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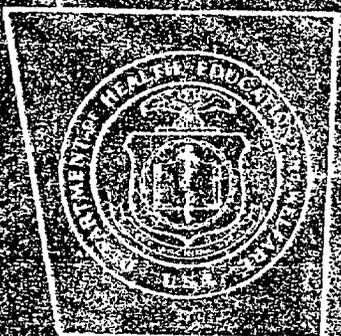
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Public Health Service

# DRINKING WATER STANDARDS

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U.S. DEPARTMENT OF  
HEALTH, EDUCATION, AND WELFARE  
Public Health Service  
Publ. H-956

# Public Health Service Drinking Water Standards

Revised 1962



**U.S. DEPARTMENT OF HEALTH, EDUCATION,  
AND WELFARE**

**PUBLIC HEALTH SERVICE**

**Washington 25, D.C.**

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**Public Health Service Publication No. 956**

**UNITED STATES  
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WASHINGTON : 1962**

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# THE PUBLIC HEALTH SERVICE DRINKING WATER STANDARDS—1962

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE,  
PUBLIC HEALTH SERVICE,  
*Washington 25, D.C., May 6, 1962.*

The Standards published herein have been promulgated as Public Health Regulations in the Federal Register. As such they became effective April 5, 1962, as the Standards to which drinking water and water supply systems used by carriers and others subject to Federal quarantine regulations must conform.

The Division of Environmental Engineering and Food Protection is responsible for the application of these Standards to all carrier water supplies.

These Standards supersede the Public Health Service Drinking Water Standards—1946, as amended in 1956. The new Standards were developed with the assistance of an Advisory Committee appointed by the Public Health Service to revise the Standards of 1946. The Committee in its deliberations took cognizance of man's changing environment and its effect on water supplies. Accordingly, new sections, such as one on radioactivity, have been added and substantive changes have been made elsewhere.

The new Standards are in a form believed useful in evaluating the quality and safety of water supplies generally and they are hereby recommended for such use.

LUTHER L. TERRY,  
*Surgeon General, Public Health Service.*

III

**ENDORSEMENT BY THE AMERICAN WATER WORKS ASSOCIATION**

Acting on behalf of the Officers and Directors, the AWWA Executive Committee adopted a resolution endorsing the 1962 revision of the USPHS Drinking Water Standards as "minimum" standards for all public water supplies.

The resolution, which will be included with the published standards, read:

WHEREAS, the 1962 Drinking Water Standards of the U.S. Public Health Service, as prepared by the Advisory Committee on Revision of U.S. Public Health Service 1946 Drinking Water Standards and promulgated for use in the administration of interstate quarantine regulations, are intended to apply only to water used on common carriers engaged in interstate commerce;

WHEREAS, the 1962 Drinking Water Standards are to serve as minimum requirements to protect the health and promote the well-being of individuals and of communities;

WHEREAS, it is the desire of the American Water Works Association to support all efforts to promote health through safe water supplies and to recognize reasonable standards of quality for water furnished by public water supply systems; and,

WHEREAS, it is the hope of the American Water Works Association that its acceptance of the 1962 Drinking Water Standards will establish these standards as minimum criteria of quality for all public water supplies in the United States; now, therefore, be it

*Resolved* by the Officers and Directors of the American Water Works Association, that the 1962 Drinking Water Standards of the U.S. Public Health Service be accepted as minimum standards for all public water supplies.

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## ADVISORY COMMITTEE REPORT

Domestic water supplies should protect the health and promote the well-being of individuals and the community. In this report on the revision of the 1946 edition of the Public Health Service Drinking Water Standards, the objective of the Committee is to recommend minimum requirements for reaching this goal.

The Public Health Service Drinking Water Standards were first adopted in 1914 to protect the health of the traveling public. The general and widespread use of these Standards since that time has led to a series of revisions which have been applicable to water supplies generally. The development of atomic energy and other technological advances requires that these Standards again be revised. To carry out this revision, the Chief Sanitary Engineer of the Public Health Service appointed the Advisory Committee. A Technical Subcommittee of Public Health Service Officers and a Toxicological Task Force were established to collect information and prepare suggestions for the consideration of the Advisory Committee.

In preparing this report on the revision of the Standards, the Committee established the following guidelines:

1. The proposed standards should be discussed widely and due cognizance should be given to International and other standards of water quality before a final report is submitted.

2. A new section on radioactivity should be added.

3. Greater attention should be given to the chemical substances being encountered increasingly in both variety and quantity in water sources.

