Minimal fines (not to exceed $100) are specified for violation of the relevant statutes or Departmental orders (Sec. 25-37).

Special provisions prohibit polluting water supplies by dead animal carcasses (Sec. 25-38) or by any other means S25-39, 25-43), and restrict the location of cemeteries within one-half mile of any reservoir (Sec. 25-41). Bathing or swimming in all water supply reservoirs is also prohibited (Sec. 25-43).

Other scattered sections of the Connecticut General Statutes deal with various aspects of drinking water quality, e.g., required fluoridation (Sec. 19-13b). All relevant statutes are found in a 1970 departmental publication entitled "Public Health Statutes - Part 3A" (O A 137 3 A (1M) 1970).

The Department's administrative regulations are contained in two departmental publications: "The Public Health Code of the State of Connecticut (April 1971); and Public Water Supply Information" (Form EHS-39 (3-71) 2M).

This latter publication is updated about every six or seven years, and contains reference to the Public Health Service Drinking Water Standards, but they have not been adopted as regulations. Pages 10-12 of the current (1971) edition of Public Water Supply Information contain the chemical and bacteriological standards of the Drinking Water Standards, and water quality is judged according to these standards.

Appendix E contains a summary of the various regulations pertaining to water supplies.

Water Supply Wells

The location and construction of public and private water supply wells are covered by detailed regulations in the Public Health Code (Sec. 19-13-51a thru 19-13-51l). A 1969 enactment (Ch. 482, Sec. 25-126 thru 25-137) created the Connecticut Well Drilling Board to develop a well drilling code "for the preservation of public health". The Board's regulations, which are to be developed in cooperation with the Department of Health and the Department of Environmental Protection, have not yet been promulgated. The duties and powers of the Health Department are expressly preserved (Sec. 25-137).

A comprehensive treatment of protective measures for wells and springs is found in the Department's 1964 pamphlet Private Water Supplies (Form S.E. 37 (5-64) 5M).

Coordination with The Department of Environmental Protection

Diversions of water from any river by a water supply entity for public or domestic use may be made only after obtaining a permit from the Department of Environmental Protection (Ch. 473, Sec. 25-8a). The Department, in acting on any such application, must "advise, consult and cooperate" with the Department of Health and other state agencies (Sec. 25-8c). Permits may be revoked or modified if the Department of Environmental Protection "finds it in the public interest to do so" (Sec. 25-8c). In 1971, enactment (Sec. 26-141 a, b,c) gave the Department of Environmental Protection the authority to develop regulations to control the flow in all streams stocked with fish. Public hearings were to have been held by July 1973, but to date they have not been held. This has been a controversial law and those utilities with surface water are worried that the low flow augmentation will be needed at time they want to keep their reservoirs as full as possible. The regulations could have a profound effect on the adequacy of drinking water reservoirs to meet future demands.

The Department of Environmental Protection also has jurisdiction over the safety features of all existing and proposed "dams, dikes, reservoirs and similar structures" (Ch. 479, Sec. 25-110). Construction of new such structures and alteration of existing structures requires a permit from the Department (Sec. 25-112). Hence, any water supply project involving such construction requires concurrent action by the Department and the Health Department.

A 1973 revision of the Water Pollution Control Act (Sec. 25-26a) forbids the pollution streams tributary to an existing or proposed water supply impoundment.

Policy

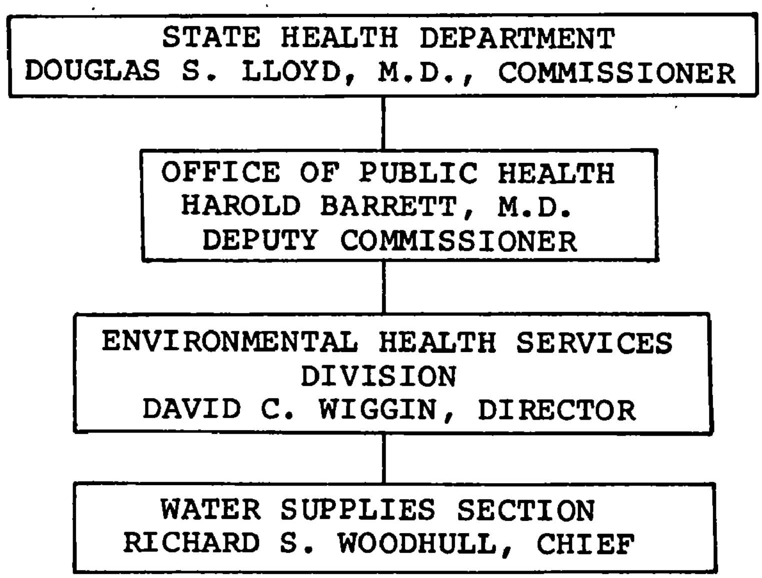
The most recent statement of the Environmental Health Services Division's policy on drinking water was made in a paper entitled Drinking Water Policy and Practice in Connecticut and presented to a conference of Connecticut water works officials and operators in Newington, Connecticut on May 14, 1972. The paper has been printed and made available by the Health Department (Appendix F).

Organization

Figure 2 presents the organizational position of the Water Supplies Section within the State Department of Health.

FIGURE 2

TABLE OF ORGANIZATION



This Section, as part of the Environmental Health Services Division, carries out the general sanitary supervision of public water supplies delegated to the State Department of Health by Sections 25-32 through 25-54 of the Connecticut General Statutes. This work is carried on in cooperation with state, regional and local health offices and with the water utilities who are responsible for the quality of water furnished to their customers. The functions of the Water Supplies Section are as follows:

(1) periodic check-ups of sources of pollution on each public water supply drainage area; (2) regular inspections of water treatment plants, including chlorination and fluoridation facilities, (3) review and approval of qualifications of treatment plant operator applicants, (4) consultations with water supply officials concerning protective measures which may be undertaken; (5) periodic collection of samples from distribution systems; (6) regular inspections of all approved check valve installations existing on cross connections between public drinking water systems and unapproved private water supplies to see that no pollution reaches the mains; (7) promotion of and assistance in surveys of water piping in factories and other buildings in cooperation with local authorities to eliminate cross connections, back-siphonage connections and sewer connections whereby public drinking water may be

contaminated; (8) investigations of complaints about taste, odor, color, sediment and staining from water; (9) approval of new sources and systems of water supply and of plans for treatment works (including fluoridation); (10) consultation with any municipality or private corporation or individual having or desiring to have any public water system concerning proposed sources of supply and methods of assuring their purity and adequacy; and (11) reports to the General Assembly on any petition to develop or introduce any system of water supply.

In addition, arrangements are made whereby samples for chemical, physical, and bacteriological analysis are forwarded by water utilities to the Laboratory Division at regular intervals. These samples supplement those analyzed by the utilities themselves and those brought in by members of the Environmental Health Services Division, Regional Office Sanitarians, and local Directors of Health.

Activities - Engineering

During 1972 the Water Supplies Section was actively engaged in carrying out the functions previously described. Nine new systems were approved and 19 treatment systems were reviewed and approved. Table 5 shows that 272 (85.3%) of the 319 public water supplies were inspected. (It should be stated that EPA looked at records for 319 supplies although the state reports that there are now 329).

The table also shows that 16 (5%) have not been visited in the last three years. Table 6 gives a breakdown of those inspected in 1972 and shows when the previous inspection had been made. These records indicate that 1972 was a good year for inspections and that in past years not as many inspections were made. Appendix D contains the forms used in making the various kinds of inspections.

Table 5

Status of Water Supply Inspections

of 319 supplies*

Date of Last Inspection	No.	%
1972	272	85.3
1971	20	6.3
1970	11	3.4
1969	6	1.9
1968 or before	10	3.1

* 1972 records

TABLE 6

Connecticut Water Supply Evaluation

Date of Previous Inspection of 272 Water Supplies
Surveyed by Water Supplies Section
in 1972

	1971	1970	1969	1968 or earlier	Unknown	New Supplies
No.	110	66	54	22	12	6
% of Total	40.5%	24.2%	19.9%	8.1%	4.4%	2.2%

The Section also began to do more in the area of cross connection control during 1972. Surveys concentrating on factories, commercial buildings and hospitals were carried out in New Milford and Torrington. In addition, 97 double check valve installations were each checked 3 times during the year. It is hoped that both the State and the utilities will do more in this area in the future.

Activities - Training

The Water Supplies Section attempts to provide some training for operators and in 1972, participated in 3 training efforts. There is no certification law in Connecticut, but operators must be approved by the Water Supplies Section. One filter plant operator was given an examination by the Chief of the Water Supplies Section and approved in 1972. One training program conducted by the Health Department is called the "Conference of Water Works Officials and Operators." It was at such a conference that the Department's latest water supply policy document was presented.

Laboratory Support

Laboratory surveillance of drinking water quality in Connecticut is carried out by a number of individuals and agencies. Sample collection is most often done by water utility personnel, but may be done by Water Supplies Section personnel or sanitarians from the Regional Offices. Analyses may be performed by the Connecticut Health Department Laboratory, private laboratories, or water utility laboratories.

There are some 47 private laboratories approved by the State Health Department to examine water and sewage samples. These laboratories are visited annually and evaluated by a laboratory survey officer of the Laboratory Division.

Both the State chemical and bacteriological laboaratories were evaluated during the study and the complete reports are included as Appendix B and Appendix C. The laboratories met the provisions of <u>Standard Methods for the Examination of Water and Wastewater</u>.

In the bacteriological review, there were a number of recommendations and suggestions. These for the most part cover laboratory procedures and methods and since the laboratory director has the report, and it is included as an appendix to this report, the recommendations and suggestions will not be repeated here. One item that should be covered here is sample transit time. In 4% of the records reviewed the time from collection to examination exceeded 48 hours. These samples should not have been examined as they far exceeded the <u>Standard Methods</u> limit of 30 hours. Since the evaluation the State laboratory has been rejecting samples over 30 hours old. One water supplies section engineer had this confirmed when he inadvertently put the wrong date on a sample he brought in.

Another aspect of bacteriological surveillance that needs work is the number and frequency of samples. Only 13 of the 45 supplies collected samples at the frequency required by the _Drinking Water Standards_. There were some supplies serving more than 10,000 persons that rely completely on the State for surveillance. An attempt should be made to get supplies to confirm to the _Drinking Water Standards_ sampling frequency, beginning with the larger supplies and working down to the smaller supplies. Should proposed Federal legislation be passed, this will become a requirement, so it would be desirable to begin now. Another area that needs attention is resampling following a sample which fails to meet the bacteriological standard of 4 per 100 ml. The Laboratory Division does an excellent job of follow-up, but it was noted that some private laboratories weren't as prompt as they should be.

The State chemical laboratory was found to be generally well equipped and analyzing a large number of samples (1566 in 1971). However, of the 13 chemical tests performed by the laboratory, only seven are in the _Drinking Water Standards_, and of these seven, only fluoride is health related.

The other eighteen chemical constituents in the Drinking Water Standards are seldom, if ever, run. Occasionally, complete trace metal, radiochemical and pesticide analyses are carried out, but only on special request. If trace metals are to be run, it will be important to add acid preservative at the time of collection to prevent plating out on the sides of the container.

The availability of data, because of the automatic data processing system of the Health Department, is commendable and a very useful tool in assessing water quality changes or trends.

WATER SUPPLY PROGRAM NEEDS

Authority, Statutes and Regulations

The Connecticut Department of Health has adequate statutory authority to carry out its mandate to protect the public health, but some changes would strengthen its position. During the court case of Stamford Water Company vs State Department of Health, in which the Court ruled in favor of Stamford Water Co. and said they did not have to build complete treatment facilities, the State Department of Health learned it did not have enforceable drinking water standards and the attorney general ruled it also did not have the enabling legislation for adopting such standards. The process for getting this enabling legislation has begun. Once this has passed, the State should adopt Federal drinking water standards as part of their regulations.

The State Department of Health has authority to review plans for new water treatment systems, but does not have a document on minimum design criteria and standards. This document would help the state in making not only their plan review but also field inspections of water supplies, and be helpful for engineering consultants involved in water treatment plant design.

Sections 19-13-B37 and B38 of the Public Health Code prohibit cross-connections between water supplies and prescribe permissible connections to water tanks and there is further discussion in Public Water Supply Information on pages 21 and 22, but there is a need for more specific regulations that will encourage and support the enactment of local programs of backflow prevention and cross connection control. The regulations should provide for the following:

1. The establishment and implementation of an effective cross connection control program by all public water systems.

2. Prohibit: (a) the installation and maintenance of water service to any premise where actual or potential cross connections exist, (b) the installation and maintenance of any connection where water from an auxilliary water system may enter a potable water system, unless satisfactory protection is provided.

3. Provide for the entry to any premise served by a public water system for the purpose of making surveys and investigations for cross-connections.

4. Criteria for booster pump installation in public water supply systems and on premises served by public water supply systems.

5. Penalties and/or discontinuance of service to anyone in violation of the cross-connection control regulations.

The penalties for violating State Department of Health orders or relevant State statutes are fines not to exceed $100. These fines are minimal and allow for continued violation by those utilities that can afford to pay the price. They should be increased and related to the potential hazard to public health produced by the violation.

The State Department of Health under Section 19-13a of the Connecticut General Statutes gives the public health council the power to adopt regulations in the public health code "pertaining to the protection and location of new water supply wells . . . " Under this provision, the State should adopt regulations that would require permits for underground waste disposal and control other potential sources of ground water pollution such as landfills or underground storage tanks.

Activities - Engineering

At the present time, the Water Supplies Section has 3 men: the Chief, one sanitary engineer, and one engineer intern. At times during the year, another engineer intern, a co-op student from Northeastern University in Boston, is available for various duties.

From Tables 5 and 6 it can be seen that the year of the survey (1972) was an above average year for inspections. Records indicate some fluctuation in the number of inspections made and the number is related to the turnover in personnel of the Water Supplies Section. This turnover rate has been higher than desirable and causes some decrease in inspections while new people are being trained. Fortunately, the Section Chief has occupied the position for a number of years giving the program continuity.

The Section has been aware of the need for added personnel and has sought more positions to assist with the increasing workload they have experienced. Mandatory fluoridation is just one activity that has been a development requiring more surveillance. Many small water supplies have been installed, and since 1960, the number of supplies for which the Section is responsible has more than doubled, while the staff of the Water Supplies Section has remained about the same.

The Section has been unable to conduct cross-connection surveys for several years, although a few were begun in 1972. With the departure of the man who began this work, it is uncertain as to whether they will continue.

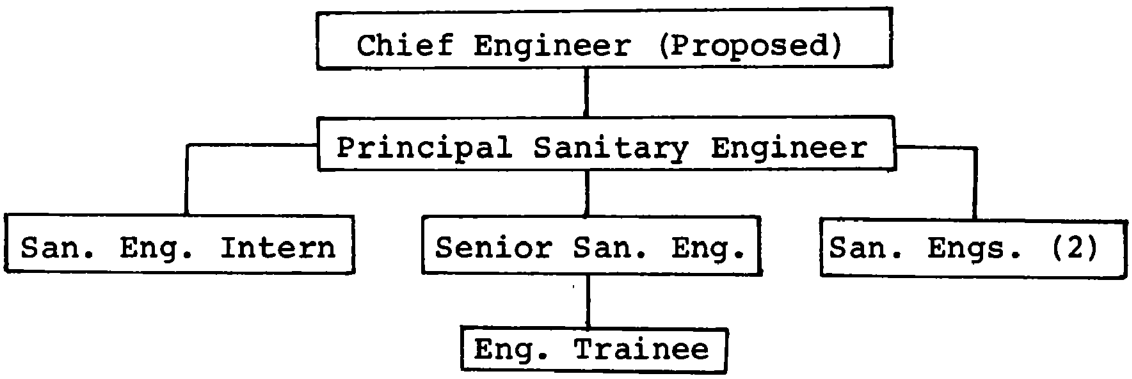
The approval of new small supplies and the fluoridation installations have demanded time that would otherwise have been spent inspecting treatment facilities and watersheds, and collecting surveillance samples.

Requests for new positions have not been granted and the turnover in younger engineers has meant that much of the time in recent years, the field staff has been quite inexperienced. This lack of experience has hampered the Section's educational efforts in terms of producing informational articles for the general public or for trade publications, and has also somewhat hampered personal contacts with water plant operators and consumer groups.

The specific manpower requirements of the Water Supplies Section are presented in Table 7. Seven professionals would be required to do the work shown in the table, assuming 230 working days per year. A Principal sanitary Engineer presently acts as "Chief" of the Water Supplies Section. He also serves as general assistant to the Director, Division of Environmental Health Services, which involves duties in areas other than water supply. Therefore, it is proposed that the Section be reorganized and the resultant organization conform to that outlined in Figure 3.

FIGURE 3

WATER SUPPLIES SECTION - ORGANIZATION CHART



This staffing proposal conforms closely with estimates developed by EPA. They estimate that one man can maintain effective surveillance over 56 water supplies during the year. This means 6 men would be required for the 329 supplies Connecticut now has. The seventh man would be the Chief Engineer and would be responsible for administering the program. Two secretaries would be needed in the Section. The proposed staff is the minimum needed for an effective water supply program. The annual cost involved would be approximately $26,000 per man (including salary, travel, office overhead, secretarial help, etc.), or $175,000. Laboratory support would be an additional expense. An estimate of laboratory cost involved in a bacteriological sampling program which meets the Drinking Water Standards specifications can be arrived at using a figure of $5 per water sample and assuming the State will examine 5% of the required monthly samples or no less than 2 from each supply per month.

System Size	Number of Systems	Samples/System/Month	Total Samples per Mo
35,000	315	2	630
35,000 - 100,000	10	4	40
100,000	4	10	40
		Total	710

Table 7

Water Supplies Section - Manpower Requirements

	No. of Supplies	No. of Inspections	No. Days Required
Untreated Well Systems (All Year)	80	80	40
Untreated Well Systems (Summer)	55	55	28
Treatment Plants Inspected Annually	11	11	11
Treatment Plants Inspected Semi-Annually	93	186	100
Treatment Plants Inspected Quarterly	130	520	260
Watersheds Inspected Annually	45	45	52
Watersheds Inspected Every 5 Years	17	3	10
New Systems and Treatment Plans Approved per Year	33	—	50
New Additions to Existing Systems	60	—	60
Special Watershed Surveys	7	7	9
Investigation of Complaints	—	30	25
Milk Farm Well Investigations	65	65	32
Court Cases	—	—	8
Special Investigations (salt, gasoline, etc.)	—	—	6
Report Writing	—	—	250
Double Check Valve Inspections	128	384	77
Interior Water Piping Surveys	—	—	20
State Park & Forest & Highway Wells	70	70	20
Administration & Consultations	—	—	360
Certification of Water Supplies For Meat and Poultry Plants	57	64	16
Foster Homes	125	130	32
Certification of Interstate Common Carrier Watering Sources	8	8	10
Certification of Interstate Common Carrier Watering Points	20	20	6
Water Resources Planning	—	—	230
Total Man Days			1712

The above tabulation indicates that the monthly requirement would be 710 samples. At $5 per sample the annual cost would be $42,600.

