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PUBLIC HEALTH SERVICE DRINKING WATER STANDARDS

UNITED STATES PUBLIC HEALTH SERVICE,
Washington, D. C., September 25, 1942.

ADOPTION

The Public Health Service hereby adopts the standards of purity for drinking water recommended by the Advisory Committee on Revision of the 1925 Drinking Water Standards, appointed by the Surgeon General in February 1941.

These Standards are adopted for use in the administration of the Interstate Quarantine Regulations as they relate to the drinking and culinary water supplied by common carriers in interstate commerce. The manual of recommended water sanitation practice is intended to serve as a guide to the reporting agency and not as a part of the official Standards which must be complied with to obtain certification of the water supply.

In the future common carriers will be required to furnish drinking and culinary water for passengers and crews in interstate traffic which will conform to these standards.

(S) THOMAS PARRAN,
Surgeon General, United States Public Health Service.

Approved: Dec. 3, 1942
(S) Watson B. Miller,
Acting Administrator, Federal Security Agency.

PREFACE TO THE 1925 EDITION

The preface of the 1925 Drinking Water Standards is presented below and represents the ideas and report of the Advisory Committee which assisted in the preparation of those Standards. This material is presented as an historical background upon which some of the findings of the present committee have been based.

In recommending the adoption of these standards the Advisory Committee submitted a report discussing the requirements as follows:

REPORT OF THE ADVISORY COMMITTEE ON OFFICIAL WATER STANDARDS [1]

The task referred to this committee by the Surgeon General of the Public Health Service is to formulate definite specifications which may be used by the Public Health Service in the administrative action which it is required to take upon the supplies of drinking water offered by common carriers for the use of passengers carried in interstate traffic. The recommendations submitted apply, therefore, only to this special case, and are not proposed for more general application.

Since the purpose of the supervision which the Public Health Service exercises over these water supplies is to safeguard the health of the public, the examinations and specific requirements herein proposed have reference chiefly to forming a

[1] Pub. Health Rep., 40: 693-721 (April 10, 1925).

judgment of safety, and are designed especially to afford protection against the most serious danger which is associated with water supplies; namely, that of infection with typhoid fever and other diseases of similar origin and transmission. Less emphasis has been placed upon physical and chemical characteristics affecting the acceptability of water with respect to appearance, taste, and odor, because these are matters of less fundamental importance and because, in actual experience, the water supplies which come under consideration, if satisfactory from the standpoint of safety, will usually be found satisfactory with respect to physical and chemical characteristics.

The first step toward the establishment of standards which will insure the safety of water supplies conforming to them is to agree upon some criterion of safety. This is necessary because "safety" in water supplies, as they are actually produced, is relative and quantitative, not absolute. Thus, to state that a water supply is "safe" does not necessarily signify that absolutely no risk is ever incurred in drinking it. What is usually meant, and all that can be asserted from any evidence at hand, is that the danger, if any, is so small that it cannot be discovered by available means of observation. Nevertheless, while it is impossible to demonstrate the absolute safety of a water supply, it is well established that the water supplies of many of our large cities are safe in the sense stated above, since the large populations using them continuously have, in recent years, suffered only a minimal incidence of typhoid fever and other potentially water-borne infections. Whether or not these water supplies have had any part whatsoever in the conveyance of such infections during the period referred to is a question that cannot be answered with full certainty; but the total incidence of the diseases has been so low that even though the water supplies be charged with responsibility for the maximum share which may reasonably be suggested, the risk of infection through them is still very small compared to the ordinary hazards of everyday life.[2]

The committee has, therefore, taken this better class of municipal water supplies as its standard of comparison with respect to safety and proposes, as a fair objective, that the water supplies furnished by common carriers to passengers in interstate traffic be of comparable safety. As regards protection of the traveling public, such a standard is fair, since it implies that the use of the water supplied to them in travel shall not add to the almost negligible risk which is ordinarily incurred at home by those who habitually use water supplies of somewhat better than average quality. From the standpoint of the carriers also, this standard is believed to be fair and reasonable, since it refers to water supplies which are actually obtainable in all sections of the country and from a great variety of sources.

The next and principal task of the committee has been to set up objective requirements which will conform to this general standard of safety; that is, requirements which will ordinarily be fulfilled by the municipal supplies of epidemiologically demonstrated safety which constitute the standard of comparison, but will exclude supplies of less assured safety. Since there is no single and measurable characteristic of water supplies which bears any known and constant relation to actual safety, the standard recommended is composite, including certain requirements relative to the source and protection of the water supplies in question as indicated by a careful sanitary survey, and certain other requirements relative to bacterial content as shown by standard tests.

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[2] This evidence actually proves only that the water supplies in question have been generally "safe" in the past during the period of low prevalence of infection. The likelihood that they will continue to be equally or more safe in the future must, of course, be reckoned from other considerations, such as the probability of future change in the pollution of their watershed, the character and consistency of their protection, etc.

It is anticipated that little objection will be raised to the requirements laid down as to source and protection, at least to their general intent, because they are based upon well recognized principles of sanitary engineering, and because they are necessarily stated in general terms which imply a rather broad consideration of each supply from all angles and the exercise of discretion in forming an ultimate judgment of its fitness. The bacteriological standard, on the other hand, is stated in definite quantitative terms. This is unavoidable if such a standard be included at all, since the methods of bacteriological examinations are quantitative and yield results in the definite terms used in the standard. However, in view of the well-recognized principle that the significance of bacteriological examinations is variable, and must be interpreted with due regard to all other facts known about the particular water supply in question, the objection may be raised that a rigid application of this standard will arbitrarily exclude a considerable number of water supplies which conform to all other requirements and which competent opinion will consider to be quite safe. The validity of this criticism is recognized, but it is not considered of sufficient force to require or justify the lowering of the bacteriological standard proposed. This viewpoint appears proper when it is recognized that the definite terms of bacteriological quality in which this standard is expressed represent only agreement as to safety, and not as to limiting values beyond which demonstrable or even presumptive danger lies. Between the point on which the committee is in agreement as to the assured safety of water supplies and the point at which agreement could be reached as to their dangerous quality is a wide zone. Within the zone lie many water supplies which, if considered in the light of available evidence from all angles, are believed to be as safe as other supplies which conform to all the bacteriological requirements.

The committee, therefore, considers it preferable to recommend that in actual practice the bacteriological standard be applied, as are other requirements, with some latitude; in other words, that supplies which, on rigid inspection, are found to be satisfactory in other respects but fail to meet the bacteriological standard, may be accepted in the discretion of the certifying authority. In view of the character of the personnel entrusted with the responsibility for investigation and administrative action, the committee feels assured that this procedure is preferable to the alternative of rigid and automatic application.

PUBLIC HEALTH SERVICE DRINKING WATER STANDARDS

Standards Adopted by the United States Public Health Service, Federal Security Agency, September 25, 1942, for Drinking and Culinary Water Supplied by Common Carriers in Interstate Commerce

(Superseding standard adopted June 20, 1925)[1]

In recommending the adoption of the revised Standards the Advisory Committee submitted a report discussing the requirements as follows:

REPORT OF THE ADVISORY COMMITTEE ON OFFICIAL WATER STANDARDS

The requirements for drinking (and culinary) water provided by common carriers for the use of passengers carried in interstate traffic, commonly known as the "Treasury Department Drinking Water Standards," were last revised in 1925, and published in the Public Health Reports of April 10 of that year. Since that time many improvements in water supply practice have been adopted with resulting increased uniformity of quality and safety to the consumer. Moreover, the Public Health Service, in recent years, has been requested by the American Public Health Association, the American Water Works Association, and the American Chemical Society to review the 1925 Standards. Accordingly, the Public Health Service has undertaken a revision of the Standards in order to have them conform more closely to current requirements for water supplies of attainable safety and potability.

To carry out such a revision the Surgeon General of the Public Health Service, on February 27, 1941, appointed the undersigned special Advisory Committee composed of representatives of various Federal organizations and scientific associations and including several members at large. A smaller subcommittee of Public Health Service officers was designated to prepare tentative suggestions for the consideration of the Advisory Committee.

After thorough consideration, the advisory committee recommends the adoption of the revisions as set forth in the text herewith submitted. The principal changes now proposed are:

(1) A distinct separation of the text into: (*a*) that portion containing the statement of the Standards, and (*b*) that portion constituting a recommended manual of water works practice representing the judgment of the technical subcommittee composed of officers of the Public Health Service. This portion of the text is intended to serve as a guide to the reporting agency and should not be

[1] Pub. Health Rep., 40: 693–721 (April 10, 1925).

considered as indicating additional requirements to be met for certification of the water supply.

(2) In the bacteriological section the use of 5–10 ml. portions or of 5–100 ml. portions is made optional; a minimum number of samples is to be examined monthly, the number depending upon the population served; the laboratories in which bacteriological examinations are made and the methods used in making them are subject to inspection at any time by the designated representative of the certifying authority.

(3) Concentration limits for lead, fluoride, arsenic, and selenium are included as part of the Standards and their presence in excess of the limits stated shall constitute ground for rejection of the supply. Limits in concentration that should not be exceeded, where other more suitable supplies are available, are given for copper, iron and manganese together, magnesium, zinc, chloride, sulfate, phenolic compounds, total solids, and alkalinity.

(4) The results of recent studies on the potential pollutional hazards existing in the water supply systems of our communities due to faulty plumbing practices, cross-connections, interconnections, etc., as well as the pollutional hazards which are due to faulty water plant and distribution system operational practices, any or all of which may jeopardize the safety of the water in the distribution system, have been adjudged as being of prime importance in the consideration of the requirements of these Standards. The utmost care and consideration have been given to the inclusion of those provisions which would serve to detect possible contamination arising in the distribution system and thus lead to its correction and further safeguarding of the traveling public.

The Committee believes that, in general, water supplies to be eligible for certification should meet all (sanitary, chemical, and bacteriological) requirements of the Standards and that definite failure to meet any one of them should be ground for rejection or provisional certification, according to the judgment of the certifying authority. However, it is realized that the statement of an official standard of drinking water quality, to be generally applicable, must be interpreted reasonably. The Committee has attempted to take into consideration all aspects of the problem. It offers these Standards with the recommendation that the judgment and discretion of the certifying authority be exercised in their application.

MEMBERSHIP OF ADVISORY COMMITTEE ON REVISION OF THE DRINKING WATER STANDARDS[1]

Joseph W. Mountin, *Chairman, Assistant Surgeon General, States Relations Division, U. S. Public Health Service, Washington, D. C.*

J. K. Hoskins, *Secretary, Senior Sanitary Engineer, Chief, Sanitation Section, U. S. Public Health Service, Washington, D. C.*

REPRESENTATIVES OF FEDERAL ORGANIZATIONS

Food and Drug Administration: J. W. Sale, Senior Chemist, Food Division, Federal Security Agency, Washington, D. C.

U. S. Geological Survey: W. D. Collins, Chemist in Charge, Quality of Water Division, Department of the Interior, Washington, D. C.

REPRESENTATIVES OF SCIENTIFIC ASSOCIATIONS

American Chemical Society: A. M. Buswell, Chief, Illinois State Water Survey Division, Urbana, Ill.

American Public Health Association: Abel Wolman, Professor of Sanitary Engineering, Johns Hopkins University, Baltimore, Md.

American Society of Civil Engineers: Arthur E. Gorman, Engineer of Water Purification, Bureau of Engineering, Department of Public Works, Chicago, Ill.

American Water Works Association: Charles R. Cox, Chief, Bureau of Water Supply, State Department of Health, Albany, N. Y.

Association of American Railroads: R. C. Bardwell, Superintendent, Water Supply, Chesapeake and Ohio Railroad, Richmond, Va.

Conference of State Sanitary Engineers: Arthur D. Weston, Director and Chief Engineer, Division of Sanitary Engineering, State Department of Health, Boston, Mass.

Society of American Bacteriologists: A. C. Hunter, Principal Bacteriologist, Food and Drug Administration, Federal Security Agency, Washington, D. C.

MEMBERS AT LARGE

Herman G. Baity, Professor of Sanitary Engineering, University of North Carolina, Chapel Hill, N. C.

R. E. Buchanan, Director, Agricultural Experiment Station, Iowa State College, Ames, Iowa.

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Technical Subcommittee, Officers of the Public Health Service

J. K. Hoskins, Senior Sanitary Engineer, Chief, Sanitation Section, States Relations Division, Washington, D. C. (Secretary).

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H. W. Streeter, Senior Sanitary Engineer, Stream Pollution Investigations, Cincinnati, Ohio.

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C. C. Ruchhoft, Principal Chemist, Stream Pollution Investigations, Cincinnati, Ohio.

Lawrence T. Fairhall, Principal Industrial Toxicologist, National Institute of Health, Bethesda, Md.

[1] Official positions indicated are as of February 27, 1941, when the Committee was organized.

PART I—PUBLIC HEALTH SERVICE STANDARDS

1. DEFINITION OF TERMS

For the purpose of these Standards the terms designated herein below shall be defined as follows:

1.1. *Adequate protection by natural agencies* implies various relative degrees of protection against the effects of pollution in surface waters; dilution, storage, sedimentation, the effects of sunlight and aeration, and the associated physical and biological processes which tend to produce natural purification; and, in the case of ground waters, storage in and percolation through the water bearing material.

1.2. *Artificial treatment* includes the various processes commonly used in water treatment, both separately and in combination, such as storage, aeration, sedimentation, coagulation, rapid or slow sand filtration, chlorination, and other accepted forms of disinfection. Rapid sand filtration treatment is commonly understood to include those auxiliary measures, notably coagulation and sedimentation, which are essential to its proper operation.

1.3. *Adequate protection by artificial treatment* implies that the method and degree of elaboration of treatment are appropriate to the source of supply; that the works are of adequate capacity to support maximum demands, are well located, designed, and constructed, are carefully and skillfully operated and supervised by properly trained and qualified personnel, and are adequately protected against floods and other sources of pollution. The evidence that the protection thus afforded is adequate must be furnished by frequent bacteriological examinations and other appropriate analyses showing that the purified water is of good and reasonably uniform quality, a recognized principle being that irregularity in quality is an indication of potential danger. A minimum specification of good quality would be conformance to the bacteriological and chemical requirements of these Standards, as indicated in sections 3 and 4.

1.4. *Sanitary defect* means any faulty structural condition, whether of location, design or construction of water collection, treatment or distribution works, which may regularly or occasionally cause the water supply to be contaminated from an extraneous source, including dual supplies, by-passes, cross-connections, or interconnections (backflow connections) or fail to be satisfactorily purified.

1.5. *Health hazard* means any faulty operating condition including any device or water treatment practice, which, when introduced into the water supply system, creates or may create a danger to the well-being of the consumer.