4. In establishing limits for toxic substances, intake from food and air should be considered.

5. The rationale employed in determining the various limits should be included in an appendix.

6. The proposed format, with the exceptions noted above, should not differ greatly from the present Standards.

7. The Standards should be generally acceptable and should be applicable to all public water supplies in the United States, as well as those supplies used by carriers subject to the Public Health Service regulations.

8. The following two types of limits used in previous editions should be continued:

- (a) Limits which, if exceeded, shall be grounds for rejection of the supply. Substances in this category may have adverse effects on health when present in concentrations above the limit.

- (b) Limits which should not be exceeded whenever more suitable supplies are, or can be made, available at reasonable cost. Substances in this category, when present in concentrations above the limit, are either objectionable to an appreciable number of people or exceed the levels required by good water quality control practices.

9. These limits should apply to the water at the free-flowing outlet of the ultimate consumer.

This revision of the Drinking Water Standards includes, for the first time, limiting concentrations of radioactivity in water. The effects on large popula-

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tion groups of chronic exposure to low levels of radioactivity are not yet well defined. The limits presented herein are an effort to derive conservative values from the best information now available and may be adjusted upward or downward as new and better data become available.

The Committee has taken cognizance of the growing problem of potentially harmful chemicals in sources of drinking water. Limits for several new chemicals have been added, including a gross limit for the concentration of some types of synthetic chemicals. It was not feasible, however, to include limits for all the many chemicals that have varying degrees of toxic potential. Consideration was given to the more common chlorinated hydrocarbon and organophosphate insecticides but the information available was not sufficient to establish specific limits for these chemicals. Moreover, the concentrations of these chemicals, where tested, have been below those which would constitute a known health hazard. The Committee believes that pollution of water supplies with such contaminants can become significant and urges that the problem be kept under closer surveillance. Further, the Committee recommends that regulatory actions be taken to minimize concentrations of such chemicals in drinking water.

In view of the accelerating pace of new developments affecting water quality, the Committee recommends that a mechanism be established for continual appraisal and appropriate revision of the Standards. It also recommends that the Public Health Service intensify its continuing studies toward the development of basic information on the relationship of the biological, chemical, physical, and radiological aspects of water quality to health.

The following pages contain the Drinking Water Standards recommended by the Committee, the membership of which is listed in appendix F.

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## PUBLIC HEALTH SERVICE DRINKING WATER STANDARDS—1962

Standards promulgated by the Public Health Service, U.S. Department of Health, Education, and Welfare, Effective April 5, 1962, for potable water used by carriers subject to the Federal Quarantine Regulations

(Superseding Standards adopted Feb. 6, 1946)<sup>1</sup>

### 1. DEFINITION OF TERMS

The terms used in these Standards are as follows:

**1.1 Adequate protection by natural means** involves one or more of the following processes of nature that produces water consistently meeting the requirements of these Standards: dilution, storage, sedimentation, sunlight, aeration, and the associated physical and biological processes which tend to accomplish natural purification in surface waters and, in the case of ground waters, the natural purification of water by infiltration through soil and percolation through underlying material and storage below the ground water table.

**1.2 Adequate protection by treatment** means any one or any combination of the controlled processes of coagulation, sedimentation, absorption, filtration, disinfection, or other processes which produce a water consistently meeting the requirements of these Standards. This protection also includes processes which are appropriate to the source of supply; works which are of adequate capacity to meet maximum demands without creating health hazards, and which are located, designed, and constructed to eliminate or prevent pollution; and conscientious operation by well-trained and competent personnel whose qualifications are commensurate with the responsibilities of the position and acceptable to the Reporting Agency and the Certifying Authority.

**1.3 Certifying Authority** means the Surgeon General of the U.S. Public Health Service or his duly authorized representatives. Reference to the Certifying Authority is applicable only for those water supplies to be certified for use on carriers subject to the Public Health Service Regulations—(42 CFR Part 72).

**1.4 The coliform group** includes all organisms considered in the coliform group as set forth in *Standard Methods for the Examination of Water and Wastewater*, current edition, prepared and published

<sup>1</sup>Public Health Reports 61: 371-384, March 15, 1946.

jointly by the American Public Health Association, American Water Works Association, and Water Pollution Control Federation.

1.5 *Health hazards* mean any conditions, devices, or practices in the water supply system and its operation which create, or may create, a danger to the health and well-being of the water consumer. An example of a health hazard is a structural defect in the water supply system, whether of location, design, or construction, which may regularly or occasionally prevent satisfactory purification of the water supply or cause it to be polluted from extraneous sources.