Chemical analysis of the 647 wells and 107 reservoirs in the state would be carried out at an estimated annual cost of $79,600. This is based on the following assumptions:

Analysis	Man-days/Sample	Samples	Man-days
Wet chemistry	0.55	323	177.6
Trace metals	0.61	323	197.0
Pesticides	2.00	107	214.0
CCE	1.00	107	107.0
Radiochemical	0.72	215	180.7
		Total	876.3

The man-days per sample figures are based on EPA guidelines, and the number of samples on a sample frequency of annually for surface waters and tri-annually for ground waters. The total estimated annual cost comes from using 3.98 man years (876.3 man days/220 work days 1 yr) times $20,000 per man year.

Activities - Training

Additional manpower, beyond that mentioned in the preceding section, will be needed if any increase in training is to be undertaken by the State Health Department. There is no question that operators need training, some for refersher courses and others for more basic training in water treatment.

In the past, EPA has provided a number of courses in the field of water treatment, but increasing pressure to charge prohibitive tuition fees is likely to end this program or make it available only to the large companies that can afford the training, not necessarily those that need it the most.

The availability of revenue sharing funds gives the State Department of Health the opportunity to staff its own training program or pay another public or private agency to carry on a training program. Since the Water Supplies Section knows the needs, they should have input into the development of a training program that will meet those needs.

Laboratory - Support - Bacteriological

The importance of a strong bacteriological surveillance program has been noted in many studies and Connecticut is no exception. A major deficiency in the surveillance program has been frequency of sample collection. (Only 13 of 45 supplies surveyed met Drinking Water Standards frequency requirements). The State should examine on a monthly basis a minimum of 5% of the number of samples required by the Drinking Water Standards or a minimum of two samples per month from supplies serving less than 35,000 persons.

Some samples by the states might be used to comply with sampling frequency requirements, but the majority of the samples would have to be examined by a utility or other private laboratories certified by the State.

Resampling should be done on the same day laboratory results indicate a bacteriological sample failed the Drinking Water Standards. Section 3.23 of the Drinking Water Standards states that "... daily samples from the same sampling point shall be collected promptly and examined until the results obtained from at least two consecutive samples show the water to be of satisfactory quality." Every effort should be made to accomplish this goal.

Laboratory Support - Chemical

Chemical surveillance of drinking water will probably become increasingly important as commercial development puts increasing pressure on watersheds. The influence of underground storage tanks and disposal of wastes in lagoons on ground water should be monitored. The need for increased surveillance in this area is indicated by the findings of this study. The present State policy of analysis for 13 substances only seven of which are in the Drinking Water Standards should be changed to include the other 18 parameters in the Standards, at least to establish a baseline of data on each supply. Once a data base is established, the State should concentrate its efforts on the health related constituents.

It is recommended that drinking water samples be collected and analyzed according to the following schedule unless more frequent analyses are indicated by the presence of certain toxic substances:

1. Surface sources - at least once per year.
2. Ground Water and Springs - at least once every three years.

There are 107 surface sources in Connecticut and 647 ground water sources which would mean a total of 323 samples for analysis per year.

To do the additional analyses, it is recommended the State obtain another atomic absorption spectrophotometer with arsenic and selenium analytical capability. It might also be desirable to have a mercury analyzer to have the most efficient operation and use of equipment. The new carbon absorption method or mini-samplers are available and the State laboratory should be equipped to carry out the CCE determination for organics. Once this is done and there is increased surveillance in pesticides, radiochemicals and metals, two to three more chemists will be needed.

PARTICIPANTS

Study Director

Charles D. Larson, Chief, Operations Section, Water Supply Branch, Air & Water Programs Division, Region I.

Field Evaluation

Charles D. Larson, Chief, Operations Section, Water Supply Branch, Air & Water Programs Division, Region I.

Stephen P. Lathrop, Staff Biologist, Operations Section, Water Supply Branch, Boston, Mass.

Thomas Hushower, Fluoridation Engineer, Water Supply Division, Washington, D. C.

Laboratory Evaluation

Earl McFarren, Research Chemist, EPA, NERC, Cincinnati, Ohio.

Edwin E. Geldreich, Consulting Bacteriologist, Water Supply Division, NERC, Cincinnati, Ohio

Laboratory Support

Fluoride Laboratory, Water Supply Division, Washington, D. C.

Water Supply Research Laboratory, NERC, Cincinnati, Ohio

Northeast Water Supply Research Laboratory, Narragansett, Rhode Island

Gulf Coast Water Supply Research Laboratory, Dauphin Island, Ala. (EPA)

Eastern Environmental Radiation Laboratory (EPA) Montgomery, Ala.

Laboratory Division, Connecticut State Dept. of Health, Hartford, Connecticut

Data Processing, Water Supply Division, Cincinnati, Ohio

Mrs. G. D. Bardo, Statistical Clerk

Mr. G. C. Kent, Water Quality Register Branch

Report Preparation

Charles D. Larson, Chief, Operations Section, Water Supply Branch, EPA, Region I

Dorothy Jacobs, Secretary

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APPENDIX A

Adequacy of The Water Fluoridation
Control Program in Connecticut

An Evaluation of Water Fluoridation
At Selected Water Supply Systems
In the State of Connecticut

FINAL DRAFT

AUG 22 1973

Thomas N. Hushower
Thomas N. Hushower, P.E.
Chief, Special Studies Section
Office of Water Program Operations
Environmental Protection Agency

Connecticut Water Supply Program Evaluation

Adequacy of the Water Fluoridation Control Program in Connecticut

Introduction

The State of Connecticut requires by Law (enacted in May 1965) the fluoridation of all public water supplies serving twenty thousand or more persons. "Whenever the fluoride content of public water supplies serving twenty thousand or more persons supplies less than 0.8 mg/l of fluoride, the person, firm, corporation or municipality having jurisdiction over the supply shall add a measured amount of fluoride to the water so as to maintain a fluoride content of between 0.8 mg/l and 1.2 mg/l...". The law became effective January 1, 1967, for water utilities serving populations of 50,000 or more and on October 1, 1967, all water utilities serving 20,000 or more persons were required to fluoridate.

The Environmental Health Services Division in the State Department of Health is responsible for approval and supervision of all public water supplies in Connecticut including all fluoridation installations. Requirements for approval and control of the fluoridation process are included in the following State publications and documents: Public Water Supply Information; Program For Application For Approval For The Addition Of Fluoridation Treatment To Public Water Supply Systems; Check List For Design And Operation Of Fluoridation Treatment Facilities; and Section 19-13b Of the General Statutes, Fluoridation Of Public Water Supplies.

On January 1, 1972, twenty-six public water supply systems of a reported 325 water systems serving over 25 customers, were fluoridating in the State of Connecticut. An estimated 2.25 million or 91 percent of the population using public water supplies received fluoridated water. 1/ Six communities were reported using one or more water sources containing natural fluorides of 0.7 mg/l or higher and one community, Coventry - Lakewood Heights, was using one or more water sources containing natural fluorides as high as 2.1 mg/l fluoride. 2/

The proven benefits derived from fluoridation in dollars to prevent dental caries for the population in Connecticut served by fluoridated water is estimated to be $20.5 million. The cost to the State for implementing the recommendations of this report is $30,000 and the cost to the local communities is estimated at $360,000 giving a benefit cost ratio to the State of 53 to 1. To receive full value of the benefits of fluoridation, it is essential that the fluoride ion levels be maintained between 0.9 - 1.1 mg/l as a reduction of only 0.2 mg/l below the optimum value (1.0 mg/l) will reduce the benefits of fluoridation by 50 percent.

1/ Fluoridation Census 1969 (Revised April 1972), U. S. Department of Health, Education, and Welfare, Public Health Service.

2/ Natural Fluoride Content of Community Water Supplies, 1969, U. S. Department of Health, Education, and Welfare, Public Health Service.

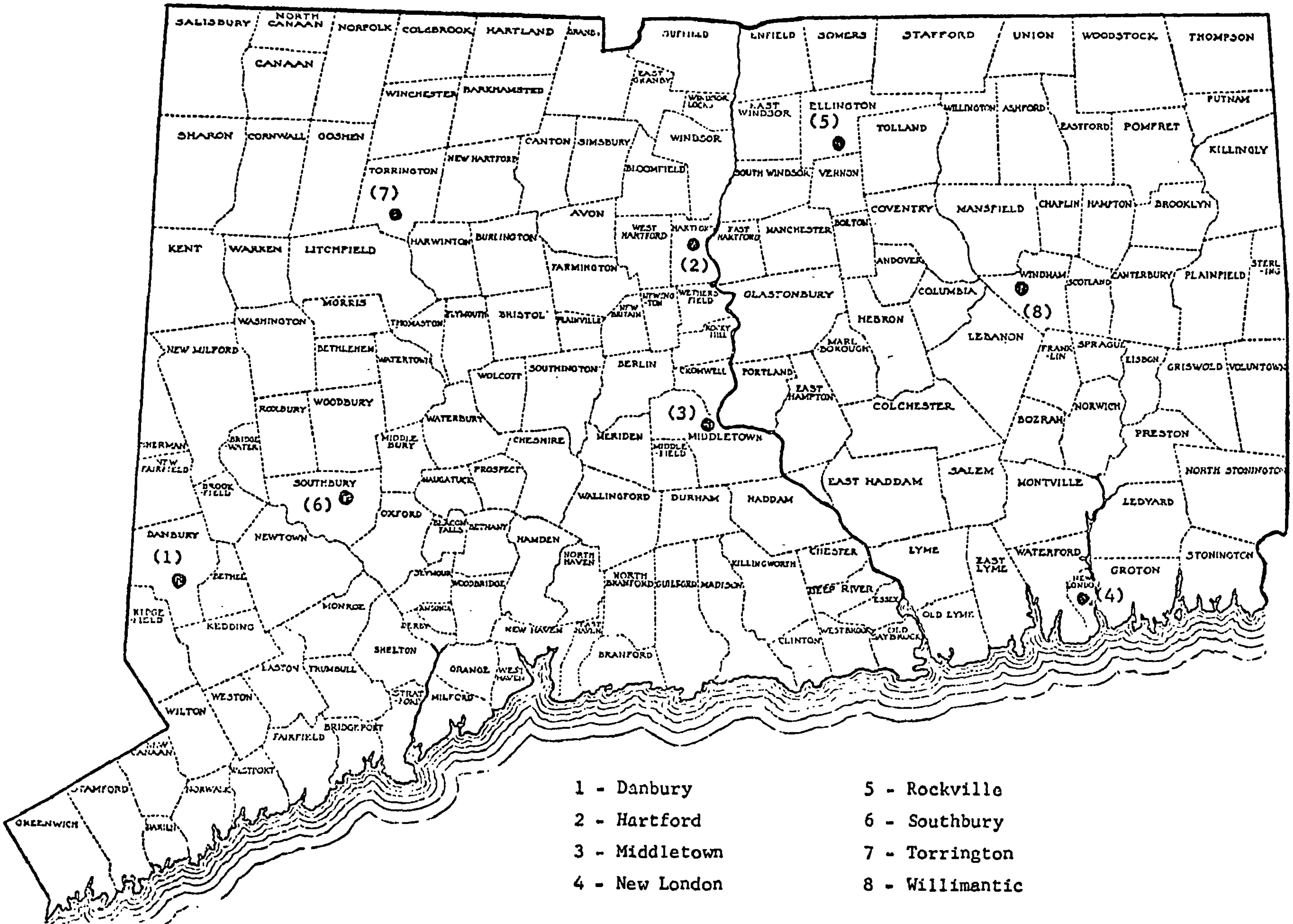
Evaluation Procedure

To evaluate the adequacy of the water fluoridation control program of the Connecticut State Department of Health, eight fluoridated water supply systems were selected for survey. The choice of the eight systems representative of the twenty-six fluoridation installations in Connecticut was based on geographical location, population served, source of water supply (ground or surface water), and fluoride compound used in fluoridation. Figure 1, Fluoridated Water Supply Systems Selected For Study, locates the eight installations visited and Table I, summarizes pertinent information on each facility.

CONNECTICUT WATER SUPPLY PROGRAM EVALUATION

Figure 1

FLUORIDATED WATER SUPPLY SYSTEMS SELECTED FOR STUDY



CONNECTICUT WATER SUPPLY PROGRAM EVALUATION
TABLE I
FLUORIDATED WATER SUPPLY SYSTEMS SELECTED FOR STUDY

Water Supply System	Location (County)	Date of Fluoridation	Population Served	Source of Supply	Avg. Flow (MGD)	Fluoride Compound	Type of Feeder	Analysis Method	Test Equipment
Danbury	Fairfield	9/68	35,000					E	T-3
Margerie				Margerie Res.	3.50	VS	V-1	(a)	
Westlake				Westlake Res.	3.50	VS	V-1		
Hartford	Hartford	1/60	389,000		55.0			E	T-4
W. Hartford				Nepaug Res. &		VS	G-1	(b)	
Reservoir, Six				Barkhamstead Res.		VA	P-1	(c)	
Middletown	Middlesex	10/60	32,000		3.20			E	T-4
River Road				2-Wells		VA	P-2		
Mt. Higby				Mt. Higby Res.		VA	P-3		
Laurel Brook				Laurel Brook Res.		VA	P-2		
New London	New London	6/68	36,000	Lake Konomoc	4.75	VS	V-2	S	T-2
Rockville	Tolland	5/70	13,280	Lake Shenipsit	3.50	VA	P-4	S	T-2
Southbury	New Haven	4/45	3,000	2-Wells	0.26	VT	P-5	ML	T-1
Torrington	Litchfield	3/58	24,000		3.90			S	T-2
Hartbrook				Reubin Hart Res.		VT	V-4		
Allen				Allen Dam Res.		VT	V-4		
Willimantic	Windham	9/58	17,300	Natchaug R.	3.3	VS	V-3	S	T-2

Fluoride Compound
- VA - Fluosilicic Acid
- VS - Sodium Silicofluoride
- VT - Sodium Fluoride

Analysis Method
- E - Electrode
- ML - Modified Lamar
- S - Spadns

Test Equipment
- T-1 Color Comparator - Taylor Water Analyzer
- T-2 Photometer - Hach DR
- T-3 Specific Ion Meter - Orion #407, Orion Electrodes
- T-4 Specific Ion Meter - Orion #401, Orion Electrodes

(a) Monitored with Hach CR 1120 Continuous Fluoride Analyzer
(b) Monitored with Foxboro Fluoride Analyzer
(c) Monitored with F&P Anafluor Continuous Fluoride Analyzer

Type of Feeder
- V-1 Volumetric - BIF 25-04 Helix Type
- V-2 Volumetric - BIF 25-01 Helix Type
- V-3 Volumetric - BIF 50-A Rotating Disk
- V-4 Volumetric - W&T A-635 Screw Type
- G-1 Gravimetric - BIF #48 Loss-In-Weight (3)
- P-1 Diaphram Pump - Milton Roy Model A (2)
- P-2 Diaphram Pump - W&T A-747 Metering Pump
- P-3 Diaphram Pump - W&T A-748 Metering Pump
- P-4 Diaphram Pump - BIF 1203 Chem-O-Feeder (2)
- P-5 Piston Pump - BIF

The survey of the eight representative fluoridation installations included a field inspection visit to the facility (the State notified the operators of the visit in advance), completion of a survey form 3/, and collection of water samples for fluoride ion analysis. Each installation was examined with respect to: fluoride ion content in the distribution system; analytical control of the fluoride ion level; fluoride chemical feed equipment and facilities; fluoride chemical compound storage and handling; operator training and interest; and, surveillance.

The actual level of fluoride ion in the distribution system is the single most important factor in evaluating the adequacy of a community water fluoridation effort and hence in evaluation of the State program responsible for approval and surveillance of the installation. However, as distribution samples collected on one particular day may not give a true picture of day-to-day operating conditions, the installations were also evaluated with respect to the following:

I. Analytical Control of the Fluoride Ion Level

A. Were the fluoride ion analyses conducted at the water plant accurate within ± 0.1 mg/1 of the value determined by the Environmental Protection Agency?

3/ A copy of the questionnaire used in the Connecticut Fluoridation Survey is appended.

B. Were finished water samples analyzed daily or more frequently for fluoride ion content?

C. Were raw water samples analyzed regularly for fluoride ion content?

D. Were laboratory equipment and facilities at the water plant adequate to conduct fluoride ion analysis according to one of the three standard methods?

E. Was laboratory equipment clean and given responsible care?

F. Were complete records kept of the fluoridation operation?

II. Fluoride Chemical Feed Equipment and Facilities

A. Were the fluoride feed equipment and facilities adequate to control the fluoride ion level in the finished water?

B. Was positive protection provided against overfeeding? Was backflow protection provided? Was equipment location and point of fluoride chemical application at the best practical site? Was the feed equipment site uncluttered?

C. Was the fluoride chemical feed installation operated continuously for the past twelve months without an interruption of more than one day?

D. Were the fluoride chemical feed equipment and facilities maintained satisfactorily?

III. Fluoride Chemical Compound - Storage and Handling

A. Was the fluoride chemical compound stored in a safe, protected and orderly manner?

B. Was safety equipment available and were safe procedures followed in handling the fluoride chemical compound?

C. Were fluoride chemical shipping containers disposed of satisfactorily or re-used only for fluoride chemical storage?

IV. Operator Training and Interest

A. Were plant operating personnel well-trained to operate the fluoride chemical feed equipment and facilities?

B. Were personnel conducting the fluoride ion analyses knowledgeable of their test equipment and standard procedures for analysis?

C. Was the water plant official interviewed in favor of fluoridation and was he interested in adding fluorides to public water supply systems?

V. Surveillance

A. Were check samples for fluoride ion analysis submitted to the state as required?

B. Had the water fluoridation installation surveyed been inspected in the past twelve months by a representative of the state water supply program surveillance agency?

Summary of Findings

Data collected on the water supply systems fluoridating in the State of Connecticut indicated five (63 percent) of the eight installations selected for investigation evidenced a fluoride ion content in the distribution system at the time of the survey within the 0.8 - 1.2 mg/l range recommended by the State Department of Health. Three (37 percent) of the facilities were underfeeding, i.e. the fluoride ion levels in the samples collected from the distribution system were less than 0.8 mg/l. None of the eight installations were overfeeding. Table II, Analysis of Samples From Selected Fluoridated Water Supply Systems, tabulates the fluoride ion analysis of the water samples collected at each facility surveyed 4/.

The operating conditions observed during the time of the survey of the eight fluoridation installations inspected are summarized as follows:

I. Analytical Control of the Fluoride Ion Level

Practices to analytically test and control the fluoride ion level in the distribution systems varied considerably. Six (75 percent) of the plant operators or laboratory personnel testing water samples for fluoride ion content conducted the

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4/ Water samples were analyzed for fluoride ion content by the Water Supply Division, Environmental Protection Agency, Washington, D. C. using the Electrode Method.