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1.6. *Water supply system* includes the works and auxiliaries for collection, treatment, and distribution of the water from the source of supply to the free-flowing outlet of the ultimate consumer.

1.7. *The coliform group of bacteria* is defined, for the purpose of these Standards, as including all organisms considered in the coli-aerogenes group as set forth in the Standard Methods for the Examination of Water and Sewage, eighth edition (1936), prepared, approved, and published jointly by the American Public Health Association and the American Water Works Association, New York City. The procedures [1] for the demonstration of bacteria of this group shall be those specified herein, for:

(*a*) The completed test, or

(*b*) The confirmed test when the liquid confirmatory medium brilliant green bile lactose broth, 2 percent, is used, providing the formation of gas in any amount in this medium during 48 hours of incubation at 37° C. is considered to constitute a positive confirmed test, or

(*c*) The confirmed test when one of the following liquid confirmatory media is used: crystal violet lactose broth, fuchsin lactose broth, or formate ricinoleate broth. For the purpose of this test, all are equivalent, but it is recommended that the laboratory worker base his selection of any one of these confirmatory media upon correlation of the confirmed results thus obtained with a series of completed tests, and that he select for use the liquid confirmatory medium yielding results most nearly agreeing with the results of the completed test. The incubation period for the selected liquid confirmatory medium shall be 48 hours at 37° C. and the formation of gas in any amount during this time shall be considered to constitute a positive confirmed test.

1.8. *The standard portion of water* for the application of the bacteriological test may be either:

(*a*) Ten milliliters (10 ml.) or

(*b*) One hundred milliliters (100 ml.)

1.9. *The standard sample* for the bacteriological test shall consist of five (5) standard portions of either:

(*a*) Ten milliliters (10 ml.) or

(*b*) One hundred milliliters (100 ml.) each.

In any disinfected supply the sample must be freed of any disinfecting agent within twenty (20) minutes of the time of its collection.[2]

1.10. *The certifying authority* is the Surgeon General of the United States Public Health Service or his duly authorized and designated

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[1] This reference shall apply to all details of technique in the bacteriological examination, including the selection and preparation of apparatus and media, the collection and handling of samples, and the intervals and conditions of storage allowable between collection and examination of the water sample.

[2] In freeing samples of chlorine or chloramines, the procedure given on page 286 in the Standard Methods for the Examination of Water and Sewage, eighth edition (1936), paragraph A-1—option 1, or paragraph A-2 shall be followed.

representatives and the *reporting agency* shall be understood to mean the respective State departments of health or their designated representatives.

2. AS TO SOURCE AND PROTECTION

2.1. The water supply shall be:

(*a*) Obtained from a source free from pollution; or

(*b*) Obtained from a source adequately purified by natural agencies; or

(*c*) Adequately protected by artificial treatment.

2.2. The water supply system in all its parts shall be free from sanitary defects and health hazards and shall be maintained at all times in a proper sanitary condition.

3. AS TO BACTERIOLOGICAL QUALITY

3.1. *Sampling.*—The bacteriological examination of water considered under this section shall be of samples collected at representative points throughout the distribution system.

The frequency of sampling and the location of sampling points on the distribution system should be such as to determine properly the bacteriological quality of the water supply. The frequency of sampling and the distribution of sampling points shall be regulated by the certifying authority after investigation of the source, method of treatment, and protection of the water concerned.

The minimum number of samples to be collected from the distribution system and examined by the reporting agency or its designated representative each month should be in accordance with the number as determined from the graph presented in figure 1 of these Standards[3] which is based upon the relationship of population served and minimum number of samples per month:

Population served	*Minimum number of samples per month*
2,500 and under	1
10,000	7
25,000	25
100,000	100
1,000,000	300
2,000,000	390
5,000,000	500

The laboratories in which these examinations are made and the methods used in making them shall be subject to inspection at any

[3] For the purpose of uniformity and simplicity in application, the number of samples to be examined each month for any given population served shall be determined from the graph in accordance with the following:

For populations of 25,000 and under to the nearest 1.
For populations of 25,001 to 100,000 to the nearest 5.
For populations of 100,001 to 2,000,000 to the nearest 10.
For populations of over 2,000,000 to the nearest 25.

time by the designated representative of the certifying authority. Compliance with the specified procedures, or failure to comply therewith, and the results obtained shall be used as a basis for certification,

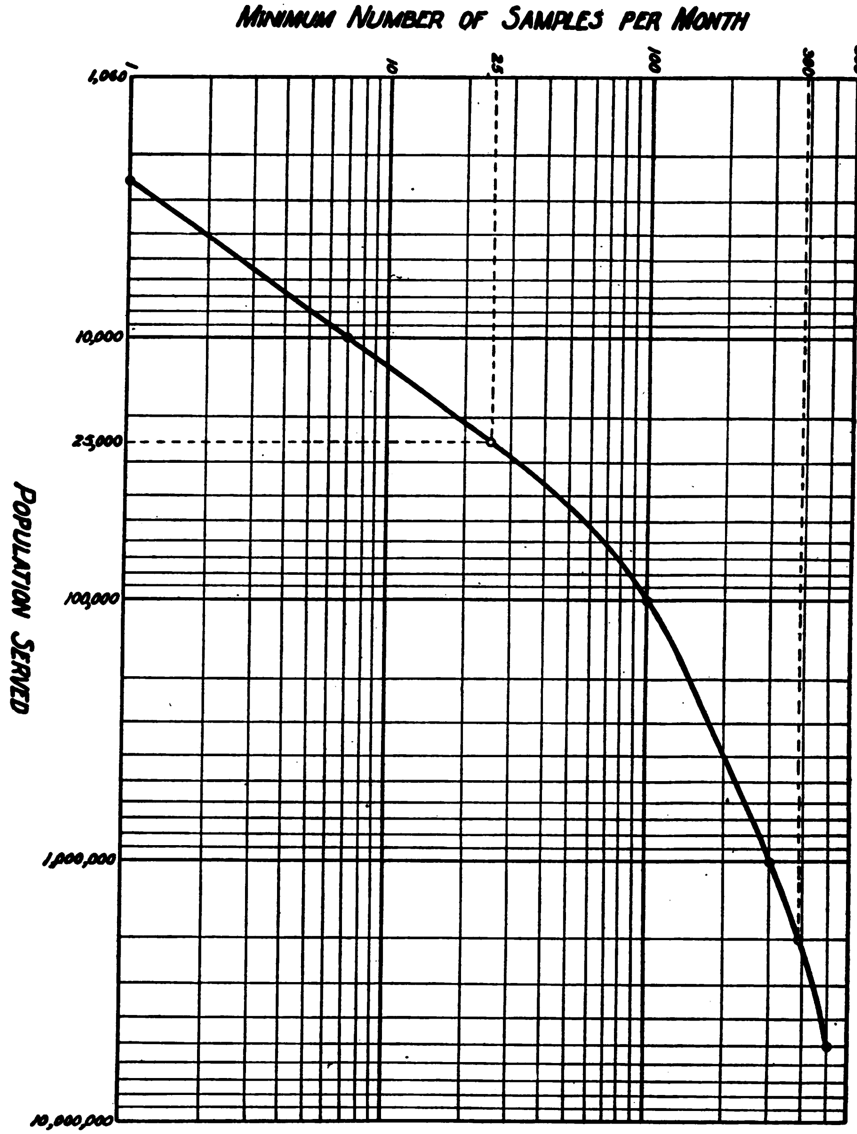

FIGURE 1.—Relation between minimum number of samples to be collected per month and population served.

or refusal of certification, by the certifying authority in accordance with the application given below.

3.2. *Application.*—Applications 3.21 and 3.22 given below shall govern when ten milliliter (10 ml.) portions are used and applications 3.23 and 3.24 shall govern when one hundred milliliter (100 ml.) portions are used.[4]

3.21. Of all the standard ten milliliter (10 ml.) portions examined per month in accordance with the specified procedure, not more than ten (10) percent shall show the presence of organisms of the coliform group.

3.22. Occasionally three (3) or more of the five (5) equal ten milliliter (10 ml.) portions constituting a single standard sample may show the presence of organisms of the coliform group, provided that this shall not be allowable if it occurs in consecutive samples or in more than

(*a*) Five (5) percent of the standard samples when twenty (20) or more samples have been examined per month.

(*b*) One (1) standard sample when less than twenty (20) samples have been examined per month.

Provided further that when three or more of the five equal ten milliliter (10 ml.) portions constituting a single standard sample show the presence of organisms of the coliform group, 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.[5]

3.23. Of all the standard one hundred milliliter (100 ml.) portions examined per month in accordance with the specified procedure, not more than sixty (60) percent shall show the presence of organisms of the coliform group.

3.24. Occasionally all of the five (5) equal one hundred milliliter (100 ml.) portions constituting a single standard sample may show the presence of organisms of the coliform group, provided that this shall not be allowable if it occurs in consecutive samples or in more than

(*a*) Twenty (20) percent of the standard samples when five (5) or more samples have been examined per month.

(*b*) One (1) standard sample when less than five (5) samples have been examined per month.

Provided further that when all five of the standard one hundred milliliter (100 ml.) portions constituting a single standard sample show the presence of organisms of the coliform group, daily samples from the same sampling point shall be collected promptly

[4] It is to be understood that in the examination of any water supply the series of samples for any one month must conform to both of the above requirements, either 3.21 and 3.22 or 3.23 and 3.24, respectively.

[5] When this occurs, and when waters of unknown quality are being examined, simultaneous tests should be made on multiple portions of a geometric series ranging from 10 ml. to 0.1 ml. or less.

and examined until the results obtained from at least two consecutive samples show the water to be of satisfactory quality.[6]

3.25. The procedure given, using a standard sample composed of five standard portions, provides for an estimation of the most probable number of coliform bacteria present in the sample as set forth in the following tabulation:

Number of portions		Most probable number of coliform bacteria per 100 ml.	
Negative	Positive	When 5-10 ml. portions are examined	When 5-100 ml. portions are examined
5	0	Less than 2.2	Less than 0.22
4	1	2.2	.22
3	2	5.1	.51
2	3	9.2	.92
1	4	16.0	1.60
0	5	More than 16.0	More than 1.60

4. AS TO THE PHYSICAL AND CHEMICAL CHARACTERISTICS

4.1. *Physical characteristics.*—The turbidity of the water shall not exceed 10 p.p.m. (silica scale), nor shall the color exceed 20 (standard cobalt scale). The water shall have no objectionable taste or odor.

4.2. *Chemical characteristics.*—The water shall not contain an excessive amount of soluble mineral substance, nor excessive amounts of any chemicals employed in treatment. Under ordinary circumstances, the analytical evidence that the water satisfies the physical and chemical standards given in sections 4.1 and 4.21 and simple evidence that it is acceptable for taste and odor will be sufficient for certification with respect to physical and chemical characteristics.

4.21. The presence of lead (Pb) in excess of 0.1 p. p. m., of fluoride in excess of 1.0 p. p. m., of arsenic in excess of 0.05 p. p. m., of selenium in excess of 0.05 p. p. m., shall constitute ground for rejection of the supply.

These limits are given in parts per million by weight and a reference to the method of analysis recommended for each determination is given in section 4.31. Salts of barium, hexavalent chromium, heavy metal glucosides, or other substances with deleterious physiological effects shall not be allowed in the water supply system.

Ordinarily analysis for these substances need be made only semi-annually. If, however, there is some presumption of unfitness because of these elements periodic determination for the element in question should be made more frequently.

[6] When this occurs, and when waters of unknown quality are being examined, simultaneous tests should be made on multiple portions of a geometric series ranging from 100 ml. to 1.0 ml. or less.

4.22. The following chemical substances which may be present in natural or treated waters should preferably not occur in excess of the following concentrations where other more suitable supplies are available in the judgment of the certifying authority. Recommended methods of analysis are given in section 4.3.

Copper (Cu) should not exceed 3.0 p. p. m.

Iron (Fe) and manganese (Mn) together should not exceed 0.3 p. p. m.

Magnesium (Mg) should not exceed 125 p. p. m.

Zinc (Zn) should not exceed 15 p. p. m.

Chloride (Cl) should not exceed 250 p. p. m.

Sulfate (SO_4) should not exceed 250 p. p. m.

Phenolic compounds should not exceed 0.001 p. p. m. in terms of phenol.

Total solids should not exceed 500 p. p. m. for a water of good chemical quality. However, if such water is not available, a total solids content of 1,000 p. p. m. may be permitted.

For waters softened by the lime soda process the total alkalinity produced should not exceed the hardness by more than 35 p. p. m. (calculated as $CaCO_3$).

For chemically treated waters the phenolphthalein alkalinity (calculated as $CaCO_3$) should not be greater than 15 p. p. m. plus 0.4 times the total alkalinity. This requirement limits the permissible pH to about 10.6 at 25° C.

For chemically treated waters the normal carbonate alkalinity should not exceed 120 p. p. m. Since the normal alkalinity is a function of the hydrogen ion concentration and the total alkalinity, this requirement may be met by keeping the total alkalinity within the limits suggested when the pH of the water is within the range given. These values apply to water at 25° C.

pH range:	*Limit for total alkalinity (p.p.m. as $CaCO_3$)*
8.0 to 9.6	400
9.7	340
9.8	300
9.9	260
10.0	230
10.1	210
10.2	190
10.3	180
10.4	170
10.5 to 10.6	160

4.3. Recommended methods of analysis:

4.31. Ions with required limits of concentration.

Arsenic (As): Official and Tentative Methods of Analysis. Association of Official Agricultural Chemists, 1940, p. 390; also "Colorimetric Microdetermination of Arsenic," Morris

B. Jacobs and Jack Nagler. Industrial and Engineering Chemistry, Anal. Ed., **14**: 442 (1942).

Fluoride (F): Standard Methods for the Examination of Water and Sewage. American Public Health Association, 1936, p. 36; also Methods of Determining Fluorides, Committee Report, A. P. Black, Chairman. Journal American Water Works Association, **33**:1965–2017 (1941).

Lead (Pb): Standard Methods for the Examination of Water and Sewage. American Public Health Association, 1936, p. 26.

Selenium (Se): Official and Tentative Methods of Analysis. Association of Official Agricultural Chemists, 1940, pp. 11 and 417; also Robinson, W. O., Dudley, H. C., Williams, K. T., and Byers, Horace G.: The Determination of Selenium and Arsenic by Distillation. Industrial and Engineering Chemistry, Anal. Ed., 6:274 (1934).

4.32. Ions and substances with suggested limits of concentration.

Copper (Cu): Standard Methods for the Examination of Water and Sewage. American Public Health Association, 1936, p. 25.