1.6 *Pollution*, as used in these Standards, means the presence of any foreign substance (organic, inorganic, radiological, or biological) in water which tends to degrade its quality so as to constitute a hazard or impair the usefulness of the water.

1.7 *Reporting Agencies* means the respective official State health agencies or their designated representatives.

1.8 *The standard sample* for the bacteriological test shall consist of:

1.81 For the bacteriological fermentation tube test, five (5) standard portions of either:

(a) ten milliliters (10 ml)

(b) one hundred milliliters (100 ml)

1.82 For the membrane filter technique, not less than fifty milliliters (50 ml).

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

## 2. SOURCE AND PROTECTION

2.1 The water supply should be obtained from the most desirable source which is feasible, and effort should be made to prevent or control pollution of the source. If the source is not adequately protected by natural means, the supply shall be adequately protected by treatment.

2.2 Frequent sanitary surveys shall be made of the water supply system to locate and identify health hazards which might exist in the system. The manner and frequency of making these surveys, and the rate at which discovered health hazards are to be removed, shall be in accordance with a program approved by the Reporting Agency and the Certifying Authority.

2.3 Approval of water supplies shall be dependent in part upon:

(a) Enforcement of rules and regulations to prevent development of health hazards;

(b) Adequate protection of the water quality throughout all parts of the system, as demonstrated by frequent surveys;

(c) Proper operation of the water supply system under the responsible charge of personnel whose qualifications are acceptable to the Reporting Agency and the Certifying Authority;

(d) Adequate capacity to meet peak demands without development of low pressures or other health hazards; and

(e) Record of laboratory examinations showing consistent compliance with the water quality requirements of these Standards.

2.4 For the purpose of application of these Standards, responsibility for the conditions in the water supply system shall be considered to be held by:

(a) The water purveyor from the source of supply to the connection to the customer's service piping; and

(b) The owner of the property served and the municipal, county, or other authority having legal jurisdiction from the point of connection to the customer's service piping to the free-flowing outlet of the ultimate consumer.

### 3. BACTERIOLOGICAL QUALITY

#### 3.1 *Sampling.*

3.11 Compliance with the bacteriological requirements of these Standards shall be based on examinations of samples collected at representative points throughout the distribution system. The frequency of sampling and the location of sampling points shall be established jointly by the Reporting Agency and the Certifying Authority after investigation by either agency, or both, of the source, method of treatment, and protection of the water concerned.

3.12 The minimum number of samples to be collected from the distribution system and examined each month should be in accordance with the number on the graph in Figure I, for the population served by the system. For the purpose of uniformity and simplicity in application, the number determined from the graph should be in accordance with the following: for a population of 25,000 and under—to the nearest 1; 25,001 to 100,000—to the nearest 5; and over 100,000—to the nearest 10.

3.13 In determining the number of samples examined monthly, the following samples may be included, provided all results are assembled and available for inspection and the laboratory methods and technical competence of the laboratory personnel are approved by the Reporting Agency and the Certifying Authority:

(a) Samples examined by the Reporting Agency.

(b) Samples examined by local government laboratories.