CONNECTICUT WATER SUPPLY PROGRAM EVALUATION
TABLE II
ANALYSIS OF SAMPLES FROM SELECTED FLUORIDATED WATER SUPPLY SYSTEMS

Water Supply System	Date of Sample	Fluoride, mg/l				
		Raw Water	Check Sample (Operator)	Check Sample (EPA)	Distribution System #1	Distribution System #2
Danbury	5/23		1.95	2.00	0.43	0.45
Margerie		0.05			0.75	
Westlake		0.03				
Hartford	9/13	0.11	0.97	0.98	1.00	1.01
W. Hartford		0.09			0.99	1.02
Reservoir Six		0.09			1.00 1.00	1.00
Middletown	5/24		0.96	0.87	0.92	0.88
River Road		0.08			0.90	
Mt. Higby		0.04				
Laurel Brook		0.05				
New London	5/24	0.03	1.05	0.96	0.80 0.84	0.80
Rockville	9/12	0.10	0.80	0.67	0.79	0.68
Southbury	5/23		1.0	0.96	0.91	0.90
Well #1		0.09				
Well #2		0.10				
Torrington	5/22		0.95	0.89	0.54	0.90
Hartbrook		0.04			0.89	
Allen		0.04				
Willimantic	9/12	0.08	0.98	0.80	0.96	0.89

analysis within $\pm$ 0.1 mg/l of the duplicate sample analysis performed by the Environmental Protection Agency. The operator at one installation (Southbury) did not conduct fluoride ion analysis by one of the three Standard Methods. Daily finished water fluoride ion analysis, required by the State, was conducted at four (50 percent) of the installations and regular raw water fluoride ion analysis was being conducted at only two (25 percent). Analytical equipment and facilities were judged adequate at seven (88 percent) of the facilities and care of equipment was satisfactory at seven (88 percent) of the plants conducting fluoride ion analyses. Records of the fluoridation operation were acceptable at six (75 percent) of the installations surveyed.

II. Fluoride Chemical Feed Equipment and Facilities

Fluoride chemical feed equipment and facilities to control the distribution system fluoride ion level to within the required range were found deficient at two (25 percent) of the eight installations surveyed. Six (75 percent) of the feeding arrangements were rated acceptable, i.e. protected against overfeeding, protected against backflow, preferred point of chemical application, and good housekeeping in the feeder area. One (12 percent) of the operators reported one or more interruptions in fluoridation of one or more days duration in the past twelve months. Maintenance was unsatisfactory at three (37 percent) of the facilities surveyed, even though the plant operators had been alerted to the inspection visit.

III. Fluoride Chemical Compound - Storage and Handling

Storage arrangements for the fluoride chemical compound fed were satisfactory at seven (88 percent) of the eight installations surveyed; however, four (50 percent) of the operators interviewed did not have available suitable safety equipment to handle the fluoride chemical compounds. Two (29 percent) of the operators were permitting unsafe reuse of the chemical shipping containers or were not disposing of the empty containers satisfactorily.

IV. Operator Training and Interest

A trained operator with a genuine interest in feeding fluorides is essential to the satisfactory operation of a fluoridation installation. One (12 percent) of the facilities surveyed was operated by an individual not completely familar with the fluoride chemical feed equipment at his plant. Two (25 percent) of the operators questioned were not adequately trained in the use of the fluoride ion test equipment provided and the procedures to follow in conducting fluoride ion analyses. The operators at three (37 percent) of the plants visited did not favor feeding fluorides to public water supply systems.

V. Surveillance

Frequent check samples of fluoride ion levels in the distribution system and regular inspection visits to the water fluoridation installation by State water supply surveillance personnel must be conducted to assure the facility is operating satisfactorily. The State Department of Health requires four water samples per month to be collected from the distribution system of fluoridated water supplies and submitted to the State Laboratory for fluoride ion analysis. A review of State records for 1971 revealed the required number of check samples from six (75 percent) of the installations selected for survey had not been tested for fluoride ion content. Three (37 percent) of the eight plants had not been visited in the past twelve months by a representative of the State water supply surveillance agency. Inspection visits to the water supply systems surveyed averaged one visit in twelve months.

Figure 2, Operating Conditions At Selected Fluoridated Water Supply Systems, summarizes the operating conditions observed at the installations inspected during the time of the survey. Conditions varied at each facility and Table III, Adequacy Of Fluoridation At Selected Fluoridated Water Supply Systems, summarizes the adequacy of the operating conditions at each facility during the time of the survey.

CONNECTICUT WATER SUPPLY PROGRAM EVALUATION

FIGURE 2

OPERATING CONDITIONS AT SELECTED FLUORIDATED WATER SUPPLY SYSTEMS

PARAMETER EVALUATED	% OF FLUORIDATED WATER SUPPLY SYSTEMS SURVEYED
Fluoride Ion Content In The Distribution System	
Fluoride Ion Level 0.8 - 1.2 mg/l	(63%)
Fluoride Ion Level < 0.8 mg/l	(37%)
Fluoride Ion Level > 1.2 mg/l	(0%)
Analytical Control Of The Fluoride Ion Level	
Operator Analysis ± 0.1 mg/l EPA Value	(75%)
Daily Finished Water Fluoride Ion Analysis	(50%)
Regular Raw Water Fluoride Ion Analysis	(25%)
Adequate Analytical Equipment & Facilities	(88%)
Adequate Care For Laboratory Equipment	(88%)
Adequate Records	(75%)
Fluoride Chemical Feed Equipment And Facilities	
Adequate Feeding Equipment and Facilities	(75%)
Adequate Feeding Arrangements	(75%)
Feed Interrupted <1-Day In Past 12-Months	(88%)
Adequate Maintenance	(63%)
Fluoride Chemical Compound - Storage And Handling	
Adequate Storage Arrangements	(88%)
Acceptable Safe Handling Provisions	(50%)
Satisfactory Disposal Of Shipping Containers	(71%)
Operator Training And Interest	
Adequately Trained To Operate Feed Equipment	(88%)
Knowledgeable Of Test Equipment & Procedures	(75%)
Accepts And Interested In Fluoridation	(63%)
Surveillance	
Check Samples To State As Required 1/	(25%)
Installation Inspected By State In Past 12-Months	(63%)

1/ Per 1971 State Department Of Health Records - 4 Per Month

CONNECTICUT WATER SUPPLY PROGRAM EVALUATION
TABLE III
ADEQUACY OF FLUORIDATION AT SELECTED WATER SUPPLY SYSTEMS

PARAMETER EVALUATED	Danbury	Hartford	Middletown	New London	Rockville	Southbury	Torrington	Willimantic
Fluoride Ion Content In The Distribution System								
Fluoride Ion Level 0.8 - 1.2 mg/l		X	X	X		X		X
Fluoride Ion Level < 0.8 mg/l	X				X		X	
Fluoride Ion Level > 1.2 mg/l								
Analytical Control Of The Fluoride Ion Level								
Operator Analysis ± 0.1 mg/l EPA Value	X	X	X	X		X	X	
Daily Finished Water Fluoride Ion Analysis				X	X	X	X	
Regular Raw Water Fluoride Ion Analysis	X							X
Adequate Analytical Equipment & Facilities	X	X	X	X	X		X	X
Adequate Care For Laboratory Equipment	X	X	X	X	X		X	X
Adequate Records	X	X	X	X	X		X	
Fluoride Chemical Feed Equipment And Facilities								
Adequate Feeding Equipment and Facilities		X	X	X	X	X	X	
Adequate Feeding Arrangements		X	X	X	X	X		X
Feed Interrupted < 1-Day In Past 12-Months		X	X	X	X	X	X	X
Adequate Maintenance		X	X	X	X		X	
Fluoride Chemical Compound - Storage And Handling								
Adequate Storage Arrangements	X	X		X	X	X	X	X
Acceptable Safe Handling Provisions	X	X		X	X			
Satisfactory Disposal Of Shipping Containers	X	X	N/A	X	X			X
Operator Training And Interest								
Adequately Trained To Operate Feed Equipment		X	X	X	X	X	X	X
Knowledgeable Of Test Equipment & Procedures	X	X		X	X		X	X
Accepts And Interested In Fluoridation		X	X	X	X			X
Surveillance								
Check Samples To State As Required 1/			X			X		
Installation Inspected By State In Past 12-Months			X	X	X	X	X	

1/ Per 1971 State Department Of Health Records - 4 Per Month
X Satisfactory or Applicable for System Surveyed
N/A Not Applicable

Conclusions and Recommendations

1. Twenty-six of the reported 325 public water supply systems in the State of Connecticut were fluoridating January 1, 1972, serving an estimated population of 2.25 million. By law the State requires the fluoridation of all water utilities serving 20,000 or more persons.

Recommendation

The State Department of Health should more actively promote the fluoridation of the smaller public water supplies in Connecticut to provide the benefits of fluoridated water to the population served by the estimated 300 public supplies not under the State Fluoridation Law.

2. Five (63 percent) of the eight fluoridated water supply systems surveyed evidenced a fluoride ion content in the distribution system within the limits required by the State Department of Health. Six (75 percent) of the plant operators or laboratory personnel testing water samples for fluoride ion content conducted the analysis within ± 0.1 mg/l of the sample results analyzed by the Environmental Protection Agency. Daily finished water fluoride ion analysis was conducted at four (50 percent) of the installations and the source of raw water was analyzed on a regular basis at only two (25 percent) of the facilities surveyed. Records of the fluoridation operation were acceptable at six (75 percent) of the plants.

Recommendation

The State Department of Health should require the operators at all fluoridation installations to conduct fluoride ion analysis according to Standard Methods to within ± 0.1 mg/l of the value reported on the State check sample. Daily finished water fluoride ion analysis, regular raw water fluoride ion analysis, adequate laboratory equipment and care of equipment, and complete records on the fluoridation operation should be enforced at all fluoridation installations.

3. Fluoride chemical feed equipment and facilities were satisfactory at six (75 percent) of the installations surveyed and feeding arrangements were judged adequate at six (75 percent). One (12 percent) of the installations had one or more interruptions in the past twelve months and maintenance was less than satisfactory at three (37 percent) of the facilities visited even though each operator had been alterted to the inspection visit.

Recommendation

The State Department of Health should provide design assistance to all communities installing fluoridation equipment, thoroughly review all proposed installations before the operation is approved, and assist the operator as needed during the "start-up" period.

All interruptions in the fluoridation operations should be required to be reported to the Environmental Health Services Division of the State Department of Health. A preventative maintenance program should be established for each facility and closely followed for the installation to receive continued approval for operation.

4. Fluoride chemical storage arrangements were judged satisfactory at seven (88 percent) of the installations surveyed. Four (50 percent) of the operators did not have available suitable safety equipment to handle the fluoride chemical compounds used and two (29 percent) of the operators were not disposing of the empty chemical shipping containers in a satisfactory manner.

Recommendation

The State Department of Health should instruct all water plant operators feeding fluorides on safe storage and handling practices for fluoride chemical compounds and promulgate regulations for storage and handling fluoride chemical compounds used in water fluoridation in the State of Connecticut.

5. A trained operator with a genuine interest in feeding fluorides is essential to the satisfactory operation of a fluoridation installation. Training deficiencies were noted in the operators knowledge of his fluoride feed equipment (Danbury) and acquaintance with the equipment and procedures used in conducting fluoride ion analysis (Middletown and Southbury). Three (37 percent) of the operators interviewed did not favor feeding fluorides to public water supply systems.

Recommendation

The State Department of Health should provide training in fluoride feed equipment operation and maintenance and fluoride determinations in water for the operators of all fluoridated water supply systems. The benefits of water fluoridation and the importance of maintaining an optimum level of fluoride ion in the distribution system at all times should be stressed. Satisfactory completion of the course should be a mandatory requirement of the plant operator for approval of his installation to feed fluorides.

6. Surveillance of each water fluoridation installation must be on a regular, continual basis to assure the facility is operating satisfactory. The operators of six (75 percent) of the plants surveyed were not submitting the required number of check samples to the State laboratory for fluoride ion analysis. Three (37 percent) of the installations had not been visited by a representative of the State water supply surveillance agency in the past twelve months.

Recommendation

The State Department of Health should enforce their policy requiring four monthly check samples to be collected from the distribution systems of fluoridated water supplies and sent to the State Laboratory for fluoride ion analysis. All interruptions in the fluoridation operations should be investigated by the Environmental Health Services Division and all plants employing new operating personnel placed in charge of the fluoridation operation should be visited immediately to assure the new operator has been adequately trained. Six man-months per year of engineering services with the necessary travel funds and laboratory support are estimated to be needed for an adequate fluoridation surveillance program in the State of Connecticut.

DATE: ___________

CONNECTICUT FLUORIDATION SURVEY

Water System:

Population Served: Average Flow:

Date Fluoridation Started:

Source of Supply:

Treatment:

Fluoride Analysis:
Raw Water: Finished Water:

Fluoridation Equipment -

Manufacturer:

Type:

Model:

Location:

Point of application:

Condition of equipment:

Operational problems:

Overfeeding safeguards:

Planned Improvements:

Remarks:

Fluoride Compound -

Chemical: Cost:

Source:

Form of shipment

Storage facilities:

Quantity used:

Safety provisions:

Remarks:

Control of Fluoridation -

Frequency of sampling:
Raw water: Finished water:

Sampling point:

Test method:

Test instrument:

Records:

Interruptions:

Remarks:

Operator Qualifications -

Experience: Classification:

Training:

Interest:

Remarks:

Surveillance -

Check samples:

Last visit by State:

Availability of technical assistance:

Remarks:

Comments -

APPENDIX B

Survey Report on the
Bacteriological Examination of Water
at the
Connecticut Department of Health Laboratory
10 Clinton Street
Hartford, Connecticut 06114
August 22 - 23, 1972

by

Edwin E. Geldreich, Consulting Bacteriologist
Water Supply Division
Water Program Operations
Office of Air and Water Programs
Environmental Protection Agency
Cincinnati, Ohio 45268

The equipment and procedures employed in the bacteriological analysis of water by the laboratory conformed with the provisions of "Standard Methods for the Examination of Water and Wastewater" (13th edition, 1971) and with the provisions of the Interstate Quarantine Drinking Water Standards, except for items marked with a cross "X" on the accompanying form EPA-103 (Rev 3-71). Items marked "O" do not apply to the procedures programmed in the laboratory. Specific deviations are described with appropriate remedial action for compliance in the following recommendations:

Recommendations

28. Dilution Bottle Closures

Dilution bottles that employ rubber stoppers (Escher type) must be covered before sterilization with a metal foil, rubberized cloth, or impermeable paper cap. This requirement is necessary to minimize contamination of the lip of the bottle while in storage and during hand manipulation of the closures during use. Because screw cap closures form a protective shield over bottle openings negating the necessity for any additional cover, it is recommended that these types of dilution bottles, with the appropriate 99 ml gradation mark, be gradually added to the supply as needed to cover normal replacement.

46. Multiple Tube Procedure

All water samples must receive a vigorous shaking immediately prior to either the inoculation of a series of presumptive tubes in the MPN procedure or to measuring appropriate volumes in the membrane filter test. This vigorous shaking requirement is needed to obtain a homogeneous distribution of suspended bacteria and is of particular concern with those waters laden with turbidity. Turbidity in water will rapidly settle, pulling suspended bacteria into the bottom sediment and thereby creating an uneven distribution of the bacterial population in measured aliquots.

48. Completed MPN Tests

Since requests for MPN data on samples submitted by the Connecticut Department of Environmental Portection, the Water Compliance Division, and the State Shellfish Program will possibly be used in enforcement actions, it is essential that approximately 20 of the confirmed tests each three months be carried to the Completed Test to substantiate the validity of data being collected on confirmed test examinations. False positive results do occasionally occur in the Confirmed Test and if the interpretation of results from the Confirmed Test do substantially differ from the Completed Test, it will be necessary to increase this minimum requirement.

Remarks

1. Laboratory Evaluation Program

The laboratory evaluation service within Connecticut is administered by Dr. William F. Vincent, Assistant Director Laboratory Division, Laboratory Standards Section. Water laboratories covered in this State program include city health departments, water treatment plants, hospitals, clinics, dairy, university and commercial facilities. A Connecticut law has established a mandatory laboratory certification requirement with a $500 penalty for operation without a valid permit. A review of this program activity prepared from summary tables supplied during our visit indicate that 47 laboratories currently hold a valid permit to examine water and sewage samples (see accompanying table). Approval is reviewed each year with renewal of the certification being based on the annual laboratory survey and satisfactory bacteriological results from analyses of three split samples. In addition to these qualifications, all laboratories must have MPN test capability even though they are using the MF test for the bacteriological examination of water.

Mr. Earl Thompson Jr. is the designated State laboratory survey officer for both water and milk laboratories. Since Mr. Thompson was on vacation during our visit and no copies of water laboratory evaluations have been forwarded to our office, it was not possible to study this program in detail, as to adequacy of the evaluation report, time spent in each laboratory, characteristic problems encountered, the bacteriological procedures used or the magnitude of testing done by these laboratories. Since official water samples may be analyzed by health departments, water treatment plants, hospital and commercial laboratories, the importance of the laboratory evaluation service for water laboratories and the need for sufficient staff time to accomplish this mission responsibility can not be over-emphasized.

The basic purpose of a laboratory evaluation, regardless of the reason for the requested service, is to extend technical consultation that will lead to improvements in overall service and reliability of data. The survey officer should examine in detail each procedure or item of critical equipment for compliance with "Standard Methods" procedures or other acceptable laboratory practices. It is important to illustrate any deficiencies observed in the records with specific case histories, such as: insufficient samples from the municipal supply per month, inadequate sampling of the distribution network, sample transit time delays, and response to unsatisfactory results. When technical

Table 1.

Registration Status as of July 1972 for Approved Water Laboratories in Connecticut

Laboratory	Survey Date	Survey Officer	Bacteriological Methods Used
City - County Health Dept.			
Bridgeport Health Dept.	Unknown	Earl Thompson Jr.	--
Greenwich Dept. of Health	"	"	--
Hartford Health Dept.	"	"	--
Milford Health Dept.	"	"	--
New Britain Dept. of Health	"	"	--
New Haven Dept. of Health	"	"	--
Norwalk Dept. of Health	"	"	--
Stamford Health Dept.	"	"	--
Waterbury Health Dept.	"	"	--
City Labs and Water and Waste Treatment Plants			
Greenwich Water Co.	"	"	--
Mianus Filter Plant (Greenwich)	"	"	--
New Haven Water Co.	"	"	MPN
Norwalk Water Laboratory	"	"	--
Willimantic Water Dept.	"	"	--
Groton Water Filtration Plant	"	"	MF
Waterbury Water and Waste Treatment	"	"	MF
Metropolitan Dist. Water Analysis (West Hartford)	"	"	--
Groton City Lab, Pollution Abatement Facility	"	"	MF
Margerie Reservoir Laboratory (Danbury)	"	"	MF
Town of Enfield Laboratory	"	"	--
Hospital and Clinics			
Connecticut Medical Lab (Bristol)	"	"	--
Doctor's Medical Lab (Greenwich)	"	"	--
Cyto Medical Lab (New London)	"	"	--
Clinical Lab of Norwalk	"	"	--
Middlesex Memorial Hospital	"	"	--
Stamford Medical Lab	"	"	MF
Commercial and Industrial Laboratories			
Bridgeport Hydraulic Co.	"	"	MF
Bridgeport Testing Lab	"	"	--
Fairfield Lab (Bridgeport)	"	"	--
Farris Water Lab (Danbury)	"	"	--
Ellis A. Tarlton Lab (Danbury)	"	"	--
James S. Minges Sanitary Eng. Lab (Farmington)	"	"	--
Ecoteck Lab (Fairfield)	"	"	--

Table 1. (Contd)

Registration Status as of July 1972 for Approved Water Laboratories in Connecticut

Laboratory	Survey Date	Survey Officer	Bacteriological Methods Used
Commercial and Industrial Laboratories (Contd)			
Marine Science Lab (General Dynamics)	Unknown	Earl Thompson Jr	--
Continental Testing Labs (Hartford)	"	"	--
Continental Testing Labs (Wethersfield)	"	"	--
Water Systems Analysis (New Fairfield)	"	"	--
SEBA Labs Inc (New London)	"	"	--
Newlands Sanitary Lab (Hartford)	"	"	MF
New Haven Area Lab	"	"	--
Lunt Soil & Water Lab (Northford)	"	"	--
Ecological Lab (Norwich)	"	"	--
Water Quality Analysis Lab (Simsbury)	"	"	--
Pollution Control Industries (Stamford)	"	"	--
Coe Lab (Storrs)	"	"	--
Kulp Private (Storrs)	"	"	--
Holzmacher, McLendon & Murrell (Melville, N.Y.)	"	"	--

procedures are questioned, the laboratory survey officer should explain the reasons for concern and demonstrate proper technique. Approved or disapproved economies that relate to available bench space, adequate utilities, commercially prepared media, presterilized and disposable plastic items, and instrumentation aids should also be reviewed for compliance to the intent of the Standard Methods concepts.