Iron (Fe) and manganese (Mn): Ibid, p. 74 and p. 82.[7]

Magnesium (Mg): Ibid, p. 79.[7]

Zinc (Zn): Ibid, p. 28.[7]

Chloride (Cl): Ibid, p. 34.[7]

Sulfate (SO_4): Ibid, p. 85.[7]

Phenolic compounds: Ibid, p. 245.[7]

With dibromquinonechlorimide as an indicator.

Total solids: Ibid, p. 56.[7]

Alkalinity: Ibid, pp. 59 and 64.[7]

[7] For the chemical determinations referred to in this report, when given, the methods of analysis recommended by the Association of Official Agricultural Chemists are satisfactory and may be substituted for those recommended by the American Public Health Association, which are specifically cited.

MANUAL OF RECOMMENDED WATER SANITATION PRACTICE

(PREPARED BY TECHNICAL SUBCOMMITTEE)

This manual is not to be considered as part of the Standards which must be met in order to obtain certification of the water supply, but is intended to serve as a guide to the reporting agency.

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MANUAL OF RECOMMENDED WATER SANITATION PRACTICE ACCOMPANYING UNITED STATES PUBLIC HEALTH SERVICE DRINKING WATER STANDARDS, 1942

INTRODUCTION

In its report accompanying the 1942 Drinking Water Standards the Advisory Committee recommended, as the principal change to be incorporated in the revision, a separation of the text into (*a*) that portion containing the statement of the Standards, and (*b*) that portion which constitutes a recommended manual of water works practice, representing the judgment of the technical subcommittee, composed of officers of the Public Health Service, and which is to serve as a guide to the reporting agency. The Advisory Committee further stated, "This latter portion of the text is not to be considered as part of the Standards which must be met in order to obtain certification of the water supply."

In undertaking the preparation of a manual such as envisioned by the Advisory Committee, the technical subcommittee has recognized that no comprehensive treatise on water supply practice is needed in this connection, in view of the several excellent texts which have been published on this subject, including a recent manual (*1*) issued by the American Water Works Association. It considers its task, in fact, to be limited to a comparatively brief and general description of those features of water supply systems and their operation which may be said to conform to accepted principles of good sanitation. It is very largely with these features that the reporting agency is concerned in forming a judgment as to whether or not a particular water supply may meet reasonably acceptable sanitary requirements in respect to its source and protection, as prescribed in section 2 of the Standards. As a further aid to the reporting agency, a section designated as part IV, containing an explanatory discussion of the bacteriological and chemical requirements of the Standards, has been added to this manual. This section is virtually an appendix, as it deals with a subject quite distinct from that of the other sections of the manual.

The main text of the manual, other than part IV, is divided into three sections, parts I, II, and III. In part I are given in outline form those features of water supply systems which may be included in the sanitary survey, including a list of major sanitary defects and health hazards which would be detrimental to the safety of a water supply. In parts II and III are two sections dealing, respectively, with recommended sanitary requirements for water treatment and for water distribution systems. These two parts of the manual are in the form of a connected discussion, amplifying the outlino material given in part I.

In preparing the manual, full advantage has been taken of criticisms of the preliminary text by various members of the Advisory Committee. Although it obviously would be impossible to reconcile fully the conflicting views of any group as large as this committee, an effort has been made to follow, so far as practicable, the concensus of opinion among a majority of the committee. The writers of the manual take this opportunity to acknowledge gratefully the many helpful comments which have been furnished by members of the Advisory Committee on the material herein presented.

In preparing the present manual, cognizance has been taken of the need which exists for affording somewhat greater sanitary protection to certain features of public water supply systems and their operation under the existing wartime conditions than might be considered as essential under those of peace. In general, however, an effort has been made to write the manual from the viewpoint of normal requirements for water sanitation as they would be considered by the reporting agency in connection with the application of the Drinking Water Standards.

Part I

PHYSICAL FEATURES OF WATER SUPPLY SYSTEMS AND THEIR SANITARY PROTECTION

The physical features of water supply systems may be said to include all of those parts which come within the definition given in paragraph 1.6 of the Standards. According to this definition, "a water supply system includes the works and auxiliaries for collection, treatment, and distribution of the water from the source of supply to the free-flowing outlet of the ultimate consumer." Strictly interpreted, sanitary protection would be concerned with all of those parts of a water system which come within this definition, though for practical purposes the attention may be concentrated mainly on those parts which have to do with sources, treatment, and distribution of the water.

A. SCOPE OF REQUISITE INFORMATION AS TO SOURCE AND PROTECTION

In order that the administrative authorities may have the necessary information upon which to base their action, it is required that each water supply coming under consideration should be carefully studied with reference to its source and protection. The precise scope of such a study and of the report thereon will vary according to the circumstances existing in each individual case and cannot be fully specified in any general terms. The general procedure, however, should be substantially as follows:

1. *A sanitary survey of the water supply should be made by a competent person.* The reliability of the data collected will depend largely upon the competence of the person by whom the survey is made, and the careful selection of personnel for this duty is of primary importance. The qualifications which constitute "competence" cannot be precisely defined, but, in general, the person making the survey should have received a technical education in the basic sanitary sciences equivalent to that given in a course in sanitary engineering in a recognized college of engineering or school of public health; he should have a broad knowledge of the sanitary features and physical facts concerning water supplies for potable use, and he should understand the essential features of water purification plants, their operation and methods of testing.

2. *A brief general description of the water supply should be submitted.* This should include the name of the owner of the supply and a brief description of sources and catchment areas, of the storage available both prior to and following any treatment, and of the plant, with date of installation of main works, and record of subsequent extensions or alterations.

3. *A brief summary of the pertinent facts relating to the sanitary condition of the water supply, as revealed by the field survey, should be submitted.* The following outline will serve to indicate the general scope of the survey. Not all of the items, however, would be pertinent to any one supply, and in some cases items not in the list would be important. Reference should be made to parts II and III of this manual for certain detailed recommendations bearing on various parts of this outline.

(A) SMALL GROUND WATER SUPPLIES

1. Nature of soil and underlying porous strata, whether of clay, sand, or gravel; thickness of water-bearing strata; depth to water table.
2. Nature of rock penetrated, noting especially existence of porous limestone.
3. Depth to strainers; length of strainer; depth of casing; well construction—material—diameter.
4. Slope of water table, preferably as determined from observational wells, or as indicated presumptively but not certainly by slope of ground surface.
5. Nature, distance, and direction of sources of pollution.
6. Possibility of surface drainage water entering the supply, and of wells being flooded by nearby streams.
7. Methods of protection.

8. Pump house construction (floors, drains, etc.); capacity of pumps; draw-down when pumps are in operation.

9. Disinfection: equipment; supervision; laboratory control.

(B) LARGE GROUND WATER SUPPLIES

1. General character of local geology.

2. Extent of drainage area likely to contribute water to the supply.

3. Size and topography of catchment area; slope of ground surface.

4. Nature and porosity of soil and underlying strata, whether clay, sand, gravel, rock (especially limestone); coarseness of sand or gravel; thickness of water-bearing strata.

5. Depth to strainers; length of strainer; depth of casing.

6. Population on the drainage area.

7. Nature, distance, and direction of local sources of pollution.

8. Pump house construction (floors, drains, etc.); capacity of pumps; draw-down when pumps are in operation.

9. Possibility of surface drainage water entering the supply; methods of protection.

10. Methods used for protecting the supply against pollution, by means of sewage treatment, waste disposal, and the like.

11. Protection of collecting well at top and on sides; protection other than check valve or gate against backflow of drain, etc.

12. Availability of an impure emergency supply.

13. Use of tile pipes or other conduits not tight where ground water may be contaminated.

14. Disinfection: equipment; supervision; laboratory control.

Examples of sanitary defects in ground water supplies are:

(1) Caves, sink holes, or abandoned borings used for surface drainage or sewage disposal in vicinity of the source; fissures or open faults in strata overlying water-bearing formations.

(2) Casing of tubular wells leaky, or not extended to sufficient depth, or not extended above ground or floor of pump room, or not closed at top; or casing improperly used as a suction pipe.

(3) Collecting well or reservoir subject to backflow of polluted water through improper drain.

(4) Source of supply or structures subject to flooding.

(5) Leak in systems under vacuum.

(6) Air lift line or lines cross-connected to a sewer or secondary water supply.

(C) SURFACE WATER SUPPLIES, UNFILTERED

1. Nature of surface geology; character of soil and rocks.

2. Character of vegetation, forests, cultivated land, etc.

3. Population and sewered population per square mile of catchment area.

4. Methods of sewage disposal, whether by diversion from watershed or by treatment.

5. Character and efficiency of sewage treatment works on watershed.

6. Proximity of sources of fecal pollution to intake of water supply.

7. Proximity, sources, and character of industrial wastes.

8. Adequacy of supply as to quantity.

9. For lake or reservoir supplies: wind direction and velocity data; drift of pollution; sunshine data (algae).

10. Character and quality of raw water—algae, turbidity, color, coliform (M. P. N.), (average, minimum and maximum).

11. Nominal period of detention in reservoir or storage basin.

12. Probable minimum time required for water to flow from sources of pollution to reservoir and through reservoir to intake.

13. Shape of reservoir, with reference to possible currents of water, induced by wind, from inlet to water supply intake.

14. Measures taken to prevent fishing, boating, landing of airplanes, swimming, wading, ice cutting, permitting animals in or upon the water, etc.

15. Efficiency and constancy of policing.

16. Disinfection of water: Kind and adequacy of equipment, duplication of parts; effectiveness of treatment, adequacy of supervision and laboratory control; contact period after disinfection; whether residual free chlorine or chloramines in chlorinated water; residuals carried.

Examples of sanitary defects are:

(1) Absence or inadequacy of chlorination, or lack of proper control of chlorination; insufficient contact period with chloramines present in treated water.

(2) Insufficient restrictions on recreational use of streams and reservoirs, together with their marginal lands, in the local catchment area.

(3) Existence of sources of pollution, such as population on watershed, lumbering, hunting, and other activities; leaching cesspools, or sewers draining into streams or lakes of the catchment area, or into the marginal lands adjacent to them.

(4) Improper location of intake with respect to bottom of reservoir and current, or to surface drainage water inlets.

(5) Intake exposed and accessible to trespassers.

(6) For lake supplies: Vessels passing near intakes; drift of ice fields; dumping of dredging, garbage, etc., into lake near intakes; inadequate toilet facilities on cribs; nonexamination of employees as carriers of water-borne diseases.

(D) SURFACE WATER SUPPLIES, FILTERED

1. Catchment area: Size, topography; population density (sewered and unsewered); surface geology; reservoirs (capacity and location).

2. Sources of pollution: Nature; distance from intake (miles and time of travel); amounts and distances of sewered population.

3. Sewage treatment on watershed: Extent; methods; populations served; effectiveness and uniformity of results.

4. Raw water characteristics: Turbidity, color, alkalinity, hardness, iron, etc.; bacterial quality (average and ranges); variations in quality, especially after heavy rainfall or at times of high run-off.

5. Rated capacity of filter plant (mgd.): Output (average and maximum daily); maximum capacity of pumps.

6. Coagulant system: Type (solution or dry feeding); chemicals used; dosage rates (average, maximum, and minimum); number and capacity of units; reserve units.

7. Mixing and flocculation basins: Type; flash mixing (average and minimum times); flocculation (average and minimum times); number, size, and arrangement of units; provisions for cleaning.

8. Sedimentation basins (number, size, and retention capacity): Plain sedimentation; post-coagulation sedimentation; methods of cleaning; flexibility of operation; efficiency of turbidity and bacterial removal.

9. Filters: Type (pressure or gravity); number; sizes and rated capacities (net filtering area); effective size and uniformity coefficient of sand; washing system (direct or from storage, rates of wash water application); loss-of-head gages; rate controllers (average and maximum rates of filtration).

10. Filtered water storage: Capacity; location; arrangement; covered or uncovered; protection against contamination; methods of cleaning; added storage in distribution system.

11. Aeration: Kind, purpose, capacity, location in purification system; efficiency.

12. Disinfection: Kind, stages (if more than one); location in purification system; capacity; method of operation; operation control; average, maximum and minimum dosage; chlorine—ammonia ratios (if ammonia used); simple or "break-point" chlorination (if used); efficiency of each stage.

13. Plant operation and control: Technical supervision (trained or untrained, full-time or part-time); number of operators; laboratory control (kind and frequency of tests); plant and laboratory records (kind, extent, use, etc.); meteorological records.

Examples of sanitary defects are:

(1) Excessive raw water pollution in relation to extent of treatment

provided (see part II, A, (1)); existence of nearby uncontrolled sources of raw water pollution.

(2) By-pass connections for raw water or partially treated water, whereby insufficiently purified water may be discharged into the distribution system.

(3) Existence of cross-connections within the plant, between conduits or basins carrying untreated or partly treated water and those containing completely treated water.

(4) Deficient output capacity of treatment works, necessitating excessive overloading or occasional by-passing of units.

(5) Lack of competent supervision and operation, or of adequate laboratory control.

(6) Deficient or inaccurate operation or laboratory records.

(7) Lack of suitable devices for measuring and recording volumes of water treated; for maintaining continuity of coagulant and chlorine dosage; deficient retention periods in settling basins; or inadequate areas, depths, sizes of sand or washing facilities for filters.

(8) Lack or deficiency in proper chlorination equipment and control, or failure to maintain proper chlorine residuals in the treated effluent at all times.

(9) Lack of suitable protection for purified water; storage capacity less than requirements for safety.

(E) PUMPING STATION AND COLLECTING SYSTEM

1. Number, type, and capacity of pumps, including reserve; condition of equipment and method of operation; condition of suction pipes.
2. Emergency intakes.
3. Emergency supply of power; record of power shut-down; effect of shut-down on surges through conduits, etc.
4. Recording apparatus on suction well elevation; rise and fall of suction well elevation.
5. Screens for fish and debris.
6. All sewers cast iron, or otherwise.
7. Curb walls around wells to protect against surface drainage.
8. Continuous or intermittent operation.

Examples of sanitary defects are:

(1) Leaky suction pipes.

(2) Pump not self-priming; unsafe water used for priming.

(3) Suction well or suction pipes unprotected from surface or subsurface pollution.

(4) Suction well subject to pollution through backflow of polluted water through drain.

(5) Improper location or inadequate protection with reference to flood waters.

(6) Lack of suitable provision for insuring continuity of pumping service under all possible conditions.

(F) DISTRIBUTION SYSTEM

1. Area and population supplied (proportion to total within corporate limits).
2. Type of distribution system; whether by gravity, direct pumping, indirect pumping, etc.
3. Use, location, and capacity of reservoirs and standpipes.
4. Adequacy of distribution system with respect to area served, sizes of mains and laterals, circulation of water, storage provided, etc.

Examples of sanitary defects are:

(1) Existence of cross-connections between primary supply and secondary supply of questionable safety at any point in the distribution system.