As stated in our letter May 14, 1971 to Dr. Ullmann concerning this State activity:

> "We would like to request that copies of your laboratory surveys be sent to Floyd B. Taylor, Chief, Water Supply Branch, E.P.A., Region I, John F. Kennedy Federal Building, Boston, Massachusetts 02203, in accordance to our organizational structure. The regional office will in turn forward these reports to our attention. These reports are carefully reviewed and are not only of value in planning intensive in-depth studies of specific state programs but are an essentail information source on all laboratories involved in monitoring potable water quality."

Dr. Ullmann has assured us during a review of the survey findings, that this oversight will be promptly corrected with a channelling of these reports to our organization.

2. Sample Transit Time Limits

It is essential that all water samples regardless of source be examined as soon as possible after collection. The transit time factor is especially critical for special stream and marine pollution investigations or in monitoring these waters as part of a water quality surveillance program. Maximum transport time for these samples must not exceed 6 hours and upon receipt in the laboratory they must be processed within 2 hours to insure valid data. During this sample storage period, the temperature of all such stream and marine pollution samples must be maintained between 4 - 10^{o} C.

Storage temperature requirements for potable water samples, particularly for those sent through the mail service continues to be a problem for central laboratories that must analyze samples from public supplies some distance away. Transit time for potable water samples should preferably be within 30 hours and under no circumstances should the laboratory process any samples older than 48 hours.

Although the frequency of receiving samples beyond a 48 hour time limit was only approximately 4 percent for all records examined, these old samples should have been rejected without analysis as not being a valid measurement of the bacteriological quality of the city water supply (Torrington and Southbury; samples 3 - 4 days old by August 21, 1972 initial analysis). The effect of storage time on the possible presence of a coliform population is unpredictable. These effects may vary with any one or any combination of factors including chemical composition, hydrogen-ion concentration, electrolyte concentration, protein nitrogen, types of bacterial flora present, and perhaps other unknown factors in individual water samples. Complete compliance with the sample transit time limit can be met when samples are collected the first part of the week, promptly mailed or delivered by car that day and processed upon arrival day in the laboratory. Delay processing by storage over Saturday and Sunday in the laboratory refrigerator should not be permitted since significant bacterial density changes can occur during this time period even at 5^{o} C. In difficult mail transport locations, a study of trucking and bus shipments may reveal faster alternate methods of similar costs.

3. Lactose vs. Lauryl Tryptose Broth

This laboratory selectivity uses lactose broth in the presumptive MPN procedure for samples of sewage treatment processes, shellfish and marine waters while employing lauryl tryptose broth on stream pollution samples. Lauryl tryptose broth gives equivalent results on coliform detection with lactose broth and has the additional benefit of suppressing aerobic spore forming bacteria that can produce false positive results in the presumptive test portion of the MPN test. Therefore, it is recommended that lauryl tryptose broth be used in the presumptive test portion of the multiple tube test as applied to all water samples and to application in the MF verification of sheen colonies. The net result would be to reduce the water media inventory and possibly reduce some of the unusual positive tube results occasionally being observed in chlorinated sewage effluent examinations.

4. U.V. Sterilization of Funnels

Although not a mandatory requirement, the use of a UV sterilization chamber to decontaminate MF funnels would add an additional measure of protection from some cross-contamination that might accidentally occur when examining large numbers of water samples of varying water quality. An appropriate cabinet to hold several funnels in a 60 second irradiation exposure (Jour. AWWA 57; 500-504; 1965) could be fabricated by a metal shop for approximately $50 or purchased through commercial sources (Millipore XX63-700-00 or of equivalent manufacture).

Application of UV sterilization does not replace the adequate rinse procedure now being used to insure complete transport of all bacteria in a sample to the membrane surface. Irradiation will prevent transport of leakage contamination of funnel assemblies from one sample to another. Funnels should be carefully cleaned after daily use with a mild detergent, avoiding the use of caustic solutions and abrasive materials including steel wool. The required cleaning procedure will prevent grease build-up and chemical deposits from accumulating and becoming protective areas for bacterial habitation that resist removal by rinsing or exposure to UV irradiation.

5. Culture Tube Closures

Although non-absorbent cotton plugs may be used as culture closures, more time is needed to prepare satisfactory plugs that reach 20 - 30 mm into the tube with approximately 30 mm extending from the tube opening for proper handling during sample pipetting or culture transfer. When using cotton plugs, culture tube capacity should be large enough to adequately contain the desired medium and sample volume additions without wetting the plug during sterilization or sample processing. Once a cotton plug is wet, it loses its effectiveness as a barrier. Cotton plug thickness should not be so tight fitting that reinserting is difficult nor so loose that the plug falls into the culture broth or to a position that makes retrieval impossible. Since cotton plugs do not protect the upper edges of the tube opening, flaming of this area is essential to reduce the risk of contamination.

Snug fitting stainless steel and plastic caps or loose fitting aluminum caps are the recommended closures for culture tubes used in the multiple tube procedure. Since these closures cover the lip and upper inch of the culture tu flaming of the tube opening is not necessary during pipetting or culture transfer by inoculation loop. Although their initial cost may be higher than per unit cost of plastic plugs or material and labor costs to make cotton plugs, metal caps are indefinitely reusable under normal laboratory conditions.

6. Plastic Sample Bottles

The rising cost of shipping samples by mail has stimulated replacement of glass sample bottles with plastic containers that can withstand the sterilization temperature - time exposure (121° C for 15 min) in the autoclave. These plastic sample bottles are available with wide mouth openings and screw cap closures. Some difficulty with autoclavable plastic bottles may be related to the purchase of polyethylene bottles that are not as rigid a plastic as is the polypropylene type. In either case, plastic bottles should not have the screw caps tightly closed during sterilization, less changes in air pressure and elevated temperature will cause some of these products to exhibit a partial collapse of the side walls. Sample bottles made of linear polyethylene plastic with a polypropylene screw closure should not be used because leakage can occur when samples are held at refrigeration temperatures. Apparently the difference in the coefficient of expansion rate for these two different plastic materials is the source of this problem. Resistance to distortion is dependent not only on the type of plastic, differences in plastic material used in cap and bottle, but also is markedly affected by the method of molding. Polypropylene (Nalgene bottle, 4 or 8 oz, Catalog No. 2105; Nalge Co., Rochester, N.Y. 14602; or equivalent product) has been found to be satisfactory when both the cap and bottle are specified of the same material. These types of plastic bottles have been used successfully in many state water laboratories and in various federal stream pollution investigations during the past ten years. While plastic sample bottles do offer advantages of cost, weight and resistance to breakage, they must be tested bacteriologically for freedom from toxic substances or organic matter that might have evolved from the plasticizer or mold release agents.

Personnel Approved

The following staff members are approved for application of (1) total coliform membrane filter test for the examination of potable waters; (2) total coliform confirmed MPN, fecal coliform MPN or MF tests on stream and marine waters and; (3) standard plate count for swimming pool water quality measurements:

Mr. Donald LeBlanc, Senior Microbiologist
Mr. Richard Heffernan, Microbiologist Trainee
Miss Zelda Geye, Laboratory Technician
Miss Maureen Daly, Laboratory technician

Conclusions

The procedures and equipment in use at the time of the survey complied in general with the provisions of Standard Methods for the Examination of Water and Wastewater (13th edition, 1971) and the Interstate Quarantine Drinking Water Standards and with corrections of deviations listed, it is recommended that the results be accepted for the bacteriological examination of potable waters under interstate regulations.

Edwin E. Geldreich
Consulting Bacteriologist

ENVIRONMENTAL PROTECTION AGENCY
Water Quality Office
Water Hygiene Division
Bacteriological Survey for
Water Laboratories

Indicating conformity with the 13th edition of Standard Methods for the Examination of Water and Wastewater (1971).

Survey By **Edwin E. Geldreich**	X = Deviation U = Undetermined O = Not Used

Laboratory **Connecticut State Dept. of Health**	Location **10 Clinton St. Hartford, Conn. 06115**	Date **8/22-23/72**

Sampling and Monitoring Response

1. Location and Frequency
   - Representative points on system. . . . . ____
   - Frequency of sampling adequate . . . . ____

2. Collection Procedure
   - Faucets with aerators should not be used. . . . . ____
   - Flush tap 1 min. prior to sampling . . . . ____
   - Pump well 1 min. to waste prior to sampling . . . . ____
   - River, stream, lake, or reservoir sampled at least 6 inches below surface and toward current. . . . . ____
   - Minimum sample not less than 100 ml . . . . ____
   - Ample air space in bottle for mixing. . . . . ____
   - Promptly identify sample legibly and indelibly . . . . ____

3. Sample Bottles
   - Wide mouth, ~~glass~~ or plastic bottles of **240 ml** capacity. . . . . . . ____
   - Sample bottles capable of sterilization and rinse . . . . ____
   - Closure:
     - a. ~~Glass stoppered bottles protected with metal foil,~~ rubberized cloth or kraft type paper . . . . ____
     - b. Metal or plastic screw cap with leakproof liner . . . . ____
   - Sodium thiosulfate added for dechlorination. . . . . ____
     - Concentration 100 mg/l added before sterilization . . . . . . ____
   - Chelation agent for stream samples (optional). . . . . ____
     - Concentration 372 mg/l added before sterilization . . . . . . O

4. Transportation and Storage
   - Complete and accurate data accompanies sample . . . . ____
   - Transit time for potable water samples should not exceed 48 hrs, preferably within 30 hrs . . . . ____
   - Transit time for source waters, reservoirs, and natural bathing waters should not exceed 6 hrs . . . . ____
   - All samples examined within 2 hours of arrival . . . . ____

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4. Transportation and Storage (Continued)

Sample refrigeration mandatory on stream samples, optional on potable water samples. . . . . ____

5. Record of Laboratory Examination

Results assembled and available for inspection . . . . ____

Number of Tests per year

MPN Test - Type of sample **Streams, recreational waters, shellfish waters**

Confirmed (+)______ (-)______ (Total) **8,300**

Completed (+)______ (-)______ (Total)______

MF Test - Type of sample **Potable waters, source waters, swimming pools**

Direct Count (+)______ (-)______ (Total) **8,400**

Verified Count (+)______ (-)______ (Total)______

Data processed rapidly through laboratory and engineering sections . . ____

Unsatisfactory sample defined as 3 or more positive tubes per MPN test or 5 or more colonies per 100 ml in MF test . . . . . . ____

High priority placed on alerting operator to unsatisfactory potable water results . . . . ____

Prompt resampling for unsatisfactory samples **(one repeat sample)** . . ____

6. Laboratory Evaluation Service

State program to evaluate all laboratories which examine potable water supplies. . . . . ____

Frequency of surveys on a **1** year basis. . . . . ____

State survey officer (Name) **Earl Thompson Jr.** . . . . ____

Status of laboratory evaluation service. . . . . ____

Total **47** labs known to examine water

47 approved laboratories

0 provisional laboratories

Laboratory Apparatus

7. Incubator

Manufacturer **--** Model **--**

Sufficient size for daily work load . . . . ____

Maintain uniform temperature in all parts (± 0.5°C). . . . . ____

Accurate thermometer with bulb immersed in liquid on top and bottom shelves. . . . . ____

Daily record of temperature or use of recording thermometer sensitive to 0.5°C change . . . . ____

Incubator not subject to excessive room temperature variations beyond a range of 50 - 80°F . . . . ____

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8. Incubator Room (Optional) Manufacturer **Unknown**

   - Well insulated, equipped with properly distributed heating and humidifying units for optimum environmental control. . . . . . . ____
   - Shelf areas used for incubation must conform to 35°C ± 0.5° temperature requirement. . . . . ____
   - Accurate thermometers with bulb immersed in liquid. . . . . ____
   - Daily record of temperature at selected areas or use recording thermometer sensitive to 0.5°C changes . . . . ____

9. Water Bath

   Manufacturer **Precision** Model **[illegible]**

   - Sufficient size for fecal coliform tests . . . . ____
   - Maintain uniform temperature 44.5°C ± 0.2°C. . . . . ____
   - Accurate thermometer immersed in water bath . . . . ____
   - Daily record of temperature or use of recording thermometer sensitive to 0.2°C changes . . . . ____

10. Hot Air Sterilizing Oven

    Manufacturer **Hotpack** Model **Not determined**

    - Size sufficient to prevent crowding of interior . . . . ____
    - Constructed to insure a stable sterilizing temperature . . . . ____
    - Equipped with accurate thermometer in range of 160-180°C or with ~~recording thermometer~~. *** accuracy checked every month** . . . . ____

11. Autoclave

    Manufacturer **American** Model **Cyclomatic**

    - Size sufficient to prevent crowding of interior . . . . ____
    - Constructed to provide uniform temperature up to and including 121°C . . . . ____
    - Equipped with accurate thermometer with bulb properly located to register minimal temperature within chamber . . . . ____
    - Pressure gage and operational safety valve . . . . ____
    - Steam source from ~~saturated steam line,~~ or from gas or electrically heated steam generator . . . . ____
    - Reach sterilization temperature in 30 min. . . . . ____
    - Pressure cooker may be used only if provided with a pressure gage and thermometer with bulb 1 in. above water level . . . . . . ____

12. Thermometers

    - Accuracy checked with thermometer certified by National Bureau of Standards or one of equivalent accuracy. . . . . ____
    - Liquid column free of discontinuous sections and graduation marks legible . . . . ____

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13. pH Meter

Manufacturer **Beckman** Model **Zeromatic**

Electronic pH meter accurate to 0.1 pH units. . . . . ____

14. Balance

Balance with 2 g sensitivity at 150 g load used for general media preparations, Type **Mettler P2000** . . . . ____

Analytical balance with 1 mg sensitivity at 10 g load used fo weighing quantities less than 2 g, Type ________ . . . ____

Appropriate weights of good quality for each balance . . . . ____

15. Microscope and Lamp

Preferably binocular wide field, 10 to 15 diameters magnification for MF colony counts, Type **AO "Forty"** . . . . ____

Fluorescent light source for sheen discernment. . . . . ____

16. Colony Count

Quebec colony counter, dark-field model preferred for standard plate counts . . . . ____

17. Inoculating Equipment

Wire loop of 22 or 24 gauge chromel, nichrome, or platinum iridium, sterilized by flame . . . . ____

Single-service transfer loops of aluminum or stainless steel, presterilized by dry heat or steam. . . . . ____

~~Disposable single service hardwood applicators,~~ presterilized by dry heat only. . . . . ____

18. Membrane Filtration Units

Manufacturer **Millipore** Type **Pyrex units**

Leak proof during filtration. . . . . ____

Metal plating not worn to expose base metal . . . . ____

19. Membrane filters

Manufacturer **Millipore** Type **HA 047 "SO"**

Full bacterial retention, satisfactory filtration speed . . . . ____

Stable in use, glycerin free. . . . . ____

Grid marked with non-toxic ink . . . . ____

~~Presterilized~~ or autoclaved 121°C for 10 min. . . . . ____

20. Absorbent Pads

Manufacturer **Millipore** Type ________

Filter paper free from growth inhibitory substances. . . . . ____

Thickness uniform to permit 1.8 - 2.2 ml medium absorption . . . . ____

~~Presterilized~~ or autoclaved with membrane filters . . . . ____

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21. Forceps **(Millipore type)**

Preferably round tip without corrugations. . . . . ____

Forceps are alcohol flamed for use in MF procedure. . . . . ____

Glassware, Metal Utensils and Plastic Items

22. Media Preparation Utensils

Borosilicate glass . . . . ____

~~Stainless steel~~. . . . . ____

Utensils clean and free from foreign residues or dried medium. . . . . ____

23. Pipets

Brand **Will** Type **Tip delivery**

Calibration error not exceeding 2.5%. ____

Tips unbroken, graduation distinctly marked . . . . ____

Deliver accurately and quickly. . . . . ____

Mouth end plugged with cotton (optional) . . . . **O**

24. Pipet Containers

~~Box, aluminum~~ or stainless steel . . . . ____

Paper wrapping of good quality sulfite paper (optional) . . . . ____

25. Petri Dishes

Brand **Falcon** Type **Plastic**

Use 100 mm x 15 mm dishes for pour plates . . . . ____

Use 60 mm x 15 mm dishes for MF cultures **(Loose fitting)** . . . . . ____

Clear, flat bottom, free from bubbles and scratches. . . . . ____

Plastic dishes may be reused if sterilized in 70% ethanol for 30 min. or by ultraviolet radiation . . . . ____

26. Petri Dish Containers

Aluminum or stainless steel cans with covers, coarsely woven wire baskets, char-resistant paper sacks or wrappings . . . . . . ____

27. Culture Tubes

Size sufficient for total volume of medium and sample portions . . . . ____

Borosilicate glass or other corrosive resistant glass . . . . ____

28. Dilution Bottles or Tubes

Borosilicate or other corrosive resistant glass . . . . ____

Screw cap with leak-proof liner free from toxic substances on sterilization . . . . **X**

(Rubber type rubber stoppers - no covers)

Graduation level indelibly marked on side of bottle or tube . . . . . . ____

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Materials and Media Preparation

29. Cleaning Glassware

Dishwasher Manufacturer **Better Built** Model **Turbomatic**

Thoroughly washed in detergent at 160° F, cycle time **3 min.** . . ____

Rinse in clean water at 180° F, cycle time **1 1/10 min.** . . . . . . ____

Final rinse in distilled water, cycle time **10 seconds** . . . . ____

Detergent brand **Whirl (Diversey Corp, Chicago)**

Washing procedure leaves no toxic residue . . . . ____

Glassware free from acidity or alkalinity . . . . ____

30. Sterilization of Materials

Dry heat sterilization (**2** hr at 170°C)

Glassware not in metal containers . . . . ____

Dry heat sterilization (2 hrs at 170°C)

Glassware in metal containers. . . . . ____

Glass sample bottles . . . . ____

Autoclaving at 121° C for 15 min . . . . ____

Plastic sample bottles . . . . ____

Dilution water blanks . . . . ____

31. Laboratory Water Quality

Still manufacturer **American Sterilizer** Construction Material **Stainless steel**

Demineralizer with ____________ recharge frequency

Protected storage tank . . . . ____

Supply adequate for all laboratory needs. . . . . ____

Free from traces of dissolved metals or chlorine . . . . ____

Free from bactericidal compounds as measured by bacteriological suitability test . . . . ____

Bacteriological quality of water measured once each year by suitability test or sooner if necessary . . . . ____

32. Buffered Dilution Water

Stock phosphate buffer solution pH 7.2 **(pH 7.1 - 7.2)** . . . . ____

Prepare fresh stock buffer when turbidity appears . . . . ____

Stock buffer autoclaved and stored at 5 - 10°C . . . . ____

1.25 ml stock buffer per 1 liter distilled water. . . . . ____

Dispense to give 99 ± 2 ml or 9 ± 0.2 ml after autoclaving. . . . . . . ____

33. pH Measurements

Calibrate pH meter against appropriate standard buffer prior to use . . ____

Standard buffer brand **Fisher** pH **6.89**

Check the pH of each sterile medium batch or at least one batch from each new medium lot number. . . . . ____

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33. pH Measurements (Continued)
    - Maintain a pH record of each sterile medium batch, the date and lot number. . . . . ____

34. Sterilization of Media
    - Carbohydrate medium sterilized 121°C for **10** min . . . . ____
    - All other media autoclaved 121°C for 15 min . . . . ____
    - Tubes packed loosely in baskets for uniform heating and cooling . . . . ____
    - Timing starts when autoclave reaches 121°C . . . . **20** . . . . ____
    - Total exposure of carbohydrate media to heat not over **45** min. . . . . ____
    - Media removed and cooled as soon as possible after sterilization . . . ____

35. Storage
    - Dehydrated media bottles kept tightly closed and stored at less than 30°C. . . . . ____
    - Dehydrated media not used if discolored or caked . . . . ____
    - Sterile culture media stored in clean area free from contamination and excessive evaporation . . . . ____
    - Sterile batches used in less than 1 week. . . . . ____
    - All media protected from sunlight . . . . ____
    - If media is stored at low temperatures, it must be incubated overnight and any tubes with air bubbles discarded . . . . **O**

Culture Media - Specifications

36. Lactose Broth
    - Manufacturer **BBL** Lot No. **[illegible]**
    - Single strength composition 13 g per liter distilled water . . . . ____
    - Single strength pH 6.9 ± 0.1, double strength pH ~~6.7 ± 0.1~~ **(pH 6.9?)** . . . . . . ____
    - Not less than 10 ml medium per tube . . . . ____
    - Composition of medium after 10 ml sample is added must contain 0.013 g per ml dry ingredients. . . . . ____

37. Lauryl Tryptose Broth
    - Manufacturer **Difco** Lot No. **[illegible]**
    - Single strength composition 35.6 g per liter distilled water . . . . ____
    - Single strength pH 6.8 ± 0.1, double strength pH ~~6.7 ± 0.1~~. . . . . . ____
    - Not less than 10 ml medium per tube . . . . ____
    - Composition of medium after 10 ml sample is added must contain 0.0356 g per ml of dry ingredients . . . . ____

38. Brilliant Green Lactose Bile Broth
    - Manufacturer **Difco** Lot No. **[illegible]**

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38. Brilliant Green Lactose Bile Broth (Continued)
    Correct composition, sterility and pH (pH 7.0 - 7.2) . . . . ____
    Not less than 10 ml medium per tube . . . . ____

39. Eosin Methylene Blue Agar
    Manufacturer Difco Lot No. 466899
    Medium contains no sucrose, Cat. No. Levine (0005)
    Correct composition, sterility and pH 7.1. . . . . ____

40. Plate Count Agar (Tryptose Glucose Yeast Agar)
    Manufacturer Difco Lot No. 558694
    Correct composition, sterility and pH 7.0 ± 0.1 . . . . ____
    Free from precipitate. . . . . ____
    Sterile medium not remelted a second time after sterilization. . . . . ____

41. EC Medium
    Manufacturer Difco Lot No. 567412
    Correct composition, sterility and pH 6.9 - 7.0 . . . . ____
    Not less than 10 ml medium per tube . . . . ____

42. M-Endo Medium
    Manufacturer BBL Lot No. 103669
    Correct composition and pH 7.1 - 7.3 . . . . ____
    Reconstituted in distilled water containing 2% ethanol. . . . . ____
    Heat to boiling point, promptly remove and cool . . . . ____
    Store in dark at 2 - 10°C . . . . ____
    Unused medium discarded after 72 hrs . . . . ____

43. M-FC Broth
    Manufacturer Difco Lot No. 556040
    Correct composition and pH 7.4 . . . . ____
    Reconstituted in 100 ml distilled water containing 1 ml of
    a 1% rosolic acid reagent. . (Difco or Harleco). . . . . ____
    Stock solution of rosolic acid discarded after 2 weeks or
    when red color changes to muddy brown . . . . ____
    Heat to boiling point, promptly remove and cool . . . . ____
    Store in dark at 2 - 10°C . . . . ____
    Unused medium discarded after 96 hrs . . . . ____

44. ____________________ Broth
    Manufacturer ____________________ Lot No. ____________
    Correct composition and pH . . . . ____

45. ____________________ Agar
    Manufacturer ____________________ Lot No. ____________

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45. ______________________ Agar (Continued)

Correct composition and pH. . . . . ____

Multiple Tube Coliform Test

46. Presumptive Procedure

Lactose broth sewage & marine lauryl tryptose broth stream pollution

Shake sample vigorously X

Potable water: 5 standard portions, either 10 or 100 ml. . . . . ____

Stream monitoring: multiple dilutions . . . . ____

Incubate tubes at 35° ± 0.5°C for 24 ± 2 hr . . . . ____

Examine for gas ______ ~~any gas bubble positive~~ . . . . ____

Return negative tubes to incubator . . . . ____

Examine for gas at 48 ± 3 hr from original incubation . . . . ____

47. Confirmed Test

Promptly submit all presumptive tubes showing gas production before or at 24 hr and 48 hr periods to Confirmed Test . . . . . . ____

a. ~~Brilliant green lactose broth~~

Gently shake presumptive tube or mix by rotating . . . . ____

Transfer one loopful of positive broth or one dip of applicator from presumptive tube to brilliant green lactose broth. . . . . ____

Incubate at 35° ± 0.5°C and check at 24 hrs for gas production. . . ____

Reincubate negative tubes for additional 24 hrs and check for gas production . . . . ____

Calculate MPN or report positive tube results. . . . . ____

b. Endo or eosin methylene blue agar plates adequate streaking to obtain discrete colonies separated by 0.5 cm. . . . . ____

Incubate at 35° ± 0.5°C for 24 ± 2 hr . . . . ____

Typical nucleated colonies with or without sheen are coliforms . . ____

If atypical unnucleated pink colonies develop, result is doubtful and completed test must be applied. . . . . ____

If no colonies or only colorless colonies appear, the confirmed test is negative. . . . . ____

48. Completed Test

Applied to all potable water samples or a proportion each three months to establish the validity of th[illegible]firmed test in determining their sanitary quality. X

Applied to positive confirmed tubes or to doubtful colonies on differential medium. . . . . ____

Streak positive confirmed tubes on Endo or EMB plates for colony isolation. . . . . ____

Laboratory	Location 10 Clinton St.	Date
Connecticut State Dept. of Health	Hartford, Conn. 06115	8/22-23/7

48. Completed Test (Continued)

Choice of selected isolated colony for verification should be one typical or two atypical to lactose or lauryl tryptose broth and to agar slant for Gram stain. ____

Incubate at 35°C ± 0.5°C for 24 hrs or 48 hrs . . . . ____

Gram negative rods without spores and gas in lactose tube with 48 hrs in positive Completed Test . . . . ____

Membrane Filter Coliform Test

49. Application as Standard Test

Use as a standard test for determining potability of water after demonstration by parallel testing that it yields information equal to that from the multiple-tube fermentation procedure . . . . ____

50. MF Procedure

Filter funnel and receptacle sterile at start of series. . . . . ____

Rapid funnel resterilization by UV, flowing steam or boiling water acceptable. . . . . ____

Membrane filter cultures and technician eyes should not be subject to UV radiation leaks. . . . . ____

Filtration volume not less than 100 ml for potable water; multiple dilutions for stream pollution . . . . ____

Rinse funnel by flushing several 20 - 30 ml portions of sterile buffered water through MF . . . . ____

Remove filter with sterile forceps . . . . ____

Roll filter over M-ENDO medium pad or agar so air bubbles will not form . . . . ____

51. Incubation

In high humidity or in tight fitting culture dishes . . . . ____

At 35°C ± 0.5°C for 22 - 24 hrs . . . . ____

52. Counting

All colonies with a metallic yellowish green surface sheen . . . . . . ____

If coliforms are found in potable samples, verify by transfers to lactose broth, then to BGB broth for evidence of gas production at 35°C within 48 hr limit. . . . . ____

Calculate direct count in coliform density per 100 ml. . . . . ____

53. Standard MF test with Enrichment

Incubate MF after filtration on pad saturated with lauryl tryptose broth for 1 1/2 - 2 hr at 35°C ± 0.5°C . . . . O

EPA-103 (Cin)
(Rev. 3-71)

Laboratory	Location	Date
Connecticut State Dept. of Health	**10 Clinton St. Hartford, Conn. 06115**	**8/22-23/71**

53. Standard MF test with Enrichment (Continued)

Transfer MF culture to M-Endo medium for a final 20 - 22 hr incubation at 35°C ± 0.5°C. . . . . ____

Count sheen colonies, verify if necessary, and calculate direct count in coliform density per 100 ml . . . . ____

Supplementary Bacteriological Methods

54. Standard Plate Count **Swimming pools (300 SPC/1 ml limit)**

Plate not more than 1 or less than 0.1 ml (sample or dilution) . . . . . ____

Add 10 ml or more liquefied agar medium at a temperature between 43 - 45°C . . . . ____

Melted medium stored for no more than 3 hr at 43 - 45°C . . . . ____

Liquid agar and sample portion thoroughly mixed by gently rotating to spread mixture evenly . . . . ____

Count only plates with between 30 and 300 colonies, exception being 1 ml sample with less than 30 colonies . . . . ____

Record only two significant figures and calculate as "standard plate count at 35°C per 1 ml of sample". . . . . ____

55. Fecal Coliform Test

a. Multiple Tube Procedure **Shellfish waters, streams**

Applied as an EC broth confirmation of all positive presumptive tubes. . . . . ____

Place EC tubes in water bath within 30 min of transfers . . . . . . ____

Incubate at 44.5°C ± 0.2°C for 24 hrs . . . . ____

Gas production is positive test for fecal coliforms. . . . . ____

Calculate MPN based on combination of positive EC tubes . . . . . ____

b. Membrane Filter Procedure **Streams**

Following filtration place MF over pad saturated with M-FC broth . . . . ____

Place MF cultures in water-proof plastic bag and submerge in water bath within 30 min. . . . . ____

Incubate at 44.5°C ± 0.2°C for 24 hrs . . . . ____

All blue colonies are fecal coliforms. . . . . ____

Calculate direct count in density per 100 ml . . . . ____

56. Delayed-Incubation Coliform Test

After filtration, place MF over pad of M-Endo containing 3.2 ml of a 12% sodium benzoate solution per 100 ml of medium . . . . . . **O**

Addition of 50 mg cycloheximide per 100 ml of preservative medium for fungus suppression is optional . . . . ____

Transport culture by mail service to laboratory within 72 hours . . . . ____

EPA-103 (Cin)
(Rev. 3-71)

Laboratory Connecticut State Dept. of Health	Location 10 Clinton St. Hartford, Conn. 06115	Date 8/22-23/72

56. Delayed-Incubation Coliform Test (Continued)

Transfer MF cultures to standard M-Endo medium at laboratory. . . . . ____

Incubate at 35°C ± 0.5°C for 20 - 22 hr . . . . ____

If at time of transfer, growth is visible, hold in refrigerator till end of work day then incubate at 35° overnight (16 - 18 hr period) . . . . ____

Count sheen colonies, verify if necessary, and calculate direct count in coliform density per 100 ml . . . . ____

57. Additional Test Capabilities

Fecal streptococci	____	Method	M-Enterococcus
Pseudomonas aeruginosa	O	Method	____
Staphylococcus	____	Method	Vogal-Johnson broth
Salmonellae	____	Method	MF -Enrich. - Selective agars
Biochemical tests	O	Purpose	____
Serological tests	O	Purpose	____
Other	____	Purpose	____

Laboratory Staff and Facilities

58. Personnel

Adequately trained or supervised for bacteriological examination of water . . . . ____

Laboratory staff 8 + 2 (Summer) (Total) Prep room staff 8 + 8 (Summer) (Total) ____

59. Reference Material

Copy of the current edition of Standard Methods available in the laboratory . . . . ____

State or federal manuals on bacteriological procedures for water available for staff use . . . . ____

60. Physical Facilities

Bench-top area adequate for periods of peak work in processing samples. . . . . ____

Sufficient cabinet space for media and chemical storage . . . . ____

Office space and equipment available for processing water examination reports and mailing sample bottles . . . . ____

Facilities clean, with adequate lighting, ventilation and reasonably free from dust and drafts . . . . ____

61. Laboratory Safety

Proper receptacles for contaminated glassware and pipettes . . . . . . ____

61. Laboratory Safety (Continued)

Adequately functioning autoclaves with periodic inspection and maintenance. . . . . ____

Accessible facilities for hand washing . . . . ____

Proper maintenance of electrical equipment to prevent fire and electrical shock . . . . ____

Convenient gas and electric outlets. ____

First aid supplies available and not out-dated . . . . ____

62. Remarks

APPENDIX C

Report of a Survey of the
Connecticut State Department of Health
Laboratory Division
10 Clinton Street
Hartford, Connecticut 06101

by

Earl F. McFarren, Chief
Water Supply Program Support Activities
Water Supply Research Laboratory

The Laboratory Division of the Connecticut State Department of Health was visited on August 22 and 23. The equipment and procedures employed in the chemical analysis of water by these laboratories conform with the provisions of Standard Methods for the Examination of Water and Wastewater (13th Edition) and with the provisions of the Public Health Drinking Water Standards, except for the items marked with a cross "x" (deviation from standard) or an "o" (not being used at present). Items marked with a "u" could not be determined at the time of the survey (see attached survey form).

Substances Determined

The laboratory routinely analyzed potable waters for color, odor, pH, turbidity, chlorides, iron, nitrates, fluorides, alkalinity, hardness, nitrites, ammonia and albuminoids. Of these thirteen substances only seven are in the 1962 drinking water standards and eighteen substances in the standards which are directly related to health effects are seldom, if ever, done. These are: cyanide, CCE, sulfates, surfactants, total dissolved solids, arsenic, barium, cadmium, chromium, copper, lead, manganese, selenium, silver, mercury, zinc, gross alpha and gross beta. The metals, radioactivity and also pesticides are routinely run on a few surface waters (15 or 20 reservoirs and four wells last year) but not routinely on any finished waters.

Laboratory Apparatus

In general, the laboratories are well equipped. It is recommended, however, that they purchase a Hach Model 2100 A turbidimeter (item 11 on the survey form), and another atomic absorption spectrophotometer in order to be better able to carry out the recommended metal analysis. This should include the purchase of an attachment for the determination of arsenic and selenium by the new high sensitivity method using an argon-hydrogen flame In order to make maximum use of all instruments and not have to be continually changing the set-up for each instrument, it may also be desirable to purchase a Coleman Mercury Analyzer just for mercury analysis. This would free one atomic absorption spectrophotometer for other analyses and some of the high cost of another A.A. Although three atomic absorption spectrophotometers are at present available in the laboratory they are being used by so many people in so many different programs, that all three are not available for water analysis, and these instruments could be used by the water program alone.

As soon as the new mini-sampler becomes available, the equipment for the determination of organics (CCE and CAE) should also be purchased (item 19).

Sampling

It is recommended that samples for metal analysis be preserved at the time of collection with acid as mercury, in particular, quickly absorbs on the walls of containers if not acidified (in a matter of minutes). Silver, iron and manganese absorb to some extent, and cadmium and lead to a lesser extent (item 32a). If samples collected for nitrate and surfactant analysis cannot be refrigerated until analyzed, they also should be preserved with mercuric chloride.

Records

A summary of the results of "Analysis of Connecticut Public Water Supplies" exists, and according to the Seventh Edition (Five Year Average 1966-1970), there are about 328 municipal supplies in the state serving over fifty persons. Water for these supplies are obtained from 102 surface sources (reservoirs, lakes and streams) and from 669 ground sources (springs or wells). Thus, if each of the ground waters(wells) were analyzed just once every three years (669 ÷ 3 = 223) and each of the surface waters were analyzed twice a year (102 x 2 = 204), only 427 (223 + 204) analyses per year would be required. Actually, according to laboratory records, 1566 municipal water samples were analyzed last year, which would seem to indicate that a more than adequate job of surveillance was being done.

Laboratory

In addition to the analysis of potable waters, the sanitary chemistry laboratory is responsible for the analysis of wastewaters, sewage, solid wastes, milk and food samples and shellfish. All of this is done in a laboratory about 25 by 60 ft which contains 7 rows of laboratory benches (one of which is used entirely for radiochemistry perparation). In general, the laboratory is overloaded. There is inadequate bench top area (all cluttered with instruments and equipment), insufficient cabinet storage space for chemicals and glassware, inadequate hood space, and inadequate desk and office space. Fortunately, the radiation counting and pesticde analyses are done in two smaller (but at present adequate) separate rooms. The laboratory is to be commended for its efforts to develop and improve on methods for detecting hydrocarbons (from gasoline and oils) in water.

Quality Control

The laboratory does routinely check the quality of their distilled water and claims to use control samples routinely to check their analyses, although control charts are not used. They also make use of reference samples supplied by the Analytical Quality Control Laboratory of EPA. However, if this laboratory desired to be certified for the analysis of those chemistries which they are now running, it will be necessary for them to establish their proficiency by either analyzing a reference sample, which we can supply or by providing us with copies of the results obtained (which presumably were acceptable) on analysis of the AQC samples.

The State of Connecticut has a laboratory improvement or certification program. There are at present about 61 certified laboratories in the state. The operation of these laboratories are checked annually by requiring them to analyze reference samples supplied to the state by the Analytical Quality Control Program of NERC, Cincinnati. These laboratories may be municipal, private or treatment plant laboratories. They are certified to analyze, for a fee, private water supplies (which the state does not do except in case of a suspected infectious disease), and to do the chemistries required in connection with water treatment. Thus, it does not appear that they are duplicating, except for a few chemistries, such as chloride, sulfates and T.D.S.), the kind of water chemistries that the state either is now doing or should be doing.

Staff

Since no one person or group of persons is concerned with just water analysis, but rather all must be involved in the analysis of many different kinds of samples, it is difficult to determine the exact number of additional persons needed to carry out the additional recommended water chemistries. However, there are at present two vacancies, both of which should be filled, if the additional metal analyses are to be undertaken. If at a later date, the analysis of organic contaminants (CCE) in potable waters is undertaken, it is anticipated that another chemist will be needed for this work, and perhaps to assist with the recommended increase in pesticide analysis.

Conclusions

The chemistry laboratory routinely analyzes potable water for thirteen substances, but only seven of these are required by the drinking water standards, and eighteen substances which are in the standards are seldom, if ever, run. Some pesticide and radiochemical analyses are done, but mostly it has been limited to a few suspected sources of supply. Some sort of a routine surveillance program needs to be established, to include not only the latter two groups of substances, but also metals (particularly in distribution systems).

The laboratory analyzed 1566 public water supply samples last year, and it would appear that this represents a more than adequate sampling program since there are only about 102 surface sources and 669 ground water (wells) sources in the state.

Samples for metal analysis should be preserved at the time of collection with acid, and those for nitrate and surfactant analysis should either be refrigerated or preserved with mercuric chloride.