(2) Return to the system of any water used for cooling; hydraulic operations, etc.

(3) Absence, or inadequate protection, or improper location of distribution reservoirs, standpipes, or elevated pressure tanks.

(4) Intermittent service, resulting in reduced or negative pressures in distribution system; sizes of mains and laterals inadequate for preventing negative pressures; presence of dead ends permitting reduced or negative pressures.

(5) Connections to sprinkler systems using toxic solutions as antifreeze.

(6) Repumping on consumer premises when pressure is low (causing negative head).

(7) Connection to sewers and sewer-flushing chambers, and improperly located blow-offs in distribution system.

(8) Lack of check valves on consumer services to prevent backflow (especially from high building storage tanks), or from ammonia systems at ice plants, or from hot water systems.

(9) Existence of hydrant wash lines connected to sewer.

(10) Presence of a secondary water system on premises where public system exists.

(11) Lack of suitable plumbing ordinances prohibiting the use of backflowing toilet or sink fixtures, or permitting the use of storage tanks connected directly to sanitary fixtures without proper vacuum breaker inlets, or permitting unsafe cross-connections between potable and nonpotable water supplies in private premises.

(12) New connections of pipe line joined to the system without prior disinfection of pipes.

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(13) Existence of tile or other leaky pipes in distribution system.

(14) Improper location of water pipes in relation to sewers and storm water drains.

Part II

RECOMMENDED SANITARY REQUIREMENTS FOR WATER TREATMENT SYSTEMS

A. GENERAL REQUIREMENTS

(1) EXTENT OF TREATMENT

(*a*) For purposes of classification with respect to treatment requirements, waters acceptable for treatment may be divided into the following groups:

GROUP 1. *Waters requiring no treatment.*—This group would be limited to underground waters subject to no possibility of contamination and meeting in all respects the requirements of these Standards, as shown by regular and frequent sanitary inspections and laboratory tests.

GROUP 2. *Waters requiring simple chlorination, or its equivalent.*—This group would include both underground and surface waters, subject to a low degree of contamination and meeting the requirements of these Standards in all respects except as to coliform bacterial content, which should average not more than 50 per 100 ml. in any month.

GROUP 3. *Waters requiring complete rapid-sand filtration treatment, or its equivalent, together with continuous postchlorination.*—This group would include all waters requiring filtration treatment for turbidity and color removal, waters of high or variable chlorine demand, and waters polluted by sewage to an extent such as to be inadmissible to groups 1 and 2, but containing numbers of coliform bacteria averaging not more than 5,000 per 100 ml. in any month and exceeding this number in not more than twenty (20) percent of the samples examined in any month.

GROUP 4. *Waters requiring auxiliary treatment in addition to complete filtration treatment and postchlorination.*—This group would include waters meeting the requirements of group 3 with respect to limiting monthly average coliform numbers, but showing numbers exceeding 5,000 per 100 ml. in more than twenty (20) percent of the samples examined during any month and not exceeding 20,000 per 100 ml. in more than five (5) percent of the samples examined during any month.

Note.—By "auxiliary treatment" is meant presedimentation or prechlorination, or their equivalents, either separately or combined, as may be necessary. Long-time storage, for periods of 30 days or more, represents a permanent and reliable safeguard which in many cases would provide something more than an effective substitute for one or both of the two other methods indicated.

Remarks.—(*a*) Although group 1 conceivably might include exceptional surface waters free of any possible contamination and further protected by storage, it hardly can be considered as a safe general rule to admit any surface water to a public supply without chlorination as a minimum safeguarding treatment, in view of the present increased hazards of chance contamination resulting from the extension of recreational and migratory travel to many hitherto inaccessible places. Under wartime conditions, additional need would exist for extreme precaution in this respect.

(*b*) The limiting monthly average coliform numbers stated for waters of groups 2 and 3 are intended as guides rather than inflexible rules, though they are based on extensive observational data (*2*) fairly representing present water treatment practice in this country. Certain recent improvements in water chlorination and its control offer promise of increasing the margin of safety of water purification efficiency, with respect to bacterial removal. These improvements have not, however, become fully incorporated into general practice throughout the country, nor does it appear desirable that they should be regarded as warranting any relaxation in the requirements for raw water quality which experience and present standards of safety would indicate as being necessary for providing adequate protection to sources of water supply in general.

(*c*) For waters of group 4, which differ from those of group 3 only in respect to variability, auxiliary treatment is intended mainly as a factor of safety in controlling variations in coliform numbers within the range of 5,000 to 20,000 per 100 ml. The larger of these two figures represents the maximum safe limit for prechlorination, or its equivalent, in addition to filtration treatment and postchlorination.

(*d*) Waters failing to meet the requirements of groups 1, 2, 3, or 4 would be considered as unsuitable for use as a source of water supply, unless they could be brought into conformance with these requirements by means of prolonged preliminary storage, or some other measure of equal permanence and reliability.

(2) OTHER RAW WATER REQUIREMENTS

In addition to meeting the aforesaid bacterial requirements, waters acceptable for treatment should not contain any toxic or otherwise harmful substances, or organisms not readily and completely removable by ordinary water treatment. Raw waters should be free of excessive amounts of acid, microscopic organisms, or organic matters causing any interference with the normal operation and efficiency of water treatment processes.

B. DESIGN AND CONSTRUCTION

In general, the design and construction of individual water treatment plants will vary with local circumstances and should be in accordance with the results of experiments on the water to be treated. The following recommendations, therefore, are intended only as a general guide to good practice and are to be interpreted somewhat broadly in the light of the particular raw water characteristics and other conditions which may be involved in a given situation.

(1) PLANT DELIVERY CAPACITY

The delivery capacity of a treatment plant, including filtered water storage at the plant, should always be in excess of the maximum expected draft on any day of the year. The excess of provided capacity over average daily draft may vary from 50 to 100 percent and normally should be at least 50 percent.

(2) PLANT LOCATION

The treatment plant, including raw water and effluent pumps, should be located at an elevation sufficiently high above surrounding bodies of water and have sufficient auxiliary power to insure continuance of operation under all circumstances, including floods. If located in a valley, the site should be adequately drained so that no surface water can gain access to wells, basins, filter tanks or other units. The plant should be located so that no conduit, basin, or other structure containing or conducting water in the process of treatment can possibly be affected by leakage from any sewer, drain, or other source of contamination.

(3) PRESETTLING RESERVOIRS

Presettling reservoirs should be located above the influence of flood waters. They should be at least two in number, so as to permit continuous operation under all circumstances, and should be of sufficient capacity to afford a nominal retention period of at least 1 day and preferably 2 or 3 days. Provision should be made for rapid and convenient removal of sludge from the reservoirs. In the treatment of highly polluted waters of variable quality, provision should be made for coagulation at the inlet and for prechlorination at the inlet or the outlet of the reservoirs, whenever such measures may be necessary. Reservoirs should be provided with boats and life preservers for the protection of employees.

(4) COAGULATION-SEDIMENTATION BASINS

In order to insure continuous operation, basins for flocculation and sedimentation of coagulated waters should be at least two in number, should be designed for series or parallel operation, and preferably should provide a total retention period of at least 5 or 6 hours, except where the use of preliminary mixing and flocculating devices and continuous sludge removal permit somewhat lower periods with unimpaired efficiency. Inlets and outlets of ordinary straight-flow basins should be at opposite ends of the basins and, if necessary, should be provided with baffles so located as to prevent short circuiting. Similar baffles may be advantageously installed in the settling compartment. The maximum velocity of flow in the settling compartment should not exceed that which usually is provided in well-designed basins of this type. The length of settling compartments in such basins, if rectangular, should be preferably at least twice the width. Stilling compartments should be provided at basin inlets. If stream use will permit, sludge drains may discharge at points located well downstream from the intake, or intakes, at points removed from the influence of cross-currents passing the intake. Otherwise, suitable sludge disposal areas should be provided. The depth of basins should be such as to maintain proper velocity of flow and sludge removal, the permissible depth being slightly lower with continuous sludge removal. Flow line elevations should not vary more than a few inches above or below the normal level.

Flash mixing and flocculation tanks.—Preliminary flash mixing and flocculating equipment, capable of adequate flexibility of adjustment to provide optimum flocculation under varying raw water conditions, is a highly desirable feature of well-designed modern filtration plants and should be credited as a distinct addition to the sanitary protection afforded by a purification system. An ideal combination of flash mixing and flocculation would provide about 1 to 2 minutes of violent agitation followed by about 20 to 30 minutes of slow mixing to promote flocculation.

(5) COAGULANT SYSTEM

Rapid-sand filtration plants should be provided with efficient modern devices for measuring and adding coagulants to the water under treatment. All chemical dosing equipment, whether of the dry-feed or solution-feed type, should have at least one unit in reserve throughout and should be provided with effective recording and alarm devices to insure continuity of service at all times. An accurate flow meter should be provided for the water treated and also for dry-feed equipment, suitable gravimetric devices for measuring the amount of chemicals added from hour to hour. All chemical feed equipment should be capable of ready adjustment to variations in the flow of water being treated.

(6) FILTERS

Slow-sand.—Slow-sand filters, if properly designed and operated, are applicable to the treatment of certain types of relatively clear waters. They preferably should be covered, should be provided with loss-of-head gages, should have a sand depth of 36 to 40 inches, and should never be operated with less than 20 inches of depth. The sand should have an effective size of 0.25 to 0.35 mm. and should be operated at rates of about 2.5 million gallons per acre daily. In operating slow-sand filters, care should be taken to avoid any sudden increases in the rate of filtration.

Rapid-sand.—Rapid-sand filters should be preferably of the gravity type, in order to permit ready and continuous inspection. The depth, effective size, and uniformity of sand should be in accordance with the requirements of adequate yield and filter efficiency. Ordinarily, sand depths of about 30 inches are customary, with effective sand size ranging from 0.40 to 0.50 mm. and uniformity coefficient from 1.5 to 2.0. The rate of filtration should conform to established practice, preferably not exceeding 3 gallons per minute per square foot of filtering area.

In general, rapid-sand filters should be designed and operated with a view to maintaining reasonably high efficiency of bacterial removal, and the filtering medium should be in good condition, free of mud balls, cracks, and other hindrances to efficient filtration. Efficient loss-of-head gages, rate controllers, and other essential control devices should be provided.

(7) FILTERED WATER STORAGE RESERVOIRS

Filtered water reservoirs at the plant preferably should be covered and located near to, but physically separated from, the plant. Where located below filters, adequate protection against leakage of drainage water from other parts of the plant into the reservoirs should be provided. Trap doors and inspection openings should be properly sealed and locked. Suitable vents, protected against outside contamination, should be provided. All effluent pipes should be properly sealed against leakage and tested by frequent inspections. Filtered water reservoirs should be thoroughly tight against external leakage, should be situated above the ground water table, and preferably should have no walls in common with any other plant units containing water in the process of treatment.

(8) INTERCONNECTIONS, CROSS-CONNECTIONS, OPEN CONNECTIONS, AND PARTITION WALLS

(*a*) No cross-connection or interconnection should be permitted to exist in a filtration plant between any conduit carrying filtered or postchlorinated water and another conduit carrying raw water or water in any prior stage of treatment.

(*b*) No conduit or basin containing finished water should be permitted to have a common division wall with another conduit or basin containing raw water or water in any prior stage of treatment.

(*c*) Rewash or filter-to-waste conduits should not be directly connected to any drainage conduit, but should be protected by a suitable one-way gap-delivery connection, so that no back-siphonage can occur under any condition.

(*d*) No conduit carrying raw water or any water in a prior stage of treatment should be located directly above another conduit carrying finished water, with a single common partition between them. This rule is not strictly applicable, however, to cast-iron pipes with tight joints carried in the open and readily accessible for inspection and repair.

(9) DRAINS

All drainage conduits should be constructed so as to be thoroughly tight against external leakage. They should discharge at points in a river or lake so located that no currents of water can under any circumstances be carried from a drain outlet to the plant intake, or to any other water intake located in the vicinity of the plant. No domestic or other sewer should be permitted to be discharged into the river or lake in the vicinity of a treatment plant intake, or directly above such intake, nor should any drain carrying contaminated surface water be permitted to be discharged likewise.

(10) CHLORINATION

(*a*) *General.*

Chlorination equipment should be selected, installed, and operated so that continuous and effective disinfection is secured under the required local conditions.

(*b*) *Chlorination equipment.*

1. Chlorination equipment should have a maximum capacity at least 50 percent greater than the highest expected dosage to be applied at any time. It should be capable of satisfactory operation under every prevailing hydraulic condition at the plant.

2. Automatic proportioning of the chlorine dosage to the rate of flow of the water treated should be provided at the larger plants and at all plants where the rate of flow varies more than 50 percent above or below the average flow. Manual control should be permissible only where the rate of flow is relatively constant and an attendant is always at hand to effect promptly the necessary adjustments in dosage.

3. All clorination equipment should be installed in duplicate, so as to provide stand-by units for insuring uninterrupted operation.

Duplicate units should be operated frequently to insure workability. A complete stock of spare parts and tools should be maintained for emergency replacements or repairs.

4. A reliable and uninterrupted supply of water, free of coarse suspended matter, should be available under adequate pressure to insure the continuous operation of solution-feed chlorinators. Hydraulically or electrically driven pumping equipment, if used for maintaining such pressure, should be provided with alternative sources of power where necessary to insure continuous operation.

5. Scales, preferably of the indicating and recording type, should be provided for weighing the cylinders of chlorine and checking the losses in weight of chlorine as fed from the cylinders during successive intervals of time. These scales should be sufficiently accurate and sensitive to measure such losses with suitable precision.

6. A sufficient number of cylinders of chlorine should be connected to the chlorinator in use so that adequate operating pressures will be maintained at various temperatures.

(*c*) *Hypochlorite solutions.*

1. Solutions of calcium or sodium hypochlorite should be prepared in a separate mixing tank, then diluted and allowed to settle, so that only a clear supernatant liquid is withdrawn to the solution storage tank and to the chlorinator.

2. The strength of stored calcium hypochlorite solutions should be checked frequently by laboratory test in order to ascertain that no loss of strength has occurred. Calcium hypochlorite solutions should be prepared freshly every 4 or 5 days, unless properly alkalinized with sodium carbonate.

(*d*) *Safety requirements.*

1. Suitable gas masks and a small bottle of ammonia for testing for leaks should be kept at convenient points immediately outside the room or enclosures in which chlorine is being stored or is in use. Gas masks should be inspected at regular intervals and kept in serviceable condition.

2. Chlorinating equipment and cylinders of chlorine should be housed preferably in separate buildings above the ground level, as a measure of safety.