It is recommended that a Hach Model 2100 A Turbidimeter be purchased as the Model 1860 is very unstable and inaccurate at low turbidities. In order to undertake the additional metal analyses, another atomic absorption spectrophotometer is also needed.

Two to three additional chemists are needed to undertake the recommended metal analyses, organics contaminants analysis and expanded radiochemical and pesticide analysis.

Earl F. McFarren
Water Supply Program Support Activities
Water Supply Research Laboratory

SURVEY OF WATER CHEMISTRY LABORATORIES

ENVIRONMENTAL PROTECTION AGENCY
Office of Water Programs
Water Hygiene Division

Indicating conformity with the 13th edition of Standard Methods for the Examination of Water and Wastewater (1971).

Survey by Earl McFarren
Date September 6, 1972

X = Deviation U = Undetermined
O = Not Used

Laboratory Conn. State Dept.of Health Director Dr. William Ullmann
Street Clinton Street Chief Chemist Kay Glynn
City Hartford State Conn. 06017 Water Supply Chief RICHARD WOODHULL

Substances Determined

	Method	
1. Physical determinations		
a. color	nessler tubes - chloroplatinate	
b. odor	sniff-standard size bottle	
c. turbidity	Hack Model 1860	x
2. Miscellaneous anions, organics and solids		
a. chlorides	Auto-analyzer	
b. cyanide		0
c. carbon chloroform extract	2 last year	0
d. fluorides	auto-analyzer - SPADNS	
e. nitrates	auto-analyzer-cadmium reducxtion	
f. sulfates	turbidimetric	0
g. surfactants	methylene blue	0
h. total dissolved solids	gravimetric	0
i. other	alkalinity (auto-analyzer M.O.) hardness (EDTA) nitrite (auto-analyzer) ammonia and albuminoids	
3. Metals		
a. arsenic	silver diethyl dithiocarbamate	0
b. barium	not done at all	0
c. cadmium	atomic absorption	0
d. chromium	atomic absorption	0
e. copper	atomic absorption	0
f. iron	auto-analyzer	
g. lead	dithizone	0
h. manganese	atomic absorption	0
i. selenium	not done at all	0
j. silver	surface water by atomic absorption	0
k. mercury	surface water by atomic absorption	0
l. zinc	surface water by atomic absorption	0
m. other		

4. Radioactivity
   a. gross beta on 17 reservoirs and 4 wells — 0
   b. radium 226
   c. strontium 90
   d. other gross alpha on 17 reservoirs and 4 wells — 0

5. Pesticides (a–j: ~~run on a few surface waters~~)
   a. aldrin — 0
   b. chlordane — 0
   c. dieldrin — 0
   d. DDT — 0
   e. endrin — 0
   f. heptachlor — 0
   g. heptachlor epoxide — 0
   h. methoxychlor — 0
   i. lindane — 0
   j. toxaphene — 0
   k. total organic phosphates plus carbamates not done — 0
   l. chlorinated phenoxy alkyl pesticides very seldom — 0
   m. other

Laboratory Apparatus

	Make	Model	
6. Color comparators			
a. visual	nessler tubes		
b. filter photometer			
7. Spectrophotometer			
a. visible			
b. flame	Beekman	Model B	
c. other	Coleman	Model 21	
8. Atomic absorption spectrophotometer			
a. air-acetylene burner	Perkin-Elmer	303 + 305	
b. nitrous-oxide burner	Varian	AA120	
c. argon-hydrogen flame	are obtaining		
d. cold-vapor (flameless)	Have		
9. Gas chromatographic equipment			
a. electron capture	Varian 200 and Tracor MT-220		
b. flame photometric			
c. microcoulometric			
d. other	Thermionic Perkin-Elmer ~~and flame~~	990 + 881	

Laboratory	Location	Date

	Make	Model	
10. Other chromatographic equipment			
a. thin-layer			
b. Kuderna-Danish evaporator	Have		
c. other			
11. Turbidimeter	Hach 1860		
12. Amperometer	Have		
13. Titrimeter	Wallace and Tiernan		
14. pH meter	Beckman	Zeromatic	
15. Fluoride electrode	Orion		
16. Arsine generator	Guitzit		
17. Cyanide still	Have		
18. Fluoride still			
19. Carbon-chloroform extraction equipment			
a. high or low flow columns			
b. carbon drying oven			
c. extraction apparatus	1 set up		
d. manifold for solvent evaporation			
20. Drying oven	Hot point		
21. Steam bath	Have		
22. Hot water bath	Have		
23. Muffle furnace	Thermolyne		
24. Distilled water still	30 gal/hr	American Sterilizer	Co.
25. Water deionizer	Barnstead		
26. Conductivity meter	YSI	Model 31	
27. Balance, sensitive to 0.1 mg	Mettler	H20	
28. Automatic analyzer for			
a. nitrates plus nitrites	cadmium reduction	CSM-6	
b. nitrites	naphthylamine hydrochloride		

		Make	Model	
28.	Automatic analyzer for (Continued)			
	c. chloride	mercury thiocyanide		
	d. sulfate			
	e. cyanide			
	f. fluoride	SPADNS with distillation		
	g. other	Hardeess - EDTA, alkalinity	methyl orange iron-thioglyco aci	
29.	Radiation Counting Equipment			
	a. internal proportional counter		Tracer Lab	
	b. alpha-scintillation counter		Johnson Labs LLR2	
	c. other	Wide beta II (Beckman) and	Packard Tricorb (liquid scintillation counter)	
30.	Other Instruments or Equipment			
	a.			
	b.			
	c.			
	d.			

Sampling

31. Containers 2-1/2 liter thow-away

   a. Non-reusable plastic containers preferred for the collection of samples for general inorganic analysis. . . . . ____

   b. Glass bottles with teflon lines caps preferred for collection of pesticide samples . . . . ____

   c. Other kind . . . . ____
   glass for phenols, pesticides, cyanides and heavy metals

32. Preservatives

   a. Samples for metal analysis preserved by the addition of nitric acid to a pH of about 2.0 0

   b. Nitrates and methylene blue active substances preserved by addition of mercuric chloride 0

   c. Cyanide preserved by the addition of sodium hydroxide to a pH of 11. . . . . ____

   d. No known or required preservative for turbidity, color, pH, chloride, sulfate, fluoride, specific conductance and total dissolved solids. . . . . ____

   e. If no preservative is used, in general samples are analyzed within 72 hrs . . . . ____

33. Identification
   a. Every bottle should be identified by attaching an appropriately inscribed tag, a label or a number corresponding to a sample identification sheet. . . . . ______
   b. The minimum information required on the tag or correspondingly numbered sheet includes; name of the water supply sampled, location of sampling site, exact date and time of collection, type of sample (raw, finished, grab or composite) by whom collected, and kind of preservative if added . . . . ______

34. Collection
   a. Samples from wells collected after pumping for a sufficient time to assure that the sample is representative of the ground water which feeds the well. . . . . u
   b. Finished (treated) water sampled at the plant by use of a pipeline drip device or the collecting and compositing of hourly (or other interval) samples . . . . u
   c. Distribution samples obtained at several different points in the system; usually grab samples obtained without first flushing the line, although both kinds of samples may at times be desirable. . . . . u

Records

35. Availability
   a. Assay results assembled and available for inspection . . . . . . ______
   b. Notation made of those water supplies which did not comply with one or more standards, and some sort of follow-up program instigated . . . . ______

36. Number analyzed annually
   a. private supplies 385 samples analyzed last year ______
   b. semi-public 1425 samples analyzed last year ______
   c. municipal 1516 samples analyzed last year ______
      (1) sources ______ ______
      (2) finished ______ ______
      (3) distribution ______ 0

37. Frequency

a. Physical characteristics measured at least once a week and preferably every day at the treatment plant. . . . . ___u___

b. Chemical characteristics determined at least once every three years on ground water supplies and semi-annually on surface water supplies unless previous data has indicated a potential problem which needs to be monitored more frequently _______

Laboratory

38. Physical facilities

a. Bench top area adequate . . . . ___x___

b. Sufficient cabinet space for chemicals and glassware . . . . . . ___x___

c. Adequate hood space. . . . . ___x___

d. Office space available for record keeping and processing reports . . . . ___x___

e. Space for storage and handling of bottles. . . . . _______

39. Glassware

a. Thoroughly washed with suitable detergent and warm water . . . _______

b. Rinsed immediately in clean tap water to remove detergent . . . _______

c. Final rinse with distilled water. . . . . _______

d. Dichromate cleaning solution used for difficult to clean glassware. . . . . _______

e. Glassware used for pesticide analysis should receive a final rinse with A. R. grade acetone or ethyl acetate . . . . . . _______

40. Organization

a. Total number of laboratories examining water___________ . . . . _______

b. Water laboratory is a separate unit, and not part of a food, drug, or toxicological laboratory . . . . ___x___

c. Each of the other regional laboratories have the same capabilities. . . . . _______

d. Radiation chemistry is a part of the water laboratory . . . . . . ___x___

Quality Control

41. Laboratory water quality

a. Conductivity of water checked at regular intervals . . . . _______

b. Use of deionized water for metal analysis . . . . _______

42. Control Samples
   a. A control sample of known composition (in addition to any necessary standards) is analyzed every time one or more unknown samples are analyzed. . . . . ______
   b. A control sample is available and used for each substance specified in the drinking water standards . . . . ______
   c. A control chart has been constructed for each substance, and the precision of each determination has been calculated . . . . ______

43. Reference Samples
   a. Accuracy and ability of laboratory to perform each analysis checked by requiring them to analyze an unknown reference sample(s) supplied by the surveying office or laboratory at least once a year . . . . ______

Staff

44. Personnel
   a. Total number of staff 16 . . . . ______
   b. Number with degrees in chemistry 8, 6 other, 2 non-degrees ______
   c. Does state operate under a merit system. . . . . ______
   d. Are job descriptions written . . . . ______
   e. Does state encourage attendance at professional meetings, short courses, etc. x

45. Salaries
   a. Chief chemist 16,00 to 18,000 . . . . ______
   b. Assistant chemist 8,000 to 12,000. . . . . ______
   c. Aids 6,300 . . . . ______

APPENDIX D

STATE OF CONNECTICUT

STATE DEPARTMENT OF HEALTH

79 ELM STREET HARTFORD, CONNECTICUT 06115

OFFICE OF PUBLIC HEALTH

Name: Date:

Address: Town:

Utility:

For your information.

Please note special recommendations.

Resampling requested.

For necessary action.

Remarks ______________________________

____

____

____

Richard S. Woodhull, Chief
Water Supplies Section
Environmental Health Services Division

Copy Sent To:

INSPECTION OF PUBLIC WATER SUPPLY

SUBJECT: ____

____

TO: ______________________ FROM: ______________________

INSPECTED: ______________________ DATE OF INSPECTION: ______________________

WATERSHED SURVEY

Refer to detailed survey report appended. Location numbers correspond to numbers on U.S. Geological Survey map kept by this department. An unsatisfactory condition is indicated by underlining and starring the location number. Underlining only indicates the existence of a condition of questionable hazard. The following locations were found unsatisfactory or questionable: ______________

____

PROTECTION AGAINST CHANCE CONTAMINATION:

Posting: ____

Fencing: ____

Patrol: ______________________ Fishing: ______________________

Appearance of reservoirs: ____

ALGAE CONTROL:

Microscopic analysis: ____

Copper sulfate treatment: ____

Remarks: ____

____

____

WELLS

NAME	TYPE	DIAM.	DEPTH	PUMP CAPACITY	DISTANCE TO NEAREST SUB-SURFACE SEWAGE SYSTEM OR SEWER

REMARKS: ____
(for additional space use reverse side)

TREATMENT
(Attach appropriate treatment inspection forms)

DISTRIBUTION

ESTIMATED POPULATION SUPPLIED: ______________________

YEARLY AVERAGE DAILY CONSUMPTION: ____________ PER CAPITA: ____________

ESTIMATED SAFE YIELD OF PRESENT SOURCES: ______________________

MAXIMUM HOUR DEMAND: ______________________

GALS. AVAILABLE MAXIMUM HOUR: ______________________

NO. OF SERVICES: ____________ NO. OF METERS: ________ % METERED: ______

SYSTEMATIC FLUSING: ______________________

DISINFECTION PROCEDURE: ______________________

DOUBLE CHECK VALVE INSTALLATIONS: ______________________

____

BLOW-OFFS TO SEWERS OR SUBMERGED IN STREAMS: ______________________

STORAGE TANKS: ______________________

CROSS CONNECTION CONTROL PROGRAM: ______________________

____

REMARKS: ______________________

____

CONCLUSIONS AND RECOMMENDATIONS

____

____

____

____

____

____

____

(for additional space use reverse side)

Town: ______________________ **WATERSHED INSPECTION FORM** Date: ______________________

Name of Utility: ______________________ Inspector(s): ______________________

Name of Watershed: ______________________ ______________________

Location No.	Town	Type of Property	Name	No. of Persons	Farm Animals	Sewage Disposal System (indicate feet to nearest watercourse, low area, etc.)						Nearest Watercourse, low area, etc.	Remarks
						Septic Tank	Cess-pool	Tile Field	Separate Waste Drain	Privy	Surface Discharge		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)

EXPLANATORY NOTES (according to Column Number)

(1) Designate by (*), if condition warrants correction; Underline (–), if condition warrants surveillance.
(2) Town where the property inspected is located.
(3) Designate whether Residence (R); Hospital (Hosp.); Business (Bus.); Factory (Fac.); Farm and type (F-Dairy); etc.
(4) Indicate whether Owner (O) or Tenant (T).
(5) Average number of persons using facility.
(6) List number and kind.
(7)-(11) Indicate number of units, if more than one; e.g., Col. (8): "3 @ 100'".
(12) Indicates if raw sewage is intended to discharge directly on the ground and/or to watercourse.
(13) Denote name (if any) or type of watercourse; e.g. brook, swale, road ditch, culvert, etc.
(14) Conclude whether system "Appeared OK": Specify what type of bad condition exists; e.g., "Overflow of (9)", "Exposed cover of (7)", "refuse or debris exposed on ground", "evidence of swimming in brook", etc. Include here also description of Swimming Pool drainage and backwash; Industrial Wastes; Dairy Wastes; etc.

Sheet ______

S.E. 1 (1-66)

INSPECTION OF WATER FILTRATION PLANT

SUBJECT: ______________________________

____

TO: ______________ FROM: ______________

INSPECTED WITH: ______________ DATE OF INSPECTION: ______________

SOURCE OF SUPPLY: ______________________________

TREATMENT FACILITIES: ______________________________

____

____

RATE OF FILTRATION (gpm/sf.): ______________ HOURS OPERATING/DAY: ______________

DESIGNED PLANT CAPACITY (MGD): ______________ RATE OF FLOW (MGD): ______________

CHEMICAL DOSAGE: Alum: ______________ Lime: ______________

SODA ASH: __________ METAPHOSPHATE: __________ ACTIVATED CARBON: __________

OTHER: ______________________________

APPEARANCE OF FLOC: ______________ SETTLING TIME (Hrs.): ______________

Test	Influent	Settled	Effluent
Color			
pH Value			
Odor			
Alkalinity (mg/l)			
CO_2 (mg/l)			
Turbidity			
Hardness (mg/l as $CaCO_3$)			
Residual Chlorine (mg/l)			

CONDITION OF TESTING EQUIPMENT: ______________ RECORDS: ______________

LENGTH OF FILTER RUNS (hrs.) ______________ RATE OF WASH (GPM/sq.ft.): ______________

METHOD OF WASHING FILTERS: ______________________________

FLOW CONTROLLERS: ______________ LOSS OF HEAD GAUGES: ______________

DATE SEDIMENTATION BASIN LAST CLEANED: ______________________________

DISPOSAL OF WASH WATER AND SLUDGE: ______________________________

INSPECTION OF WATER FILTRATION PLANT

SUBJECT: ____________________

____

TO: __________ FROM: __________

INSPECTED WITH: __________ DATE OF INSPECTION: __________

SOURCE OF SUPPLY: ____________________

TREATMENT FACILITIES: ____________________

____

____

RATE OF FILTRATION (gpm/sf.): __________ HOURS OPERATING/DAY: __________

DESIGNED PLANT CAPACITY (MGD): __________ RATE OF FLOW (MGD): __________

CHEMICAL DOSAGE: Alum: __________ Lime: __________

SODA ASH: __________ METAPHOSPHATE: __________ ACTIVATED CARBON: __________

OTHER: ____________________

APPEARANCE OF FLOC: __________ SETTLING TIME (Hrs.): __________

Test	Influent	Settled	Effluent
Color			
pH Value			
Odor			
Alkalinity (mg/l)			
CO_2 (mg/l)			
Turbidity			
Hardness (mg/l as $CaCO_3$)			
Residual Chlorine (mg/l)			

CONDITION OF TESTING EQUIPMENT: __________ RECORDS: __________

LENGTH OF FILTER RUNS (hrs.) __________ RATE OF WASH (GPM/sq.ft.): __________

METHOD OF WASHING FILTERS: ____________________

FLOW CONTROLLERS: __________ LOSS OF HEAD GAUGES: __________

DATE SEDIMENTATION BASIN LAST CLEANED: ____________________

DISPOSAL OF WASH WATER AND SLUDGE: ____________________

CHLORINATION: (Attach appropriate chlorinator inspection form).