3. The room or building housing chlorinators in service should be maintained at a temperature of above 60° F., but never in excess of the normal summer temperature. The cylinders of chlorine should be shielded, where necessary, from excessive heat or cold. Direct heat should not be applied to cylinders of chlorine, nor should hot water be poured over them or come in contact with the cylinder valve.

4. Adequate ventilation should be provided for all enclosures in which chlorine is being fed or stored.

5. All joints of tubing connecting chlorine cylinders and chlorinators should be kept absolutely tight and inspected frequently to insure tightness. Tubing should slope upward from the cylinders.

(*e*) *Control of chlorination.*

1. Chlorine should be applied continuously to the filtered effluent at a point where thorough and rapid mixing with the treated water will be effected. Free active chlorine should be in contact with the treated water for not less than 20 minutes, or chloramine preferably for at least 3 hours, before the treated water reaches the first consumer.

2. The proper dosage of chlorine will be determined by regular and frequent routine bacteriological and residual chlorine tests, both at the plant and at various points in the distribution system. In general, a safe desirable minimum of residual free chlorine at distant points in the distribution system would be 0.05 or 0.10 p. p. m., depending on circumstances. For chloramines, the desirable residual would be somewhat higher. The residual carried in the finished water as delivered from the treatment plant should be regulated accordingly. At times of threatened or prevalent outbreaks of water-borne disease, the residual chlorine should be increased preferably to a minimum of 0.2 or 0.3 p. p. m. in all parts of the distribution system, if possible, regardless of tastes or odors in the delivered water. Similar measures should be taken in the event of any lapse in the normal efficiency of the treatment plant.

3. Routine sampling points should be maintained at the treatment plant and at several vital points in the water distribution system. Sample collections should be made regularly at the latter points and the samples tested bacteriologically and for residual chlorine. Chlorine demand tests should be made occasionally on samples collected in the distribution system for comparison with the results of similar tests at the treatment plant. Any abnormal increase in the chlorine demand, or decrease in the residual chlorine at any point in the distribution system, should be checked and, if consistently observed, followed up by a thorough physical investigation of that portion of the system.

4. The tests for residual chlorine should be made in accordance with the eighth edition of the "Standard Methods for the Examination of Water and Sewage, 1936" published jointly by the American Public Health Association and the American Water Works Association. This test should be made at least once during each successive period of 8 hours every day in the finished water at the treatment plant and at least three times weekly at regular sampling points in the distribution system.

5. Special care should be taken to maintain a detailed and accurate record of chlorination and the results thereof. Such a record should

show: rate of flow of water treated, gross weight of chlorine cylinder in use, weight of chlorine used for 24 hours, setting of chlorinator, and time of making and results of residual chlorine test.

6. Unless bacteriological and other tests should indicate the need of maintaining higher minimum concentrations of residual chlorine, at least 0.2 p. p. m. of free chlorine should be maintained in the treated water after a contact period of at least 10 minutes. When chloramine treatment is used for disinfection, the residual chlorine concentration, as indicated by the orthotolidine reagent, should be at least 0.4 p. p. m. after 2 hours of contact. Where "break-point" chlorination is practiced, a sufficient concentration of residual free chlorine should be maintained at the treatment plant so that it will be not less than 0.05 to 0.10 p. p. m. at all points in the distribution system. When required in specific instances, the minimum concentration of residual chlorine and the minimum retention period for the chlorinated water should be increased as directed by the State Department of Health.

7. Results of recent studies have indicated that the product of required concentration and period of contact of chloramine with water may range from 20 to 30 times the corresponding product for free active chlorine, in order to obtain comparable bactericidal action. The required dosage can be determined by means of "breakpoint" tests of the water and adjustment of the chlorine dosage so as to allow for some absorption of free chlorine in the distribution system initially. This absorption should diminish after the chlorine demand of organic matter remaining in the system has been satisfied.

C. OPERATION CONTROL

(1) SUPERVISION

Every water treatment plant engaged in purifying water for domestic use should be under the charge of a technically trained supervisor. For plants treating variable or highly polluted raw waters, trained supervision should be continuous and full-time. For certain types of small plants, part-time trained supervision may be practicable under favorable circumstances. Under these conditions, the supervisor should be in constant touch with the plant attendants and available on call in any emergency, and should visit the plant at least twice each week.

(2) LABORATORY TESTS AND CONTROL

(*a*) The schedule of laboratory tests followed in controlling the operation of a water treatment plant will vary with the size of the plant and character of water treated, though certain minimum requirements may be stated. For the ordinary plant, the minimum schedule of laboratory tests should include determinations of air and water temperature, turbidity or color (or both), alkalinity, pH value, hardness, residual chlorine, bacterial count at 20° C. or 37° C. (or both), and coliform bacterial numbers, both presumptive and confirmed. Where "break-point" chlorination is practiced, a continuous record of free ammonia in the water to be chlorinated should be maintained. Occasionally special tests may be necessary, such as for residual alum, iron, manganese, or other undesirable constituents of the final effluent. Where prechlorination is used in addition to post-chlorination, tests for residual chlorine should be made at each major stage of treatment and, in the raw water, tests for chlorine demand.

(*b*) For operation control at the plant, the frequency of tests, particularly for turbidity, residual chlorine, bacterial count, and coliform organisms, though dependent on the character of water treated and on its variability, should be such that at least one test each 24 hours and every day of the week will be carried out. For the larger plants, at least three sets of samples are usually collected daily for bacteriological tests. Determinations of turbidity and residual chlorine are made more frequently, sometimes at hourly intervals when the character of the raw or partly treated water is changing rapidly.[1]

(*c*) An important though somewhat less tangible element in judging the efficiency of plant operation is the general appearance of the plant and its surroundings. A neat, well-kept plant with attractive grounds is almost invariably an index of efficient operation, though, in some of the smaller plants especially, this criterion may not always be infallible. Mere neatness in the external maintenance of a plant, however, cannot offset lack of proper training on the part of the operator.

In rating the general efficiency of operation control, the following items are of primary importance:

(1) Training and experience of supervisor and operating staff.

(2) Adequacy of operation records.

(3) Efficiency of laboratory control.

(4) Suitability of plant design and construction to the character and pollution of the raw water.

(5) Capacity of the plant in relation to the average and maximum required output.

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[1] The following rule, wholly arbitrary, would give sampling frequencies depending in part on the daily volume of water treated and on the density of raw water pollution.

$$N=\sqrt[3]{VC}$$

where N=number of samples per 24 hours,
V=volume of water treated in million gallons daily,
C=coliform number, M. P. N., in thousands per 100 ml.

According to this rule, the number of samples per 24 hours would range from 1 to 2 for a 1 mgd. plant with raw water coliforms 1 to 5 thousands per 100 ml. and from 5 to 8 for a 100 mgd. plant with the same range in coliform numbers.

Part III

RECOMMENDED GENERAL SANITARY REQUIREMENTS FOR WATER DISTRIBUTION SYSTEMS

A. GENERAL

1. A water distribution system should be designed and constructed so as to provide at all times an adequate supply of water at ample pressure in all parts of the system.

2. The safety and palatability of the water should not be impaired in any manner while flowing through the distribution system, or any part thereof.

3. The system should be provided with sufficient valves and blow-offs so that necessary repairs can be made without undue interruption of service over any considerable area.

4. No unprotected open reservoir, or physical cross-connection whereby unsafe water can enter the distribution system, should be permitted.

5. The system should be tight against excessive leakage and its various mains and branches should be separated from rivers and other possible sources of contamination.

6. The system should be designed so as to afford effective circulation of water, with a minimum of dead ends.

7. The distribution system should be maintained in a sanitary manner, with due precautions against contamination of the water in any part of it as the result of necessary repairs, replacements, or extension of mains.

8. Frequent and regular bacteriological examinations should be made of water samples collected at various control points in the distribution system, with an immediate and thorough checking of any unusual results.

B. PIPING SYSTEM

1. The water mains should be of adequate size so that negative pressure will not occur under any condition of draft on the system.

2. Joints should be of such design and should be installed so as to show no leakage under a standard pressure test before covering. Materials used for caulking should be of a character such as not to foster the growth of coliform bacteria.

3. Corrective water treatment should be instituted where deposits in the mains tend to reduce the effective size and capacity of the pipes. For biological deposits, heavy chlorination may be effective.

4. The piping system should be designed so as to maintain an adequate positive pressure of water in all parts of the system, regardless of unusual drafts on any parts of the system. Pressure-equalizing

standpipes or reservoirs should be located at suitably distant points from the pumping or main supply station.

5. Where dead ends are necessary as a stage in the growth of the system, they should be located and arranged with a view to connecting them ultimately so as to provide circulation.

6. Water pipes should be laid, so far as possible, above the elevation of nearby sewers and at least 10 feet laterally from them. Where this requirement cannot be met because of physical conditions, extra precautions should be taken in securing absolute and permanent tightness of water pipe joints.

7. Where a water service pipe crosses a street sewer at less than 6 feet vertically above the sewer, or is within 10 feet of it horizontally, all of that part of the water pipe lying within these distances should be constructed preferably of copper or brass pipe connected to the iron pipe with a brass fitting. In such cases it is preferable to use copper or brass pipe from the water main to the house, and the house sewers should be constructed of extra heavy cast iron with water tight joints. Where priorities necessitate the use of materials other than brass or copper, extra-heavy iron pipe should be used under these conditions.

8. Sanitary precautions should be taken in laying new water pipes. Where avoidable, pipe should not be laid in water or where it can be flooded with water or sewage in laying. Leakage tests should be made by means of hydrostatic pressure. New mains should be kept filled with a strong hypochlorite or chlorine solution (40–60 p. p. m. of chlorine) for at least 24 hours and then drained before being placed in service. Fire hydrants should not be drained into the sewers or storm drains. Valve chambers should be of watertight construction and should not be connected directly to a storm or sanitary sewer.

C. CROSS AND OPEN CONNECTIONS

1. In general, no physical cross-connection should be permitted between a public or private water distribution system containing potable water and any other system containing water of questionable safety.

2. Open connections, physically separated, may be permissible under regulation and supervision by the local or State health department.

3. House or industrial toilet or sink fixtures capable of back-siphonage into the water system should be classed as cross-connections and should be prohibited, except where supplied by an independent elevated storage tank physically separated from the water supply pipes and protected by an approved siphon-breaker inlet. Dual water systems should be avoided where possible.

Part IV

A. Discussion of Chemical Requirements for the Revised Drinking Water Standards

It is fairly obvious that a water which is turbid, or colored to a degree which is easily noticeable, or which has an unpleasant or unusual odor or taste, will be looked upon with suspicion by the consumers to whom it is served for drinking purposes. For this reason its use should not be permitted where clarification of the water is practicable, or where a more acceptable supply is available.

The presence of considerable amounts of calcium and magnesium salts makes the water unsuitable to use for washing, and it is also unpleasant for drinking to persons who have been accustomed to softer water, but persons who are accustomed to the harder waters may find the softer waters less agreeable to their taste. Although it is open to question whether it would be justifiable to require the dilution of hard water by distilled water in order to keep within the limits specified in the Standards, it would be proper to require carriers to select the local supplies which most nearly fulfill the requirements of the Standards with respect to mineral content.

Insofar as the chemical composition of the water may cause inconvenience by its irritating effect upon the intestinal canal, or by any more serious effect upon well-being, the certifying authority will be justified in requiring that due regard be paid to this matter by common carriers. Unfortunately, it is difficult to secure reliable information concerning the physiological activity of salts as found in waters. Idiosyncracy is important. It is universally admitted that poisonous or otherwise harmful elements or salts in significant quantities, such as lead, hexavalent chromium, arsenic, fluoride or selenium, should not be allowed in water for drinking or culinary purposes. It is difficult, however, to fix limits for the less poisonous substances or salts which are normally present. The effect of sulfates, and especially of magnesium sulfate, is, however, well recognized, and it would be desirable to avoid the use of waters in which the concentration of these salts is sufficiently high to be annoying. The use of salts of barium or of hexavalent chromium for treating the water or water system should not be allowed on a drinking water supply. Molecularly dehydrated phosphates have come into use for water treatment but sufficient information upon the physiological effects of small amounts of these salts is not available. Consequently, their use in excess of 10.0 p. p. m. for treating any drinking water should be avoided. When waters are treated with chemicals in order to soften or to purify them, it is desirable that any excess use of the chemical be avoided. Limits for alkalinity resulting from excess lime or other softening procedures already have been suggested. More than a small amount of free chlorine (1.0 p. p. m.) or chloramine (2.0 p. p. m.) is objectionable in the effluent from a treatment plant because of resulting chlorinous taste in the water. In general, it is considered proper to insist that effort be made to find waters which are as satisfactory as possible from the standpoint of chemical characteristics, but with due regard to the region within which the water supply must be obtained.

Relation between pH, total alkalinity, hydroxide, carbonate and bicarbonate alkalinities in waters.—In the chemical analyses of water, it is often desirable to know the concentrations of hydroxide, carbonate and bicarbonate alkalinities present in the sample, as well as the total alkalinity to methyl orange. At present, according to Standard Methods (*3*), the OH^-, $CO^=_3$, and HCO^-_3 components of a total alkalinity are calculated from the values for the methyl orange (T) and phenolphthalein (P) alkalinities by means of the relations given in part II, section VI, paragraph 3.1 (p. 66). Experimentally, the phenolphthalein titration of samples containing carbon dioxide and mixed carbonates is far from satisfactory. Furthermore, the formulae for calculating the amounts of OH^-, $CO^=_3$, and HCO^-_3 alkalinity from the values of P and T ignore the laws of chemical equilibrium. The formulae assume that neither OH^- and HCO^-_3 nor $CO^=_3$ and CO_2 may exist in the same solution, assumptions which are quantitatively incorrect. Also the formulae give values for OH^- which too often do not check with those calculated from the pH of the water.

On the basis of the ionization equilibria of carbonates and water, DeMartini (*4*) formulated equations by means of which the concentrations of CO_2, HCO^-_3, $CO^=_3$, and OH^- present in a given sample can be calculated from the values for pH and total alkalinity. Moore (*5*), using the best available values for the ionization constants of carbonic acid and water, presents the DeMartini equations as follows:

$$(1)\ OH^-\ \text{(in terms of } CaCO_3) = \frac{5\times 10^{-10}}{(H^+)}$$

$$(2)\ CO^=_3\ \text{(in terms of } CaCO_3) = \frac{5.61\times 10^{-6}}{(H^+)}\times A$$

$$(3)\ HCO^-_3\ \text{(in terms of } CaCO_3) = 50{,}000\times A$$

$$(4)\ CO_2\ \text{(as } CO_2) = 9.70\times 10^{10}\times (H^+)\times A$$

Where A is the factor
$$\frac{\dfrac{T}{50{,}000}+(H^+)-\dfrac{10^{-14}}{(H^+)}}{1-\dfrac{11.22\times 10^{-11}}{(H^+)}}$$

in which T stands for total alkalinity and (H^+) represents the hydrogen ion concentration and is related to pH by the expression $pH=\log\dfrac{1}{(H^+)}$.