SAMPLES COLLECTED:

Source	Color Apparent	Color True	Alkalinity (mg/l)	(Coliform organisms/100 ml)

CONCLUSIONS AND RECOMMENDATIONS:

____

____

____

____

2-65

INSPECTION OF FLUORIDATOR

SUBJECT: ______________________________

____

TO: ______________ FROM: ______________

INSPECTED WITH: ______________ DATE OF INSPECTION: ______________

SOURCE OF SUPPLY: ______________________________

RATE OF WATER FLOW: ______________ SETTING OF FEEDER: ______________

TYPE OF FEEDER: ______________________________

____

POINT OF FLUORIDE INJECTION: ______________________________

TYPE OF CHEMICAL USED: ______________________________

RATE OF CHEMICAL FEED: ______________ FLUORIDE DOSAGE RATE (mg/1 as F): ______________

FREQUENCY OF TESTING: ______________ TESTING PROCEDURE USED: ______________

CONDITION OF TESTING EQUIPMENT: ______________________________

FLUORIDE TEST (mg/1): ______________ RECORDS: ______________

SAMPLES COLLECTED FLUORIDE (mg/1)

(1) ______________________________

(2) ______________________________

(3) ______________________________

REMARKS: ______________________________

____

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2-65

INSPECTION OF HYPOCHLORINATOR

SUBJECT: ______________________________

____

TO: ______________ FROM: ______________

INSPECTED WITH: ______________ DATE OF INSPECTION: ______________

SOURCE OF SUPPLY: ______________________________

TYPE OF CHLORINATOR: ______________________________

____

____

ALTERNATE CHLORINATOR: ______________________________

____

SPARE PARTS AVAILABLE: ______________________________

STANDBY POWER: ______________ CONDITION: ______________

STROKE SETTING OF CHLORINATOR: __________ RATE OF WATER FLOW: __________

STROKES/MINUTE: __________ APPROX. RATE OF CHLORINE DOSAGE, lbs./m.g.: __________

POINT OF HYPOCHLORITE INJECTION: ______________________________

MAINE PRESSURE (AT POINT OF INJECTION): ______________________________

SAMPLING POINT FOR RESIDUAL CHLORINE: ______________________________

P.P.M. Chlorine Residual (after 10 min. contact) Flash: __________ Total: ______

INTERFERENCE USING SODIUM ARSENITE: ______________________________

mg/l. Chlorine Residual, After Change (after 10 min. contact)

Flash: ______________ Total: ______________

RECORDS IN GOOD ORDER: __________ FREQUENCY OF RESIDUAL CHLORINE TESTING: __________

AMOUNT AND KIND OF CHLORINE ON HAND: ______________________________

TYPE & CONDITION OF RESIDUAL CHLORINE TEST KIT: ______________________________

SAMPLES COLLECTED:

Lab. No.	Pt. of Collection	Chlor. Res (mg/l)	Coliform/100 ml

REMARKS AND RECOMMENDATIONS: ______________________________

____

INSPECTION OF GAS CHLORINATOR

SUBJECT: ____

____

TO: ____________________ FROM: ____________________

INSPECTED WITH ____________________ DATE OF INSPECTION: ____________________

TYPE OF CHLORINATOR: ____

ALTERNATE CHLORINATOR: ____

STANDBY POWER: ____________________ CONDITION: ____________________

INJECTOR PRESSURE (#/sq.in.) ____________ MAIN PRESSURE (#/sq.in.) ____________

CHLORINE TANK PRESSURE (#/sq.in.) ____________ RATE OF WATER FLOW: ____________

RATE OF CHLORINE DOSAGE, (lbs./24 hours) ____________________

DOSAGE RATE, (lbs./m.g.) ____________________

TESTING POINT FOR RESIDUAL CHLORINE: ____________________
P.P.M. Chlorine Residual (after 10 min. contact) Flash: ________ Total: ________

INTERFERENCE USING SODIUM ARSENITE: ____________________ mg/l

CHANGE IN CHLORINE DOSAGE: ____________________
Mg/l Chlorine Residual, after Change (after 10 min. contact) Flash: ____ Total: ____

RECORDS IN GOOD ORDER: ____________ FREQUENCY OF RESIDUAL CHLORINE TESTING ____________

PLATFORM SCALES: ____

PAST 24 HRS., AVERAGE CHLORINE DOSAGE RATE (#/m.g.) ____________________

ARRANGEMENT OF CHLORINE CYLINDERS: ____

____________________ GAS MASK: ____________ DATE OF CANISTER: ____________

SPARE PARTS AVAILABLE FOR CHLORINATOR: ____________________

RESIDUAL CHLORINE TESTING EQUIPMENT, CONDITION: ____________________

SAMPLES COLLECTED:

Lab. No.	Pt. of Collection	Chlor. Res. (mg/l)	Coliform/100 ml

REMARKS AND RECOMMENDATIONS: ____

____

INSPECTION OF PUBLIC WATER SUPPLY

SUBJECT: ____

____

TO: ______________________ FROM: ______________________

INSPECTED WITH: ______________________ DATE OF INSPECTION: ______________________

SOURCES OF SUPPLY

SURFACE WATER:

SOURCE	SAFE YIELD	PUMPING CAPACITY

WATERSHED SURVEY: Refer to detailed survey report appended. Location numbers correspond to numbers on U.S. Geological Survey map kept by this department. An unsatisfactory condition is indicated by underlining and starring the location number. Underlining only indicates the existence of a condition of questionable hazard. The following locations were found unsatisfactory or questionable: ______________________

____

PROTECTION AGAINST CHANCE CONTAMINATION:

Posting: ____

Fencing: ____

Patrol: ______________________ Fishing: ______________________

Appearance of Reservoirs: ______________________

ALGAE CONTROL:

Microscopic Analysis: ______________________

Copper Sulfate Treatment: ______________________

REMARKS: ____

____

____

GROUND WATER:

NAME	TYPE	DIAM.	DEPTH	PUMP CAPACITY	DISTANCE TO NEAREST SUBSURFACE SEWAGE SYSTEM OR SEWER

REMARKS: ____

____

____

TREATMENT

(Attach appropriate treatment inspection forms)

DISTRIBUTION

ESTIMATED POPULATION SUPPLIED: ______________________

YEARLY AVERAGE DAILY CONSUMPTION: ______________ PER CAPITA: __________

ESTIMATED SAFE YIELD OF PRESENT SOURCES: ______________________

MAXIMUM HOUR DEMAND: ______________________

GALS. AVAILABLE MAXIMUM HOUR: ______________________

NO. OF SERVICES: ______________ NO. OF METERS: ________ % METERED: ________

SYSTEMATIC FLUSHING: ______________________

DISINFECTION PROCEDURE: ______________________

DOUBLE CHECK VALVE INSTALLATIONS: ______________________

____

BLOW-OFFS TO SEWERS OR SUBMERGED IN STREAMS: ______________________

STORAGE TANKS: ______________________

TRANSFER PUMPS: ______________________

____

BOOSTER STATIONS: ______________________

____

CROSS CONNECTION CONTROL PROGRAM: ______________________

____

REMARKS: ____

____

WATER QUALITY

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CONCLUSIONS AND RECOMMENDATIONS

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(for additional space use reverse side)

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APPENDIX E

APPENDIX E

Summary of Connecticut Water Supply Laws and Regulations

Code: CGS - Connecticut General Statute

CPHC - Connecticut Public Health Code (1971)

PWS - Private Water Supplies (Conn. Health Dept. 1964)

PWSI - Public Water Supply Information (Conn. Health Dept. 1971)

1. Basic regulatory authority - CGS 25-32
2. "Water Supply" defined - CGS 25-32
3. Drinking water quality standards - PWSI, pp. 9-12
4. Project plan review and approval - CGS 25-33; PWSL, pp. 22-24
5. Water system permit
6. Laboratory services - CGS 25-40; CPHC 19-13-A28 thru 35; PWS, pp. 4-6; PWSI, pp. 8-9.
7. Sampling requirements
8. State surveillance
   - (a) Frequency - CGS 25-34
   - (b) Remedies - CGS 25-37
9. Water rights - CGS 25-8A
10. Operator certification and training - CGS 25-32, 25-37
11. Treatment
    - (a) General - PWSI, pp. 13-19
    - (b) Flouridation - CGS 19-13b; PWSI, p. 20
12. Individual water supplies - PWS (passim)
13. Wells
    - (a) Driller licensing - CGS, ch. 482, esp. 25-129

(b) Construction standards - CPHC 19-13-B51f-k; PWSI, pp. 4-8

14. Cross connection control - PWSI, pp. 21-22

PHASE I - STATE OF CONNECTICUT STATUTES

Chapter 333 - State Department of Health

Sec. 19-13a - regulation of water supply wells and springs - public health council may adopt needed regulations (4)

Sec. 19-13b - flouridation of public water supplies - any town of 20,000 or more shall add necessary flouride (4).

Sec. 19-13c - protection of wells (4).

Sec. 19-64 - common drinking cups (7).

Sec. 19-83 - jurisdiction of local director of health over streams is complete.

Chapter 16 - General Assembly

Sec. 2-20a - bills seeking incorporation and franchise of water companies (9).

Chapter 102 - Municipal Waterworks Systems.

Sec. 7-234 can raise necessary money by obligation bonds.

Title 16 - Public Service Companies

Sec. 16-1 includes regulations and supervision of water supply.

Chapter 280 - Operation of Railroads

Sec. 16-168 provides for drinking water.

Chapter 283 - Water Companies

Sec. 16-260 - water meters may be required.

Chapter 473 - Water Resource Commission

Sec. 25-7a - sale of water by public water systems.

Sec. 25-8a - diversion of river waters for public or domestic use.

Part III - Water and Ice Supplies

Sec. 25-32 - state health department has jurisdiction.

Sec. 25-34 - investigation of water or ice supply will be had on complaint.

Sec. 25-38 - prohibits carcass of animal near drinking water supply.

Sec. 25-39 - anyone polluting drinking water will be fined not more than $500.

Sec. 25-40 - analysis of water - anytime directors of health feel health might be menaced, samples will be sent to state for testing.

Sec. 25-41 - cemetary not to be within one half mile of reservoir.

Sec. 25-43 - no bathing or polluting of water supply reservoirs or of two miles of streams that lead to it.

Sec. 25-45 - local ordinance concerning reservoirs shall be upheld.

Sec. 25-46 - interstate waters used for drinking water supply will be protected.

Sec. 25-51 - injunction can be had against injury to ice or water supply.

Chapter 475 - Interstate Sanitation Commission (55)

Chapter 476 - New England Interstate Water Pollution Control Commission (67)

Chapter 482 - Well Drilling

Sec.25-137 sets out in detail requirements for drilling wells, its code, certificate of registration, permits, records and clearly states that purity, potability and safe-guarding well water is in the province of the health department.

Chapter 943 - Offenses Against Public Peace and Safety

Sec. 53-214 - forbids pollution of drinking utensils.

PHASE II - STATE OF CONNECTICUT RULES AND REGULATIONS

Chapter II of Public Health Code is Environmental Health - the April, 1971, 272-page Connecticut State Department of Health Code for the State of Connecticut is attached.

Sec. 19-13-B20b - subsection (a) and (e) spells out details of how close septic tanks will be to water supply.

Sec. 19-13-B20e - water pipes shall be in different trenches from sewer lines where practicable.

Sec. 19-13-B27 - Youth Camp Water Supply.

Sec. 19-13-B28(c) - mobile homes - water supply.

Sec. 19-13-B29 - motels and overnight cabins water supply and drinking facilities.

Sec. 19-13-B35 - swimming pools-drinking cups and drinking fountains.

Sec. 19-13-B36 - pool - cross connection between water supplies prohibited.

Sec. 19-13-B38 - permissible arrangements for connections to water tanks or pools.

Sec. 19-13-B39 - water supplies for public and employees.

Sec. 19-13-B41 - sanitation of public fairgrounds (a) water supply.

Sec. 19-13-B42 - sanitation of places dispensing foods or beverages (f) is water supply - also note (1).

Sec. 19-13-B43 - artificial ice plants.

Sec. 19-13-B45 - minimum requirements for drainage and toilet systems - purpose is to avoid contamination of drinking water.

Sec. 19-13-B47 - disinfection of water mains and valves - construction or repairs should avoid harm to water supply.

Sec. 19-13-B49 - catering food service (f) - water supply will be from approved source.

Approved Sanitizing Process (Page 77) - Sections 1, m and n deal with food and drink and how it will be stored.

Water Supply Wells - Sec. 19-13B51a to 19-13B1L - these detail specifications for wells in the state.

Sec. 19-13-1360 - water supply for workers' quarters - Note: (1) says no pipe connection will be made between potable and any other kind of water supply.

Sec. 19-13-B78 - slaughterhouses - (c) pertains to water supply requirements.

Sec. 19-13-B80 - no chemical substance shall be added to public water supply other than that already approved.

Chapter 6 - Land and air conveyance of common carriers.

Sec. 19-13-F2 - sources of water for air and land transportation will meet U. S. Public Health Service Standards.

Sec. 19-13-F3 - details of delivery of water and ice to land and air transports (c) says no dumping of waste over public water supply watershed.

Sec. 19-13-F6 outlines specification for coolers, filters, etc.

PUBLIC WATER SUPPLY INFORMATION FOR CONNECTICUT

Outlines at length problems related to public water supply such as back-siphonage and sewer connections, chemical substance in water supplies analysis of water. This is in a 26-page booklet that is attached.

PRIVATE WATER SUPPLIES (8th Edition)

23-page book on the problems like odor, taste and color, water piping, etc. as they relate to private water supplies.

APPENDIX F

BOB #85-S69004
Exp. March 1970

MUNICIPAL WATER SUPPLY SANITARY SURVEY

SURVEY DATE

1. [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ] 12 (for office use only) (DUP. ON EVERY CARD) 13 [ ][ ] mo. [ ][ ] day [ ][ ] yr. 18

2. Name of supply ______________________________

3. Location ______________________________
post office — common name, if different

4. Demands, MGD:

	PRESENT	10-YR. ESTIMATE	UNKNOWN
A. Avg. day	19 ... 23	24 ... 28	30
B. Max. day	31 ... 35	36 ... 40	42
C. Max. month	43 ... 47	48 ... 52	54

5. Water use has been restricted [ ][ ] (55 56) times for a total of [ ][ ][ ] (57 59) days during any one year of the past 5 years.

6. LABORATORY CONTROL

A. Bacteriological (Distribution system only)

			UNKNOWN
(1) Min. number samples recommended per month by PHS DWS		60 62	
(2) Avg. number/month for last 12 months		63 65	67
(3) Range of least and most monthly samples	from 68 70	to 71 73	75

END CARD ONE [1] 80

(4) Number of months the Drinking Water Standards were not met during the last 12 months for:

		UNKNOWN
(a) Quality	13 14	15
(b) Number of samples	16 17	18
(c) NONE collected	19 20	21

(5) Are samples representative of distribution system?	22 yes	23 no
(6) Are check samples collected as provided for in the Drinking Water Standards?	24 yes	25 no
(7) Are samples requiring check samples reported by telephone?	26 yes	27 no
(8) Is the laboratory certified?	28 yes	29 no
(a) Within the past 3 years?	30 yes	31 no
(b) If "yes" to one or both, by whom was it certified.	32 State	33 PHS
(9) Are samples received by lab within 30 hours?	34 yes	35 no

ECA-19

B. Chemical (finished water only)

(1) Samples of finished water are analyzed each ☐ 36 month, ☐ 37 year, ☐ 38 2 years, ☐ 39 3 years, ☐ 40 infrequently ☐ 41 never.

(2) Type of analysis: ☐ 42 complete (DWS) ☐ 43 partial.

(3) Date of last chemical analysis ☐☐ 45 mo. ☐☐ day ☐☐ yr 50

(4) Analyzed by ☐ 51 utility, ☐ 52 state, ☐ 53 PHS, ☐ 54 university, ☐ 55 other.

(5) Tests run for operational control and their frequency are:

Tests	Continuous	Each shift	Daily	Weekly	Less frequently than weekly
Alkalinity	☐ 57	☐	☐	☐	☐ 61
Aluminum	☐ 62	☐	☐	☐	☐ 66
Chloride	☐ 67	☐	☐	☐	☐ 71
Chlorine residual	☐ 72	☐	☐	☐	☐ 76
(END CARD TWO) 2 80					
Color	☐ 13	☐	☐	☐	☐ 17
Fluoride	☐ 18	☐	☐	☐	☐ 22
Hardness	☐ 23	☐	☐	☐	☐ 27
Iron	☐ 28	☐	☐	☐	☐ 32
Jar tests	☐ 33	☐	☐	☐	☐ 37
Manganese	☐ 38	☐	☐	☐	☐ 42
pH	☐ 43	☐	☐	☐	☐ 47
Taste & Odor	☐ 48	☐	☐	☐	☐ 52
Turbidity	☐ 53	☐	☐	☐	☐ 57
Zeta potential	☐ 58	☐	☐	☐	☐ 62
Other ______	☐ 63	☐	☐	☐	☐ 67

C. Radioactivity

(1) Samples are analyzed each ☐ 69 month, ☐ 70 year, ☐ 71 2 years, ☐ 72 3 years, ☐ 73 infrequently ☐ 74 never. (END CARD 3) 3 80

(2) Date of last radiological analysis ☐☐ 13 mo. ☐☐ day ☐☐ yr 18

(3) Analyzed by ☐ 19 utility, ☐ 20 state, ☐ 21 PHS, ☐ 22 university, ☐ 23 other. (specify)

7. SANITARY SURVEY

A. Date of most recent survey ☐☐ 24 mo. ☐☐ day ☐☐ yr. 29 or ☐ 30 none

B. Survey made by: ☐ 31 state, ☐ 32 PHS, ☐ 33 local health department, ☐ 34 utility, ☐ 35 consultant.

C. Facilities surveyed: ☐ 36 source, ☐ 37 transmission, ☐ 38 treatment, ☐ 39 storage, ☐ 40 distribution.

8. FACILITIES & OPERATION (describe deficiencies on reverse side)

	YES	NO
A. Are there common walls between finished and lesser quality water?	☐ 41	☐ 42
B. Are there inter-connections to other systems		
(1) of known acceptable quality	☐ 43	☐ 44
(2) of unknown quality		
(a) with protection	☐ 45	☐ 46
(b) without protection	☐ 47	☐ 48
C. Is there a cross-connection control program		
(1) on new construction only	☐ 49	☐ 50
(2) for continuous re-inspection	☐ 51	☐ 52
D. Are finished water reservoirs properly covered?	☐ 53	☐ 54
E. Is there detectable chlorine residual in distant parts of the distribution system?	☐ 55	☐ 56
F. Can the treatment plant be by-passed?	☐ 57	☐ 58
G. Are there satisfactory procedures to:		
(1) prevent personal accidents	☐ 59	☐ 60
(2) prevent chlorine accidents	☐ 61	☐ 62
(3) disinfect all new and/or repaired distribution system mains, valves, fittings, including check samples before being placed in service?	☐ 63	☐ 64
H. Are there areas of low pressure (< 20 psi) in the distribution system under maximum water use?	☐ 65	☐ 66

I. Operating problems most often encountered are: ☐ 67 taste & odor ☐ 68 phenols, ☐ 69 corrosive water, ☐ 70 short filter runs, ☐ 71 other, specify.

8. FACILITIES & OPERATION, continued

J. Chlorination process was interrupted [ ][ ] (72 73) times in the last 12 months.

(1) Interruptions were due to: [ ] (74) chlorinator failure, [ ] (75) feedwater pump, [ ] (76) changing cylinders, [ ] (77) power failure, [ ] (78) other, explain. (END CARD 4) [4] (80)

K. Percent of land area within service area where water is available (nearest whole percent) [ ][ ][ ] (13 15) %.

	YES	NO
L. Were plans and specs. for treatment plant approved by the state?	[ ] 16	[ ] 17

9. SOURCE, TREATMENT & DISTRIBUTION (describe deficiencies on reverse side)

A. Are the following adequate:

	YES	NO
(1) Source, with respect to the following:		
(a) quantity	[ ] 18	[ ] 19
(b) bacteriological quality	[ ] 20	[ ] 21
(c) chemical quality	[ ] 22	[ ] 23
(d) physical quality	[ ] 24	[ ] 25
(e) adequate protection	[ ] 26	[ ] 27
(2) Transmission of raw water	[ ] 28	[ ] 29
(3) Is the raw water sampled for:		
(a) Bacteriological contamination	[ ] 30	[ ] 31
(b) Chemical contamination	[ ] 32	[ ] 33
(4) Treatment, with respect to the folowing:		
(a) aeration	[ ] 34	[ ] 35
(b) chemical feed, capacity	[ ] 36	[ ] 37
(c) chemical feed, stand-by equipment	[ ] 38	[ ] 39
(d) chemical mixing	[ ] 40	[ ] 41
(e) flocculation	[ ] 42	[ ] 43

9. SOURCE, TREATMENT & DISTRIBUTION, continued

A. Are the following adequate (continued):

	YES	NO
(4) Treatment, continued:		
(f) settling	☐ 44	☐ 45
(g) recarbonation	☐ 46	☐ 47
(h) filtration	☐ 48	☐ 49
(i) disinfection, capacity	☐ 50	☐ 51
(j) disinfection, stand-by equipment	☐ 52	☐ 53
(k) taste & odor control	☐ 54	☐ 55
(l) fluoridation	☐ 56	☐ 57
(5) Distribution, with respect to the following:		
(a) storage	☐ 58	☐ 59
(b) booster chlorination	☐ 60	☐ 61
(c) high service pumping	☐ 62	☐ 63
(d) booster pumping	☐ 64	☐ 65
(e) pressure	☐ 66	☐ 67
(6) Maintenance	☐ 68	☐ 69
(7) Records for:		
(a) disinfection	☐ 70	☐ 71
(b) filter runs	☐ 72	☐ 73
(c) chemical consumption	☐ 74	☐ 75
(d) operational control tests	☐ 76	☐ 77
(e) bacteriological examinations	☐ 78	☐ 79
(8) Cross-connection control	END CARD 5	[5] 80
(a) ordinance	☐ [illegible]	☐ [illegible]
(b) program implementation	☐ 15	☐ 16
(c) progress	☐ 17	☐ 18

9. SOURCE, TREATMENT & DISTRIBUTION, continued

B. During the past 3 years, raw water quality has ☐ (19) improved, ☐ (20) deteriorated, or ☐ (21) stayed the same.

10. PERSONNEL

A. Water Purification Operator

(1) Highest level of formal education: ☐ (22) 8th grade or less, ☐ (23) high school, ☐ (24) technical or trade school, ☐ (25) university.