The total alkalinity is an equilibrium mixture of its OH^-, $CO^=_3$, and HCO^-_3 components. If the amounts of OH^-, $CO^=_3$, and HCO^-_3 in a given alkalinity are expressed in terms of percentage of the total alkalinity, any given equilibrium mixture can be represented by a point on a triangular coordinate diagram. The triangular diagram has for its three coordinates the percent fractions of each of the three alkalinity components, OH^-, $CO^=_3$, and HCO^-_3. These vary from

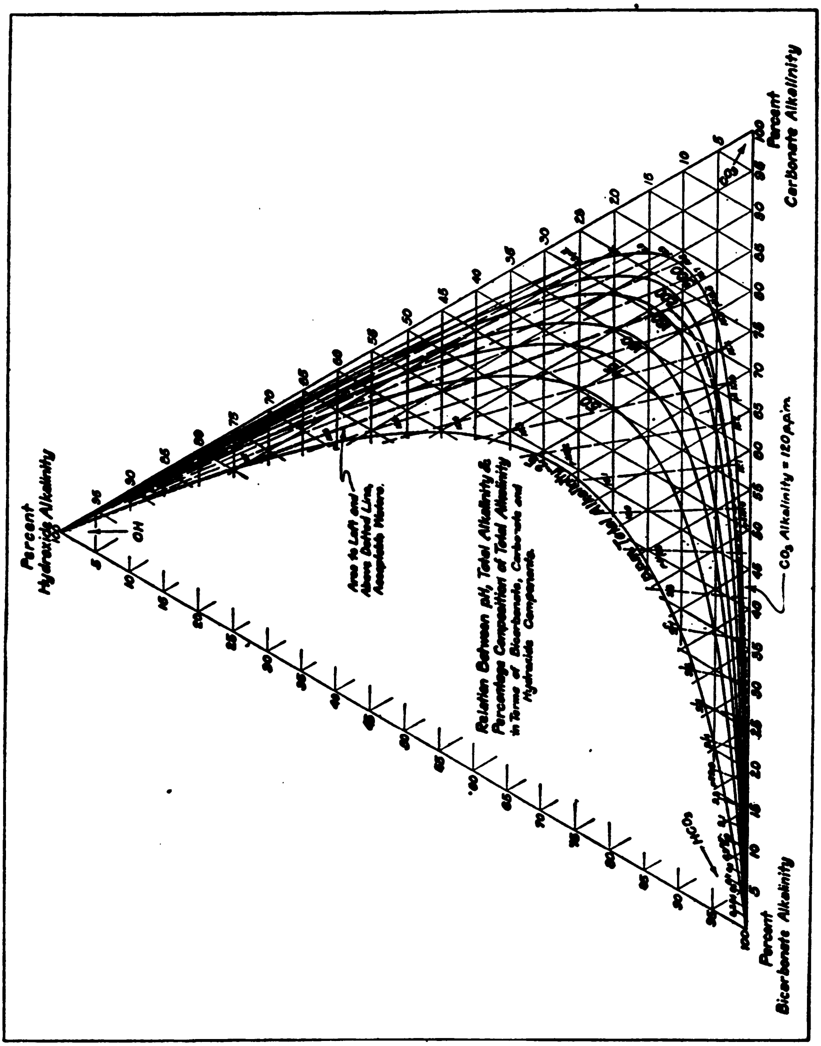

FIGURE 2.—Relation between pH, total alkalinity, and percentage composition of total alkalinity.

0 percent at the three sides of the triangle to 100 percent at the opposite apex.

Using Moore's equations, the amounts of OH^-, $CO^=_3$, and HCO^-_3 in equilibrium with each other at pH values ranging from 7.0 to 11.6 for alkalinity values of 25, 50, 75, 100, 150, 200, and 300 p. p. m. were calculated, converted to the percent fraction basis and plotted on the triangular diagram. The curves show how the relative proportions of OH^-, $CO^=_3$, and HCO^-_3 for any given alkalinity change with pH. In the diagram there are presented curves for waters with total alkalinities of 25, 50, 75, 100, 150, 200, and 300 p. p. m. (heavy solid line curves). The thin lines running from the base of the triangle to the opposite apex (100 percent OH^-) represent samples of any given pH and show how for any given pH the relative amounts of OH^-, $CO^=_3$, and HCO^-_3 will vary with total alkalinity.

The proposed Standards set the following limits: (1) the water shall not have a pH greater than 10.6, and (2) the carbonate ($CO^=_3$) alkalinity shall not exceed 120 p. p. m. The thick broken lines represent these limits. All samples whose compositions are represented by points to the left of the 10.6 pH tie-line and above the 120 p. p. m. $CO^=_3$ line are acceptable. All samples of composition represented by points to the right of and below the limiting lines are to be rejected.

Because chemical equilibria are affected by change in temperature and by changes in the ionic strength of the solution, Moore's equations are strictly valid only for waters at 25° C. and low dissolved solids concentration. (Ionic strength is more or less proportional to dissolved solids concentration.) However, for practical purposes the equations will hold quite accurately for all pH values up to 10.0 in waters containing up to 500 p. p. m. dissolved solids at temperatures from 15° to 25° C.

B. Discussion of Bacteriological Requirements for the Revised Drinking Water Standards

The bacteriological examinations which have come to be recognized generally as of most value in the sanitary examination of water supplies are:

(1) The count of total colonies developing from measured portions planted in agar or gelatin plates and incubated for 48 hours at 20° C.

(2) A similar count of total colonies developing on agar plates incubated for 24 hours at 37° C.

(3) The quantitative estimation of organisms of the coliform group by applying specific tests to multiple portions of measured volume.

Of these three determinations, the test for organisms of the coliform group is almost universally conceded to be the most significant because it affords the most nearly specific test for the presence of fecal contamination. Only this test has been included, therefore, in the bacteriological standard recommended, as neither the 37° C. nor the 20° C. plate count would appear to add information of sufficient importance, for the purpose of these Standards, to warrant their inclusion in the required examination. The omission of plate counts from the Standards is not to be construed, however, as denying or minimizing their importance in routine examinations made in connection with the control of water purification processes.

For the purposes of the Standards the coliform group is defined as including all organisms considered in the coli-aerogenes group as set forth in Standard Methods for the Examination of Water and Sewage, eighth edition (1936), as prepared, approved, and published jointly by the American Public Health Association and the American Water Works Association, New York City.

In accordance with this definition, the Standard provides that the procedure required for demonstration of the coliform group be as prescribed in Standard Methods, eighth edition, 1936, referred to above, for the tests designated:

(*a*) The completed test, or

(*b*) The confirmed test, when a liquid confirmatory medium (brilliant green lactose bile broth, 2 percent) is used, provided the formation of gas in any amount in this medium during 48 hours of incubation at 37° C. is considered to constitute a positive confirmed test, or

(*c*) The confirmed test where (1) crystal violet lactose broth, (2) fuchsin lactose broth, or (3) formate ricinoleate broth are used; providing the worker demonstrates the conformance of results, obtained with these three media, to the required conditions.

Moreover, it is recommended that this reference to Standard Methods shall be considered as applicable to all details of technique, including the selection and preparation of apparatus and culture media, the collection and handling of samples, and allowable intervals between collection and examination. As the standard procedure cited in this reference does not require differentiation between the various forms or types which are included under the general definition of the coliform group as given above, it has not seemed advisable, in the present state of knowledge, to require such differentiation in the application of the Standards. Two considerations tend to militate against the necessity or propriety of complicating the Standards by the incorporation of such differentiation. First, an analysis of the records of a considerable number of municipal water supplies during the past 20 years suggests that the coliform group has served effectively as an indicator of fecal pollution when the procedure for the determination of the coliform group was carried out in exact accordance with the methods specified. Second, competent research findings indicate that all constituent members of the coliform group are usually found in human fecal material. Consequently, it seems advisable to emphasize here a strict observance of the methods referred to, rather than to introduce any unnecessary procedures for the differentiation of the coliform group.

The principles involved in the quantitative interpretation of fermentation tests according to the "most probable number" concept, in multiple portions of equal volume and in portions constituting a geometric series, were discussed fully in appendix III of the Standards promulgated in 1925 and since then this discussion has been amplified by various authors. As these principles now are understood universally and enumeration procedures concerned are used quite widely, it has not appeared necessary to repeat this discussion in the current revision. The testing of multiple portions of equal volume affords a more precise measure of the density of the coliform group within a relatively narrow range of variation than does the testing of portions in geometric series. Therefore, as the waters which will be offered for certification should represent only a narrow range of very moderate pollution, the Standards require that the examination of each sample shall consist of the separate testing of five equal portions either of 10 ml. or of 100 ml. each.[2] For laboratories which are equipped to make such tests, the examination of the larger, 100 ml., portions provides for: (1) a more definitive measure of the density of coliforms in the range of about 1 per 100 ml., as established by the Standards, and (2) information as to the approach of unfavorable conditions in the water.

The procedure for the examination of 100 ml. portions offers no difficulty in laboratory technique, the only additional requirements being larger containers, larger quantities of media, slightly greater incubator space, and the collection of a larger sample. If economy of incubator space is desirable, multiple-strength lactose broth may be used in conformity with the provisions in Standard Methods of Water Analysis. In practice it has been found satisfactory to use standard dilution water bottles of 160–180 ml. capacity as tubes or containers for the 100 ml. portions. These bottles, containing 30–35 ml. of quadruple-strength lactose broth and equipped with the ordinary inverted vial or with a Cowles (*6*) tube, are sterilized in the usual manner. For convenience in checking volumes, or to eliminate the necessity for the use of volumetric pipettes, the bottles may be graduated at the 35 ml. and at the 135 ml. points. This procedure lends itself readily to the planting of samples directly into lactose broth at the site of collection of the sample.

There is, of course, no essential reason why the number of portions tested should be five rather than some larger number, except that labor and materials are limited, and five portions are considered sufficient for such precision as is ordinarily necessary.

With reference to the total number of samples which should be examined, the intervals at which they should be collected, and the location of the sampling points on the distribution system, it is recog-

[2] It is advisable, however, especially in the examination of waters of unknown quality or which may be suspected to be highly polluted, to make simultaneous tests in portions of a geometric series, ranging from 100 ml. to 1.0 ml. or less.

nized that such requirements are affected by (1) the nature of the source of the water, (2) the character and the consistency of the treatment provided, (3) the sanitary conditions of the distribution system, (4) the average daily volume of water delivered to the distribution system, and (5) the total population served. It is obviously desirable, from the standpoint of precision and significance of results, to examine a large number of samples collected at frequent and regular intervals, and, when normal conditions obtain, preferably at uniformly spaced points on the distribution system, but when abnormal conditions exist, at such points as will produce the maximum information concerning the cause of any abnormalities in water quality. It is obvious also that it is not practicable to lay down hard and fast requirements adapted to the qualities of each supply in question. It has appeared desirable, however, to establish for the ideal supply a requirement for the minimum number of samples to be collected and examined during specified intervals, based on the population served, and to delegate to the inspecting officer, who should have knowledge of the conditions affecting the supply in question, the authority to increase the number of samples required and to fix the times and the sites for collection of samples on the distribution system.

In accordance with these principles, the first requirement stated in the Standards, namely, that "of all the standard 100 ml. or 10 ml. portions examined per month in accordance with the specified procedure, not more than 60 percent or 10 percent, respectively, shall show the presence of organisms of the coliform group," may be interpreted as implying that the mean density of organisms of the coliform group shall not exceed about 1 per 100 ml. The second clause of the Standards, which specifies that not more than 20 percent (or 5 percent when 10 ml. portions are examined) of samples tested (or not more than one sample if the whole number tested be less than 20 for 10 ml. portions or less than 5 for 100 ml. portions) shall show the presence of organisms of the coliform group in all five 100 ml. portions, or in three or more of the five 10 ml. portions, is more complex in its implications [3] and more difficult to explain. It recognizes that, according to the laws of chance, this result would occur in a certain small proportion of the samples tested, even though the mean density of organisms of the coliform group in the whole body of water tested actually remained constant at about 1 per 100 ml. or less and, consequently, that it warrants no inference of actual fluctuations in density unless it occurs with greater frequency than would be expected according to the theory of chance occurrences. A more frequent occurrence, sufficient to indicate occasional higher pollution, is believed, however, to be an indication of potential danger, even though

[3] This was ably discussed in appendix III of the 1925 Standards and this discussion has been amplified by various authors since that time.

the average quality of the water should be satisfactory (that is, in conformity to the first provision of the Standards). This clause of the Standards undertakes, therefore, to set a limit to the allowable frequency of positive results in an increased number of portions of any sample. It is necessary in so doing to recognize that water supplies actually do vary in their degree of pollution from day to day, and that in many instances the series of tests which will be considered may be small; hence, the limit (20 and 5 percent) is set at a frequency which is higher than reasonably might be expected in a large series of samples from a water in which the actual density of organisms of the coliform group never greatly exceeded 1 per 100 ml. In the case of 10 ml. portions the limit for this frequency is set at 5 percent, which is approximately five times higher than the normal expectancy. With 100 ml. portions the requirement is somewhat more stringent as the 20 percent frequency allowed is only about 2.5 times higher than reasonably might be expected. As the possibility of an increase in pollution is ever present, the Standards provide further that when positive results are obtained in increased numbers of portions of any sample, additional and more frequent samples shall be collected and examined. The results from such additional samples will demonstrate whether the increase in positive results are due to the probabilities of chance, or to an actual increase in density of pollution.

In the bacteriological standard which has been promulgated, the committee has undertaken to set up two controlling factors: (1) two limiting values to the density of organisms of the coliform group, one limit applying to the mean density as calculated from the entire series of tests made during any one month and one to the range and frequency of occasional deviations from this mean, and (2) failure to conform with the specified procedures for making the bacteriological examinations may be used as the basis for a refusal of certification of a supply. That is, a failure to follow the specified procedures might produce results which would not provide for a satisfactory opinion of the quality of the water supply concerned.

REFERENCES

(*1*) Manual of Water Quality and Treatment. American Water Works Association, 1940. Reprinted 1941.
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(*3*) Standard Methods for the Examination of Water and Sewage. American Public Health Association, 1936.
(*4*) DeMartini, F. E.: Corrosion and the Langelier calcium carbonate saturation index. J. Am. Water Works Assoc., **30**:85 (1938).
(*5*) Moore, Edward W.: Graphic determination of carbon dioxide and the three forms of alkalinity. J. Am. Water Works Assoc., **31**:51 (1939).
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DEATHS DURING WEEK ENDED JANUARY 2, 1943

[From the Weekly Mortality Index, issued by the Bureau of the Census, Department of Commerce]

	Week ended Jan. 2, 1943	Corresponding week 1942
Data from 86 large cities of the United States:		
Total deaths	9,996	9,035
Average for 3 prior years	9,081	
Total deaths, first 52 weeks of year	435,592	429,433
Deaths per 1,000 population, first 52 weeks of year, annual rate	11.8	11.6
Deaths under 1 year of age	672	555
Average for 3 prior years	567	
Deaths under 1 year of age, first 52 weeks of year	30,147	27,241
Data from industrial insurance companies:		
Policies in force	65,275,760	64,826,273
Number of death claims	11,201	10,639
Death claims per 1,000 policies in force, annual rate	8.9	8.6
Death claims per 1,000 policies, first 52 weeks of year, annual rate	9.1	9.3

PREVALENCE OF DISEASE

No health department, State or local, can effectively prevent or control disease without knowledge of when, where, and under what conditions cases are occurring

UNITED STATES

REPORTS FROM STATES FOR WEEK ENDED JANUARY 9, 1943

Summary

While reports for the current week show increases over the preceding week's totals for seven of the nine common communicable diseases included in the following tables, all except those of meningococcus meningitis were near or below the median numbers reported in the corresponding weeks of the 5-year period 1938–42.

A total of 278 cases of meningococcus meningitis was reported for the week, as compared with 187 for the preceding week, and 92 for the next earlier week. The current figure is higher than that for the corresponding week of any other year since 1928, the earliest year for which comparable figures became available. The corresponding 5-year (1938–42) weekly median is 45. The largest numbers were reported in Virginia (30 cases), New York (23; 16 in New York City), Pennsylvania (20; 8 in Philadelphia), Oregon (19), Maine and Maryland (16 each; 12 in Baltimore), Massachusetts (15), and California (13).

There were 34 cases of poliomyelitis reported, 10 of which were in California, 4 in Texas, and 2 in Arkansas. The corresponding median is 28.

The number of reported cases of measles increased from 5,786 to 8,182 for the current week as compared with 7,892 for the corresponding week last year and 7,816 for the same week in 1941, which is also the 5-year median. Of the current week's total, 2,238 cases were reported in Pennsylvania, 695 in Washington, and 670 in New York.

A total of 3,457 cases of scarlet fever was reported, as compared with 2,858 for the preceding week and a median of 3,597. About 62 percent of the current total number was reported in the East North Central, Middle Atlantic, and New England States.

Although below the 5-year median, the number of smallpox cases reported was 42, of which 15 were in Indiana, 8 in Texas, and 6 in Pennsylvania.

The number of reported cases of whooping cough increased from 2,632 to 3,648. The current incidence is slightly above the 5-year median.

Other reports for the week include 1 case of anthrax (in Pennsylvania), 188 cases of dysentery (22 amebic, 134 bacillary, and 32 unspecified), 6 cases of infectious encephalitis, 1 case of Rocky Mountain spotted fever (in Indiana), 40 cases of tularemia, 88 cases of endemic typhus fever, 34 of which were in Texas and 14 each in North Carolina and Georgia.

There were 10,709 deaths recorded in 90 large cities of the United States for the week ended January 9, 1943, as compared with 10,222 for the preceding week, and a 3-year average (1940–42) of 9,838.

Below are given the cumulative numbers of cases of certain diseases reported for 52-week periods of 1942 and 1941, and median numbers for comparable periods of the years 1937-41. In some instances the figures used were for the calendar year instead of the 52-week period.

52 weeks	Anthrax	Diphtheria	Dysentery			Encephalitis, infectious	Influenza	Leprosy	Measles
			Amebic	Bacillary	Unspecified				
1942	78	15,559	1,179	12,127	6,405	568	109,167	45	505,861
1941	96	17,007	3,175	24,281	1,461	3,045	423,246	49	866,608
Median, 1937–41	65	24,086	3,039	[1] 21,531	[1] 1,135	1,267	292,271	49	374,854

52 weeks	Meningitis, meningococcus	Poliomyelitis	Rocky Mountain spotted fever	Scarlet fever	Smallpox	Tularemia	Typhoid and paratyphoid fever	Typhus fever	Whooping cough
1942	3,774	4,193	456	126,853	863	915	6,703	3,729	177,916
1941	2,039	9,089	505	127,735	1,356	1,482	8,513	2,790	207,843
Median, 1937-41	2,039	9,089	457	162,052	9,574	1,620	12,736	2,393	207,843

[1] 4-year average.

Telegraphic morbidity reports from State health officers for the week ended January 9, 1943, and comparison with corresponding week of 1942 and 5-year median

In these tables a zero indicates a definite report, while leaders imply that, although none were reported, cases may have occurred.

Division and State	Diphtheria			Influenza			Measles			Meningitis, meningococcus		
	Week ended—		Median 1938–42	Week ended—		Median 1938–42	Week ended—		Median 1938–42	Week ended—		Median 1938–42
	Jan. 9, 1943	Jan. 10, 1942		Jan. 9, 1943	Jan. 10, 1942		Jan. 9, 1943	Jan. 10, 1942		Jan. 9, 1943	Jan. 10, 1942	
NEW ENG.												
Maine	0	1	2	------	1	10	25	174	74	16	1	0
New Hampshire	0	0	0	3	------	------	44	11	11	0	0	0
Vermont	0	1	0	24	------	------	328	7	24	0	1	0
Massachusetts	2	5	5	------	------	------	515	213	213	15	4	2
Rhode Island	2	0	0	25	1	------	7	38	1	4	0	0
Connecticut	1	0	0	11	7	10	376	110	110	0	2	1
MID. ATL.												
New York	24	16	16	[1] 17	[1] 8	[1] 23	670	493	493	23	7	5
New Jersey	3	7	12	27	18	18	346	134	134	11	3	1
Pennsylvania	16	23	24	7	------	------	2,238	1,121	1,121	20	2	2
E. NO. CEN.												
Ohio	18	12	23	16	26	7	40	95	95	8	1	4
Indiana	5	13	17	31	49	46	149	42	33	1	2	1
Illinois	16	41	41	13	18	18	169	89	89	6	0	2
Michigan [2]	4	3	5	1	24	------	45	83	189	5	0	0
Wisconsin	4	1	1	62	31	49	303	273	359	1	2	0
W. NO. CEN.												
Minnesota	2	2	3	2	1	1	6	208	109	0	0	0
Iowa	5	11	9	2	------	2	50	90	90	2	1	1
Missouri	3	2	11	6	10	70	24	27	27	7	0	0
North Dakota	0	2	2	49	36	36	1	71	31	0	1	0
South Dakota	21	2	3	------	------	1	103	2	2	2	0	0
Nebraska	4	2	2	60	9	9	130	4	8	6	0	0
Kansas	4	6	6	6	9	16	64	186	112	2	2	2
SO. ATL.												
Delaware	1	1	1	------	------	------	6	1	3	0	0	0
Maryland [2]	10	15	4	9	11	15	13	260	11	16	2	1
Dist. of Col.	0	0	3	5	6	2	9	5	3	2	0	0
Virginia	15	29	22	659	346	454	53	155	146	30	1	1
West Virginia	8	7	9	38	16	16	15	232	61	2	0	0
North Carolina	24	27	33	12	6	17	9	639	317	3	1	1
South Carolina	4	7	11	651	474	909	5	82	33	11	0	1
Georgia	18	13	16	181	105	133	4	225	61	1	2	0
Florida	13	7	7	6	15	15	8	23	23	0	1	1
E. SO. CEN.												
Kentucky	5	6	10	2	2	56	93	26	60	2	0	1
Tennessee	4	11	11	89	72	143	39	40	39	9	0	2
Alabama	1	7	12	106	177	377	7	23	46	4	1	1
Mississippi [2]	3	16	11	------	------	------	------	------	------	0	1	1
W. SO. CEN.												
Arkansas	15	4	12	179	192	192	39	73	44	3	0	0
Louisiana	7	13	13	9	7	15	11	13	3	4	0	1
Oklahoma	5	13	14	74	187	222	6	157	7	4	1	1
Texas	48	46	34	1,157	1,520	492	22	499	51	3	1	2
MOUNTAIN												
Montana	0	0	2	14	9	9	38	52	15	0	0	0
Idaho	1	0	0	2	------	3	220	1	9	2	0	0
Wyoming	3	0	0	54	4	4	10	14	6	2	0	0
Colorado	13	12	12	45	62	62	87	124	92	5	0	0
New Mexico	1	1	2	------	6	6	10	29	29	1	0	1
Arizona	0	1	8	115	195	178	7	87	6	3	0	1
Utah [2]	1	0	0	32	9	9	551	48	48	3	1	0
Nevada	0	0	------	------	------	------	33	4	------	2	0	------
PACIFIC												
Washington	7	0	0	------	2	------	695	31	31	5	2	0
Oregon	1	2	2	16	21	71	412	83	29	19	0	0
California	30	17	21	35	108	108	147	1,495	90	13	2	2
Total	372	405	488	3,852	3,800	3,800	8,182	7,892	7,816	278	45	45

See footnotes at end of table.

Telegraphic morbidity reports from State health officers for the week ended January 9, 1943, and comparison with corresponding week of 1942 and 5-year median—Con.

Division and State	Poliomyelitis: Week ended— Jan. 9, 1943	Poliomyelitis: Week ended— Jan. 10, 1942	Poliomyelitis: Median 1938–42	Scarlet fever: Week ended— Jan. 9, 1943	Scarlet fever: Week ended— Jan. 10, 1942	Scarlet fever: Median 1938–42	Smallpox: Week ended— Jan. 9, 1943	Smallpox: Week ended— Jan. 10, 1942	Smallpox: Median 1938–42	Typhoid and paratyphoid fever: Week ended— Jan. 9, 1943	Typhoid and paratyphoid fever: Week ended— Jan. 10, 1942	Typhoid and paratyphoid fever: Median 1938–42
NEW ENG.												
Maine	0	2	0	16	11	11	0	0	0	0	0	0
New Hampshire	0	1	0	6	11	11	0	0	0	0	0	0
Vermont	0	1	0	5	8	8	0	0	0	0	0	0
Massachusetts	1	1	1	331	303	142	0	0	0	2	2	1
Rhode Island	1	0	0	21	13	6	0	0	0	0	0	0
Connecticut	0	0	0	75	24	39	0	0	0	1	1	0
MID. ATL.												
New York	1	0	1	373	367	361	0	0	0	2	4	4
New Jersey	0	1	0	76	120	130	1	0	0	0	0	0
Pennsylvania	0	1	0	226	292	281	6	0	0	5	9	9
E. NO. CEN.												
Ohio	1	1	1	327	290	318	3	0	3	3	3	3
Indiana	1	1	1	92	70	187	15	2	11	1	2	1
Illinois	0	0	1	219	199	383	0	0	3	2	3	3
Michigan [2]	1	0	0	72	100	156	0	0	0	0	0	0
Wisconsin	1	0	0	273	145	145	0	0	4	0	0	1
W. NO. CEN.												
Minnesota	0	0	1	66	69	89	0	1	5	2	0	0
Iowa	1	1	1	53	24	69	0	0	16	1	0	0
Missouri	1	0	0	71	33	57	0	1	1	0	1	2
North Dakota	0	0	0	21	16	26	0	0	1	0	0	0
South Dakota	1	2	0	38	54	29	1	0	5	0	0	0
Nebraska	0	0	0	40	22	35	0	0	1	0	1	0
Kansas	1	0	0	80	84	142	0	0	0	0	0	1
SO. ATL.												
Delaware	0	0	0	12	40	14	0	0	0	0	1	0
Maryland [2]	0	1	0	43	55	54	0	0	0	2	4	2
Dist. of Col	1	0	0	15	10	11	0	0	0	0	0	0
Virginia	1	0	0	71	32	46	0	0	0	1	8	3
West Virginia	0	1	0	49	62	62	0	0	0	4	0	2
North Carolina	0	0	0	78	102	58	0	0	0	0	2	1
South Carolina	1	1	0	12	13	13	0	0	0	1	8	4
Georgia	0	0	1	23	27	18	0	0	0	4	6	3
Florida	0	1	0	13	7	7	0	1	0	0	3	2
E. SO. CEN.												
Kentucky	1	0	1	58	60	60	0	0	0	1	2	1
Tennessee	1	1	0	49	48	38	0	1	1	0	0	1
Alabama	0	1	0	22	36	27	2	0	0	0	3	2
Mississippi [2]	0	1	0	13	20	13	0	0	0	0	0	0
W. SO. CEN.												
Arkansas	2	1	0	6	7	13	1	0	2	6	1	1
Louisiana	0	0	0	10	9	10	0	0	0	2	3	4
Oklahoma	0	1	0	18	16	28	0	1	8	3	1	1
Texas	4	2	1	52	54	54	8	1	0	5	5	9
MOUNTAIN												
Montana	0	1	0	17	26	26	1	0	1	0	0	0
Idaho	0	0	0	8	5	10	3	0	0	0	1	1
Wyoming	1	0	0	59	5	7	0	0	0	0	0	0
Colorado	0	0	0	60	24	33	0	1	6	1	0	1
New Mexico	0	0	0	6	10	10	0	0	0	1	3	3
Arizona	1	0	0	5	7	5	0	0	0	0	0	2
Utah [2]	0	0	0	76	21	21	0	0	0	1	0	0
Nevada	0	0	-----	7	0	-----	0	0	-----	0	0	-----
PACIFIC												
Washington	0	0	0	30	52	48	0	0	1	0	1	1
Oregon	0	2	1	14	12	32	1	0	0	0	0	1
California	10	2	2	150	86	111	0	1	1	2	6	4
Total	34	28	28	3,457	3,101	3,454	42	10	74	53	84	84

See footnotes at end of table.