(2) Level of training in water treatment: ☐ (26) college course, ☐ (27) technical or trade school, ☐ (28) short school, ☐ (29) on the job, ☐ (30) none, ☐ (31) other, specify ______________________.

(3) Length of time on this job: ☐☐ (32 33) years, ☐☐ (34 35) months.

(4) Number of previous positions as water treatment operator ☐☐ (36 37)

(5) Total years of water purification experience ☐☐ (38 39)

(6) Level of study in sanitary microbiology: ☐ (40) college course, ☐ (41) technical or trade school, ☐ (42) short school, ☐ (43) on the job, ☐ (44) none, ☐ (45) other, specify ______________________.

(7) Level of study in water chemistry: ☐ (46) college course, ☐ (47) technical or trade school, ☐ (48) short school, ☐ (49) on the job, ☐ (50) none, ☐ (51) other, specify ______________________.

(8) Is the operator a full-time employee? ☐ (52) yes ☐ (53) no

(9) Salary range (per year) of operator: ☐ (54) <$1,999 ☐ (55) $2,000–4,999 ☐ (56) $5,000–7,499 ☐ (57) $7,500–9,999 ☐ (58) $10,000

10. PERSONNEL, continued

A. continued

(10) Is your present staff adequate in:

(a) number ☐ 60 yes ☐ 61 no

(b) quality ☐ 62 yes ☐ 63 no

B. Operator's major complaint ______________________________

____

____

C. Most frequent customer's complaint: ______________________________

____

____

D. Management's most frequent complaint: ______________________________

____

____

11. FINANCIAL INFORMATION

A. Bonded indebtedness: (water supply)

(1) General obligation bonds $ [66 – 73]. *END CARD 6* [6] 80

(a) statutory limit $ [13 – 20].

(2) Revenue bonds $ [21 – 28].

(a) statutory limit $ [29 – 36].

B. Capital stock, par value $ [37 – 44].

bonds, par value $ [45 – 52].

C. Water funds are [ ]53 kept separate or [ ]54 mingled with other funds.

D. Is there an annual payment to the general fund? [ ]55 yes [ ]56 no

E. Operation is controlled by: [ ]57 mayor-council, [ ]58 mayor-commission, [ ]59 independent water board, [ ]60 other, specify.________________.

F. Is there active planning for expansion or improvement? [ ]61 yes [ ]62 no

(1) Value of planned improvement $ [63 – 70].

(2) Planning by utility [ ]71 yes [ ]72 no

(3) Planning by consultants [ ]73 yes [ ]74 no *END CARD 7* [7] 80

G. If expansion is planned, it will be carried out within:

	1 YR.	2-5 YRS.	6-10 YRS.
(1) Source	[ ] 13	[ ]	[ ] 15
(2) Treatment	[ ] 16	[ ]	[ ] 18
(3) Distribution	[ ] 19	[ ]	[ ] 21
(4) Other ________________	[ ] 22	[ ]	[ ] 24

H. Costs of production:

	CENTS/1,000 GALLONS
(1) Chemicals	[26] . [28]
(2) Labor, power, etc.	[29] . [31]
(3) Depreciation	[32] . [34]
(4) Other, including office, administration, meter reading, collection, etc.	[35] . [37]
(5) Total	[38] . [40]

11. FINANCIAL INFORMATION, continued

I. Tariff (Residential)

(1) Connection fee $ [ ][ ][ ][ ] . (41–44)

(2) Sales unit is [ ] (45) per 1,000 gallons or [ ] (46) per 100 cu. ft.

(a) [ ][ ][ ] (47) cents for the first [ ][ ] (50, 51) units

(b) [ ][ ][ ] (52) cents for the next [ ][ ] (55, 56) units

(c) [ ][ ][ ] (57) cents for the next [ ][ ] (60, 61) units

(d) etc. as needed to cover steps.

END CARD 8 [8] (80)

APPENDIX G

Drinking Water Policy and Practice In Connecticut

Richard S. Woodhull, M.S., P.E.
Chief, Water Supplies Section

It is useful to periodically assess Connecticut's position with regard to its practices in the past and what it hopes to make them in the future, particularly in the light of new information as it becomes available to us. We are now well into the '70's which were heralded as the era of the great society. How has this "great society" affected water works in Connecticut?

Development on Reservoir Watersheds

Most of us have noticed the increasing development of our reservoir watersheds. Homes, shopping centers, business, industry and recreational activities have combined in applying pressure against the water utilities in their struggle to maintain clean, pure streams and reservoirs. Connecticut now averages 1 resident for each of her 3 million acres as contrasted to only 2/3 this population density just 20 years ago. Perhaps more telling than the number of people is their way of life. Our affluent society drives 1.76 million motor vehicles which comes to 2.4 vehicles per family. The exhaust emissions, which include such pollutants as lead, hydrocarbons, sulphur, nitrogen, oil and gasoline are discharged to the environment. Air pollutants settle out and are washed out by rain which carries them to our waterways and reservoirs. Lead is known to be especially bad because this heavy metal accumulates in the bones and other parts of the body where it does its damage so slowly that we are not aware of the poisoning taking place. It is because of this threat that the state health department has warned that interstate highways carrying large numbers of vehicles should not be constructed near drinking water reservoirs. The state public health council feels it best to maintain a minimum protective distance of at least 1/4 mile between the roadway and any reservoir.

Housing developments are detrimental to watersheds in many ways. We usually think first of the danger of bacterial contamination from possible

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overflows from subsurface sewage disposal systems. Where housing is well spaced, land drainage is good, and disposal systems are installed in accordance with the public health code, this is not a great problem. The difficulty comes when house lots are too small, drainage is marginal or poor, and code enforcement is lax. Other forms of pollution accompany the householder. He is anxious to establish and maintain a green lawn, usually over the entire area of his lot. This means the application of quantities of fertilizer and water. The trouble here is that much of the nitrogen applied is not held or used by the soil and is leached into the underlying ground water and into surface streams. Gravel wells in such areas are particularly susceptible to this kind of pollution and several public wells have in fact exceeded the critical nitrate level and have had to be removed from service. Nitrate nitrogen above 10 mg/1 is likely to interfere in infants with the capacity of the blood to carry oxygen resulting in strangling and "blue babies". There has been evidence presented recently to indicate that nursery school children are also adversely affected by high nitrates.

Development spawns paved roads, driveways, parking lots, roofs and ground and surface water drains, all of which reduces ground water infiltration and hastens runoff of water to streams and reservoirs. This runoff carries salt from de-icing operations; detergents from auto washing; oil, antifreeze and gasoline from draining radiators and crankcases and from spillage; various insecticides, herbicides and rodenticides; also a load of silt, sediment and other leavings washed from pavement and bared earth. Chloride levels in reservoirs generally have risen from 3–5 mg/1 in the era prior to road salting to current levels of 12–15 ppm, and our studies show this trend is still rising. A major concern in this is the attendant rise in sodium which accompanies the chlorides. The desirable limit for sodium in drinking water is 20 mg/1, because of its involvement in heart disease, toxemia in pregnancy, and pre-menstrual swelling among other problems. Persons on low salt diets are limited to 20 mg/1 of sodium in their drinking water and should be warned if this limit is regularly exceeded. Where chlorides are from sodium chloride, which is the material usually applied for de-icing roads, the sodium fraction will amount to approximately 2/3 the chloride content; that is, a chloride content of 30 mg/1 will mean the sodium limit of 20 mg has been reached. Water utilities generally should request state and local highway departments operating on their watersheds or near their wells to refrain from the use of sodium chloride. Where de-icing is necessary, the use of calcium chloride rather than sodium chloride would be preferable.

Use of Pesticides and Herbicides

The widespread use of pesticides on watersheds is to be discouraged.

Some varieties such as the chlorinated hydrocarbons, examples of which are DDT, chlordane, lindane and dieldrin are long-lived and do not break down quickly to simple chemical components upon exposure to air and water as some other types do. They are non-specific and destroy non-target, desirable soil organisms and plankton as well as the objectionable insect. Their concentration magnifies as they climb the biological ladder from insect or plant to animal to man. Certain herbicides such as 2,4,5–T have been implicated in causing birth defects, and others containing arsenic are known, long-lived cumulative poisons. Wherever it is deemed necessary to use spray or fertilizers care should be taken to prevent their getting in the water. Spray material should be applied with ground equipment directly to the areas to be treated and nowhere else. For use around reservoirs and close to feeder streams the department approves only special ammate without chromium or bromocil, which are short-lived herbicides which break down quickly to simple constituent chemical elements, copper sulphate is approved for algae control in doses up to 4#/mg. Diquat can be used for killing emergent water weeds only where the reservoir can be withdrawn from use for at least 7 days, or in treating upstream ponds where a flow time of 7 days or more is assured before reaching the distributing reservoir. Total dosage is limited to 1 mg/1 and a special permit is required. The same is true of sodium or potassium endothol, except that its permissible dosage is limited to 0.5 mg/1. In rural areas, unplowed, uncultivated strips of land should be left between fertilized and sprayed fields and watercourses that drain the area. These will act as buffers that will protect the streams from runoff of manure and chemical fertilizers, from soil erosion and from sprayed wind drift and surface runoff.

Public Sewers to be Avoided on Watersheds

The installation of sanitary sewers should be avoided in watershed areas. They lead to dense development by multiple housing units, business and industry with all their attendant pollutional hazards including motor traffic. Sewers, by necessity, tend to follow the brooks and thus bring large quantities of sewage into close proximity to the water. There is leakage at sewer joints and overflow may occur from manholes or from relief overflow points in case of overloading or blockage of the sewer. Sewage pumping stations are particularly hazardous, and require that special precautions be taken when they are located on water supply watersheds. Watershed zoning may be one tool that could be employed to a much greater extent to protect water supplies.

Protection Against Water-Borne Diseases

That water supply sources need better protection is becoming ever more evident. Long have we been cognizant of the danger of spreading disease thru our public water supplies. The water-borne scourge, typhoid fever, was beaten by the use of chlorine to treat our drinking water, and many assumed that by defeating the bacteria the battle was won – there would be no more water-borne disease. Now, many years later, we are learning that bacterial control is only a part of our problem. Research reinforced by case history has shown that virus particles are also carried by drinking water. This was demonstrated by wide spread dissemination of infectious hepatitis in New Delhi in 1955 and among members of the Holy Cross football team in Worcester more recently. Viruses have been implicated in certain forms of conjunctivitis, meningitis and cancer, and some feel they may be involved in some cases of appendicitis, heart disease and spontaneous abortion. The types of viruses involved include reo, adeno, coxsackie and echo. In 1970 the Federal Environmental Protection Agency released a report which stated: "... we are not sure today whether or not current water treatment processes are definitely capable of eliminating all harmful viral pollutants from all water supplies. Also we wonder whether or not the treatment will provide the public with sufficient margin of safety to cope with the occasional occurrence of the very unfavorable conditions. These conditions, for instance, may include severe epidemics of human enteric virus disease, unfavorable hydrographical conditions, drought, cold weather and many others. ... there is highly circumstantial evidence to suggest that the high annual incidence of infectious hepatitis may be partially attributable to a widespread and chronic water pollution with low levels of this virus."

In March of 1972, the Environmental Protection Agency reported at a Washington hearing before the Senate Subcommittee on the Environment that disease producing viruses had been found in the tap water at Billerica and at Lawrence in Massachusetts. Both cities use polluted water sources, Billerica drawing from the Concord River and Lawrence taking its water from the Merrimack River. Both cities have complete water treatment facilities, including filtration and chlorination. Of 32 samples of drinking water tested from each system, viruses were present in two of Lawrence's and four of Billerica's. James McDermott, Director of the Water Supply Programs Division of the Environmental Protection Agency said the scientists making these tests at the Northeastern Water Supply Laboratory in Narragansett, Rhode Island made a breakthrough by discovering the following:

- "Echo virus, which occurs in 34 sub-types and can cause nonbacterial meningitis, muscular paralysis, respiratory diseases, hepatitis, inflammation of the lining of the heart, diarrhea, vomiting and flu.
- "Polio virus, which is significant mainly as an indicator that other viruses may be present; most Americans are innoculated against poliomyelitis.
- "Reo virus, the disease potential of which is obscure, but which is also associated with such flu symptoms as diarrhea and vomiting."

McDermott also pointed out that a single virus particle may infect a person, although out of each 100 to 1,000 persons infected, only one may show disease symptoms. But, an infected person may become ill later, be a carrier, or, in the case of a pregnant woman, imperil the fetus.

There is, as yet, no practical, reliable method for detecting a single virus particle in, say, 20 gallons of water. The Environmental Protection Agency set out 2 years ago to try to develop such a method, on the theory that it viruses were present in drinking water and could be detected, the elimination of virus-induced diseases – possibly including certain forms of cancer – could become a realistic goal.

At the same hearing Dan Okun, Chief of Environmental Sciences at the University of North Carolina, warned that conventional treatment fails to eliminate pesticides that cause cancer and birth deformities in animals, and plastics that may cause genetic damage.

Maintaining Clean Water Sources

All of this news reinforces the conviction that we must use sources of water supply that are as remote as possible from sources of pollution and that are kept just as clean as possible. We should permit the discharge of neither sewage nor industrial wastes to reservoirs or to watercourses tributary to them. This is no time to relax the surveillance of watersheds, but rather a time to work harder than ever to preserve their purity. We should be encouraging zoning which will restrict watershed use and we should hold and maintain control over crucial lands around reservoirs and along the main tributary streams.

Providing Filtration on all Surface Water Supplies

Going beyond watershed control, we need to strengthen our water treatment procedures. Far too many utilities are depending on simple chlorination as the only treatment of reservoir water. Important as chlorination is, it cannot, by itself, assure the purity of drinking water. In order for chlorine to be fully effective against bacteria and viruses it is necessary that the water be clear – free from algae, crustacea, worms, larvae, sediment and suspended impurities that interfere with the disinfection process. The common crustacea such as daphnia or cyclops, for instance, can habor bacteria and viruses within their bodies where they are shielded from chlorine, and will be released into the water perhaps only by decaying in the distribution system or upon the shattering impact of striking a glass being filled for a drink. Of course, the same effect will be had by the customer if he drinks the infected organisms whole, viruses and all.

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Even true color can interfere in a material way with providing safe drinking water to the public. Color indicates the presence of excessive amounts of lignans tannins, and organic matter which exert a chlorine demand and reduces the amount available for disinfection, especially as the water travels into the distribution system. This reduces the all-important chlorine contact time and leads plant operators to raise the chlorine dosage to compensate. The combination of the resultant chlorine compound odors with the remaining color is enough to turn many consumers off, and cause them to seek other sources of drinking water which look and taste better, but which may not be safe.

Filtration plants not only produce clear water, they provide contact time for disinfection in the final clear water tank and in settling tanks prior to filtration where pre-chlorination can be used; and viruses take more chlorine for longer contact to kill than do bacteria. This also gives the added advantage of duplicate points of chlorination so that interruptions due to equipment failure or maintenance are avoided. Tastes and odors can be eliminated by the use of activated carbon when filters are available to subsequently remove the carbon; and the things people object to most in addition to bad taste and odor, that is what they can see, such as fly larvae, worms, sediment and color, do not get thru a modern complete treatment plant.

Every water utility that uses a pond or reservoir for its water source and does not now filter, should be planning on doing so – the sooner the better. When seeking new water sources we should develop ground water and seek cleaner upland surface waters. We should not plan on using waters known to receive sewage or industrial waste effluents.

Protection of Distribution System

Good water can be turned bad by poor management of the distribution system. Degradation of quality can be allayed by treating the water to prevent it from corroding iron and copper pipe. The adjustment of the pH value to between 7.2 and 7.6 with lime or caustic soda together with the addition of sodium hexametaphosphate in the amount of about 2 mg/l will correct most corrosion problems. The treatment is simple and inexpensive and should be used. This, together with coagulation and filtration to remove organic food, will prevent the growth of slimes and iron and manganese bacteria in the distribution system which are the cause of many dirty water complaints.

Incredibly, some water systems still store treated water in open tanks or basins. Such tanks, of course, accumulate bird droppings, drowned rats and cats, and sediments and air pollutants of all sorts. Algae and bacteria proliferate in such tanks and bad water quality is the inevitable result. Any water system still using such storage facilities should most certainly have a program laid out for correcting such a basic failing.

It is well known how dangerous cross connections can be and yet too many water utilities do little, if anything, to prevent them. One of the most important safeguards is to provide adequate and uninterrupted water pressure in all parts of the system. Back-siphonage connections and other types of cross connections become active only when pressure is reduced below normal or when a vacuum is produced. Therefore, it is rudimentary to see to it that pipe sizes are large enough and that storage tanks and booster pumping stations are installed where needed. It is helpful if chlorine residuals can be maintained throughout the system, and a representative bacteriological sampling program is a must. This is the final proof that safe drinking water is being served.

Each water utility should perform at least annually an inspection of piping on premises which may be hazardous. Such premises will include any property known to have a second water source. It will include places known to use toxic substances, such as factories that do plating or laboratories in schools and hospitals that may handle not only dangerous chemical solutions but also bacteria and viral suspensions. Premises that operate high pressure recycled systems with fresh water makeup such as car washes, factories with cooling towers or treated boiler water systems should be on the list. In order to determine the hazardous spots rating regular inspection, a complete survey will be needed; after that only changes and additions will need particular attention. Utility rules should include right of entry for inspection and the right to use the ultimate weapon – shut-off of water in case a hazardous condition is not corrected. This approach will be backed up by the health department. Water works utilities surveys will show the customer how to better protect himself by installing back-flow prevention devices at points in his own piping which will isolate drinking fountains from high hazard plant areas. Water works utilities rules should require a vacuum breaker on a service to an underground sprinkling system and no drinking use beyond that point. These rules could even include an annual charge to the owner of hazardous premises for making the necessary inspection of his interior water piping. When inspections are made regularly, and the customer knows they are to be made, the amount of either purposeful or unintended formation of cross connections and by-passing of protective devices such as air gaps will be cut to a minimum.

Conclusion

That the water works man must watch out for a long list of perils is precisely what his duty is -- to produce safe, palatable drinking water in adequate quantity for all despite the mounting environmental hazards and the growing demands.