Telegraphic morbidity reports from State health officers for the week ended January 9 1943—Continued

Division and State	Whooping cough: Week ended Jan. 9, 1943	Whooping cough: Week ended Jan. 10, 1942	Whooping cough: Median 1938–42	Week ended Jan. 9, 1943: Anthrax	Dysentery: Amebic	Dysentery: Bacillary	Dysentery: Unspecified	Encephalitis, infectious	Leprosy	Rocky Mt. spotted fever	Tularemia	Typhus fever
NEW ENG.												
Maine	131	29	41	0	0	0	0	0	0	0	0	0
New Hampshire	0	30	5	0	0	0	0	0	0	0	0	0
Vermont	64	33	50	0	0	0	0	0	0	0	0	0
Massachusetts	247	265	248	0	0	2	0	0	0	0	0	0
Rhode Island	30	61	36	0	0	0	0	0	0	0	0	0
Connecticut	85	78	71	0	0	7	0	0	0	0	0	0
MID. ATL.												
New York	416	665	389	0	2	27	0	1	0	0	0	0
New Jersey	204	234	215	0	1	0	0	0	0	0	1	0
Pennsylvania	410	283	216	1	0	0	0	0	0	0	0	0
E. NO. CEN.												
Ohio	144	227	227	0	0	2	0	0	0	0	6	0
Indiana	26	29	29	0	0	0	0	0	0	[3] 1	4	0
Illinois	199	174	145	0	2	1	0	0	0	0	5	0
Michigan [2]	97	166	100	0	0	1	0	0	0	0	0	0
Wisconsin	192	207	121	0	0	0	0	0	0	0	0	0
W. NO. CEN.												
Minnesota	84	34	35	0	0	0	0	0	0	0	1	0
Iowa	14	11	9	0	0	0	0	0	0	0	1	0
Missouri	29	17	17	0	0	0	0	1	0	0	1	0
North Dakota	21	6	16	0	0	0	0	0	0	0	0	0
South Dakota	8	12	3	0	0	0	0	0	0	0	0	0
Nebraska	2	10	12	0	0	0	0	0	0	0	0	0
Kansas	46	59	59	0	0	0	0	2	0	0	3	0
SO. ATL.												
Delaware	8	0	8	0	0	0	0	0	0	0	0	0
Maryland [2]	77	21	46	0	0	0	0	0	0	0	1	0
Dist. of Col.	20	38	17	0	0	0	0	0	0	0	0	0
Virginia	61	46	81	0	0	0	24	0	0	0	7	1
West Virginia	22	40	40	0	0	0	0	0	0	0	0	1
North Carolina	115	295	192	0	0	0	0	0	0	0	1	14
South Carolina	36	30	55	0	0	9	0	0	0	0	1	4
Georgia	30	18	18	0	1	1	0	0	0	0	1	14
Florida	15	24	6	0	1	0	0	0	0	0	0	5
E. SO. CEN.												
Kentucky	23	75	22	0	0	0	0	0	0	0	2	0
Tennessee	25	20	19	0	0	0	1	0	0	0	3	0
Alabama	31	13	14	0	0	0	0	0	0	0	0	12
Mississippi [3]	-----	-----	-----	0	0	0	0	0	0	0	0	0
W. SO. CEN												
Arkansas	33	3	10	0	6	0	0	0	0	0	0	0
Louisiana	12	1	2	0	0	0	0	0	0	0	0	2
Oklahoma	13	1	13	0	0	0	0	0	0	0	0	0
Texas	230	81	81	0	7	81	0	0	0	0	0	34
MOUNTAIN												
Montana	34	25	13	0	0	0	0	0	0	0	0	0
Idaho	3	1	4	0	0	0	0	0	0	0	0	0
Wyoming	5	16	8	0	0	0	0	2	0	0	0	0
Colorado	12	27	27	0	0	0	0	0	0	0	0	0
New Mexico	9	53	15	0	0	0	0	0	0	0	0	0
Arizona	37	21	19	0	0	0	7	0	0	0	0	0
Utah [2]	20	44	32	0	0	0	0	0	0	0	0	0
Nevada	10	4	-----	0	0	0	0	0	0	0	2	0
PACIFIC												
Washington	16	137	43	0	0	0	0	0	0	0	0	0
Oregon	5	35	10	0	2	3	0	0	0	0	0	0
California	297	165	154	0	0	0	0	0	0	0	0	0
Total	3,648	3,864	3,627	1	22	134	32	6	0	1	40	87

[1] New York City only.
[2] Period ended earlier than Saturday.
[3] Delayed report.

WEEKLY REPORTS FROM CITIES

City reports for week ended December 26, 1942

This table lists the reports from 85 cities of more than 10,000 population distributed throughout the United States, and represents a cross section of the current urban incidence of the diseases included in the table.

	Diphtheria cases	Encephalitis, infectious, cases	Influenza		Measles cases	Meningitis, meningococcus, cases	Pneumonia deaths	Poliomyelitis cases	Scarlet fever cases	Smallpox cases	Typhoid and paratyphoid fever cases	Whooping cough cases
			Cases	Deaths								
Atlanta, Ga	0	0	11	2	3	0	4	0	4	0	0	2
Baltimore, Md	0	0	4	1	1	7	28	0	15	0	0	45
Barre, Vt	0	0	------	0	2	0	0	0	0	0	0	0
Billings, Mont	0	0	------	0	0	0	1	0	0	0	0	2
Birmingham, Ala	0	0	2	1	0	0	4	0	5	0	0	0
Boise, Idaho	0	0	------	0	0	0	0	0	0	0	0	0
Boston, Mass	1	0	------	0	38	0	16	0	73	0	0	24
Bridgeport, Conn	0	0	1	0	0	1	4	0	4	0	0	2
Brunswick, Ga	0	0	------	0	0	0	0	0	0	0	0	0
Buffalo, N. Y	1	0	------	1	93	1	11	0	6	0	0	25
Camden, N. J	0	0	------	0	3	0	1	0	3	0	0	6
Charleston, S. C	0	0	35	0	0	0	3	0	0	0	0	0
Charleston, W. Va	0	0	------	0	0	0	0	0	1	0	0	0
Chicago, Ill	9	0	3	1	42	2	37	0	52	0	0	49
Cincinnati, Ohio	0	0	------	1	11	0	6	0	12	0	0	5
Cleveland, Ohio	4	0	4	3	2	2	13	0	38	0	0	51
Columbus, Ohio	0	0	------	0	1	0	2	0	13	0	0	1
Concord, N. H	0	0	------	0	1	0	1	0	0	0	0	0
Cumberland, Md	0	0	------	0	0	0	1	0	1	0	0	0
Dallas, Tex	2	0	------	0	1	0	3	0	1	0	0	1
Denver, Colo	5	0	9	0	19	1	5	0	8	0	0	1
Detroit, Mich	1	0	------	1	9	0	10	0	32	0	0	59
Duluth, Minn	0	0	------	0	0	0	2	0	0	0	0	0
Fall River, Mass	0	0	------	0	0	0	0	0	0	0	0	4
Flint, Mich	0	0	------	0	2	0	4	0	3	0	0	3
Fort Wayne, Ind	0	0	------	0	0	0	1	0	0	0	0	0
Frederick, Md	0	0	------	0	0	0	0	0	0	0	0	0
Galveston, Tex	1	0	------	1	0	0	1	0	1	0	0	0
Grand Rapids, Mich	0	0	------	0	0	0	2	0	1	0	0	7
Great Falls, Mont	0	0	------	0	1	0	0	0	2	0	0	6
Hartford, Conn	1	0	------	0	4	1	5	0	0	0	0	0
Helena, Mont	0	0	------	0	0	0	0	0	0	0	0	0
Houston, Tex	0	0	------	0	0	0	5	0	1	0	2	8
Indianapolis, Ind	2	0	------	0	10	0	2	0	4	0	0	2
Kansas City, Mo	0	1	------	0	2	0	3	0	21	0	0	0
Kenosha, Wis	0	0	------	0	1	0	0	0	3	0	0	1
Little Rock, Ark	0	0	------	0	0	0	1	0	0	0	0	0
Los Angeles, Calif	4	0	11	4	11	0	14	4	19	0	0	16
Lynchburg, Va	0	0	------	0	0	0	4	0	1	0	0	0
Memphis, Tenn	0	0	------	0	0	0	6	0	1	0	0	0
Milwaukee, Wis	0	0	------	0	39	0	4	0	65	0	0	11
Minneapolis, Minn	0	0	------	0	1	0	6	1	11	0	0	5
Missoula, Mont	0	0	------	0	0	0	0	0	0	0	0	0
Mobile, Ala	0	0	2	2	0	0	3	0	2	0	0	0
Nashville, Tenn	1	0	------	0	4	0	2	1	2	0	0	1
Newark, N. J	0	0	3	0	11	0	6	0	5	0	0	7
New Haven, Conn	0	0	------	0	0	0	1	0	1	0	0	0
New Orleans, La	1	0	2	3	3	0	9	0	1	0	2	0
New York, N. Y	19	1	10	3	13	5	89	2	146	0	2	56
Omaha, Nebr	1	0	------	0	1	0	4	0	5	0	0	1
Philadelphia, Pa	0	0	3	1	520	3	38	0	46	0	0	68
Pittsburgh, Pa	0	0	1	3	1	1	8	0	8	0	0	5
Portland, Maine	1	0	------	0	0	4	2	0	3	0	0	10
Providence, R. I	0	0	------	0	0	1	3	0	2	0	0	26
Pueblo, Colo	0	0	------	0	0	0	0	0	1	0	0	1
Racine, Wis	0	0	------	0	23	0	0	0	21	0	0	0
Raleigh, N. C	0	0	------	0	0	0	2	0	1	0	0	0
Reading, Pa	0	0	------	0	22	0	0	0	0	0	0	4
Richmond, Va	0	0	2	1	0	1	6	0	2	0	0	1

City reports for week ended December 26, 1942—Continued

	Diphtheria cases	Encephalitis, infectious, cases	Influenza		Measles cases	Meningitis, meningococcus, cases	Pneumonia deaths	Poliomyelitis cases	Scarlet fever cases	Smallpox cases	Typhoid and paratyphoid fever cases	Whooping cough cases
			Cases	Deaths								
Roanoke, Va	0	0	------	0	0	0	0	0	0	0	0	0
Rochester, N. Y	0	0	------	0	6	0	2	0	4	0	0	27
Sacramento, Calif	5	0	------	0	1	1	2	0	1	0	0	1
Saint Louis, Mo	0	0	------	0	0	0	11	0	5	0	4	9
Saint Paul, Minn	0	0	------	1	1	0	6	0	6	0	0	8
Salt Lake City, Utah	0	0	------	0	138	0	1	0	20	0	0	6
San Antonio, Tex	0	0	------	1	0	0	4	4	0	0	0	3
San Francisco, Calif	0	0	------	0	5	0	5	1	9	0	0	9
Savannah, Ga	0	0	------	0	1	0	2	0	1	0	0	0
Seattle, Wash	0	0	------	1	23	0	3	0	0	0	0	7
South Bend, Ind	0	0	------	0	0	0	0	0	0	0	0	3
Spokane, Wash	0	0	1	1	32	0	1	0	5	0	0	2
Springfield, Ill	0	0	------	0	0	0	1	0	1	0	0	2
Springfield, Mass	0	0	------	0	23	0	8	0	65	0	0	2
Syracuse, N. Y	0	0	------	0	2	0	4	0	1	0	0	17
Tacoma, Wash	0	0	------	0	36	0	3	0	0	0	0	0
Tampa, Fla	0	0	------	1	1	0	3	0	1	0	0	0
Topeka, Kans	0	0	------	0	7	1	1	0	1	0	0	1
Trenton, N. J	0	0	1	0	0	0	2	0	5	0	0	0
Washington, D. C	1	0	3	2	0	1	12	0	12	0	0	9
Wheeling, W. Va	0	0	------	0	0	0	1	0	2	0	0	2
Wichita, Kans	2	0	------	0	2	0	3	0	5	0	1	1
Wilmington, Del	0	0	------	0	0	0	4	0	0	0	0	5
Wilmington, N. C	1	0	------	0	0	0	1	0	2	0	0	8
Winston-Salem, N. C	0	0	------	0	2	0	4	0	0	0	0	3
Worcester, Mass	0	0	------	0	8	0	12	0	7	0	0	0

Dysentery, amebic.—Cases: Atlanta, 1; New York, 1.
Dysentery, bacillary.—Cases: Baltimore, 1; Buffalo, 1; Chicago, 1; Detroit, 1; Little Rock, 1; Los Angeles, 2; New York, 9; Rochester, 1; San Francisco, 1.
Tularemia.—Cases: Chicago, 1; New Orleans, 1; Nashville, 1.
Typhus fever.—Cases: Atlanta, 1; Dallas, 1; Houston, 1; New York, 1; Savannah, 3.

Rates (annual basis) per 100,000 population, for the group of 85 cities in the preceding table (estimated population, 1942, 33,824,180)

Period	Diphtheria cases	Influenza		Measles cases	Pneumonia deaths	Scarlet fever cases	Smallpox cases	Typhoid and paratyphoid fever cases	Whooping cough cases
		Cases	Deaths						
Week ended Dec. 26, 1942	9.71	16.65	5.55	182.37	73.84	123.33	0.00	1.70	98.97
Average for week 1937–41	18.54	122.91	[1] 8.68	[2] 169.02	[1] 65.91	156.40	2.49	2.96	161.86

[1] 3-year average, 1939–41.
[2] 5-year median.

PLAGUE INFECTION IN TACOMA, WASHINGTON

Plague infection has been reported proved in pools of fleas and in tissue from rats, *R. norvegicus* and (one specimen) *R. rattus*, taken in Tacoma, Wash., as follows: Collected on December 7, 1942, in pools of 40 fleas from 116 rats and 13 fleas from 8 rats; December 14, 42 fleas from 66 rats and 7 fleas from 7 rats; December 15, tissue from 2 rats, proved separately; December 16, 28 fleas from 66 rats and 17 fleas from 6 rats, *R. rattus*.

FOREIGN REPORTS

CANADA

Provinces—Communicable diseases—Week ended December 12, 1942.—During the week ended December 12, 1942, cases of certain communicable diseases were reported by the Dominion Bureau of Statistics of Canada as follows:

Disease	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Total
Cerebrospinal meningitis		2		7	4		1			14
Chickenpox		11		452	394	114	101	23	53	1,148
Diphtheria		20	5	71	2	6	4	5		113
Dysentery				13						13
Encephalomyelitis							3			3
German measles				2	6	2	4	1	5	20
Influenza		12	2		18	4			9	45
Lethargic encephalitis							1			1
Measles		2		144	199	5	44		10	404
Mumps		54	1	170	820	86	103	38	258	1,530
Pneumonia		6			15	1		1	17	40
Poliomyelitis				1				1		2
Scarlet fever		4	13	162	80	11	18	14	55	357
Tuberculosis		10	7	144	64	11	24	13	26	299
Typhoid and paratyphoid fever		1		10	2					13
Undulant fever								1		1
Whooping cough		3	1	286	96	15	8	10	11	430
Other communicable diseases		7		48	264	34	1	1	7	362

JAMAICA

Notifiable diseases—4 weeks ended December 19, 1942.—During the 4 weeks ended December 19, 1942, cases of certain notifiable diseases were reported in Kingston, Jamaica, and in the island outside of Kingston, as follows:

Disease	Kingston	Other localities	Disease	Kingston	Other localities
Chickenpox		6	Scarlet fever		1
Diphtheria		1	Tuberculosis	19	60
Dysentery	3	1	Typhoid fever	4	49
Leprosy		5	Typhus fever	2	1
Puerperal fever		1			