DRINKING WATER STANDARDS, 1962

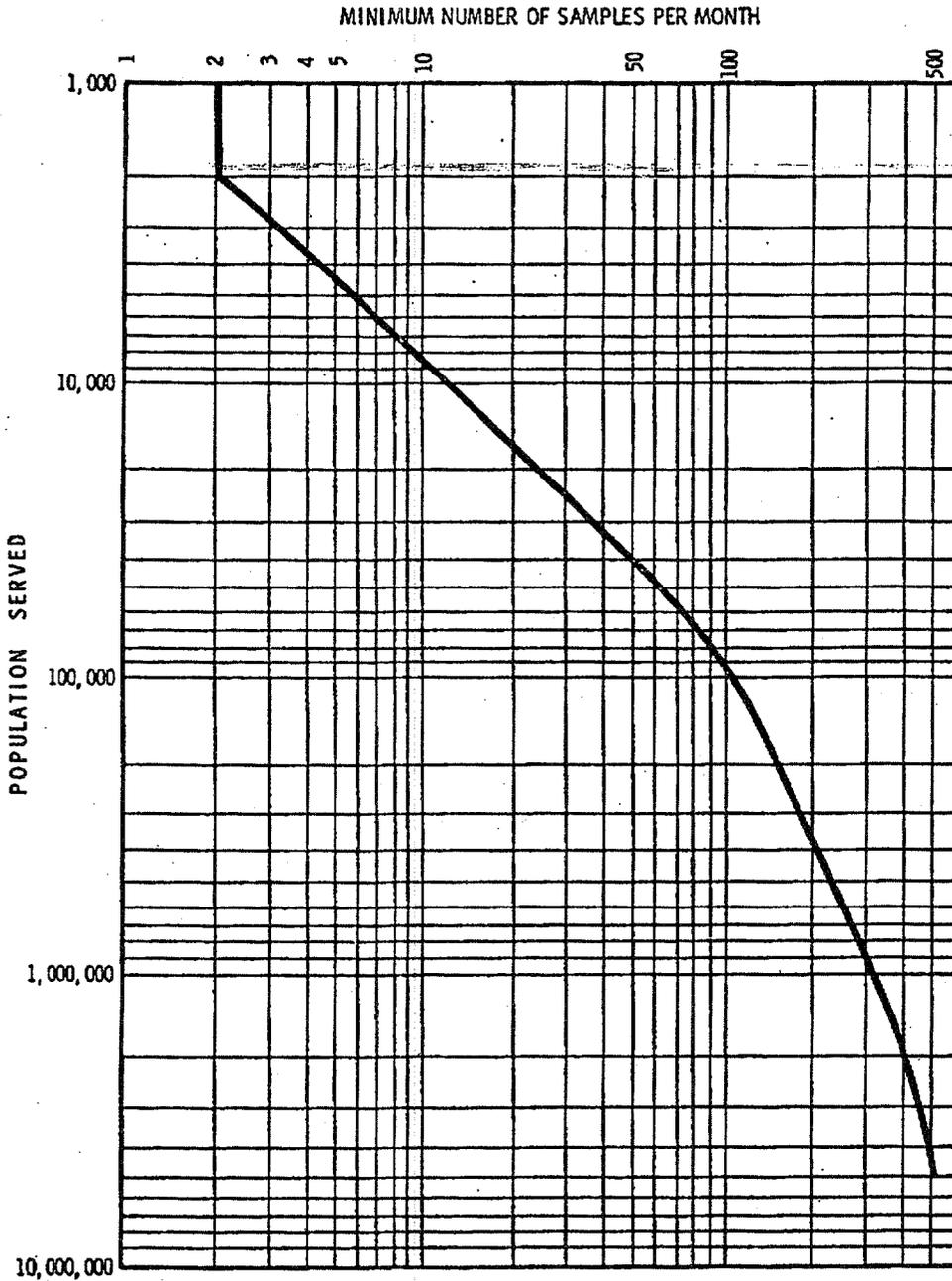


Figure 1

(c) Samples examined by the water works authority.

(d) Samples examined by commercial laboratories.

3.14 The laboratories in which these examinations are made and the methods used in making them shall be subject to inspection at any time by the designated representatives of the Certifying Authority and the Reporting Agency. Compliance with the

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until the results obtained from at least two consecutive samples show the water to be of satisfactory quality.

3.23 When the membrane filter technique is used, the arithmetic mean coliform density of all standard samples examined per month shall not exceed one per 100 ml. Coliform colonies per standard sample shall not exceed 3/50 ml, 4/100 ml, 7/200 ml, or 13/500 ml in:

- (a) Two consecutive samples;
- (b) More than one standard sample when less than 20 are examined per month; or
- (c) More than five percent of the standard samples when 20 or more are examined per month.

When coliform colonies in a single standard sample exceed the above values, daily samples from the same sampling point shall be collected promptly and examined until the results obtained from at least two consecutive samples show the water to be of satisfactory quality.

4. PHYSICAL CHARACTERISTICS

4.1 *Sampling.*—The frequency and manner of sampling shall be determined by the Reporting Agency and the Certifying Authority. Under normal circumstances samples should be collected one or more times per week from representative points in the distribution system and examined for turbidity, color, threshold odor, and taste.

4.2 *Limits.*—Drinking water should contain no impurity which would cause offense to the sense of sight, taste, or smell. Under general use, the following limits should not be exceeded:

Turbidity -----	5 units
Color -----	15 units
Threshold Odor Number -----	3

5. CHEMICAL CHARACTERISTICS

5.1 *Sampling.*

5.11 The frequency and manner of sampling shall be determined by the Reporting Agency and the Certifying Authority. Under normal circumstances, analyses for substances listed below need be made only semiannually. If, however, there is some presumption of unfitness because of the presence of undesirable elements, compounds, or materials, periodic determinations for the suspected toxicant or material, should be made more frequently and an exhaustive sanitary survey should be made to determine the source of the pollution. Where the concentration of a substance is not expected to increase in processing and distribution, available and acceptable source water analyses performed in accordance with standard methods may be used as evidence of compliance with these Standards.

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5.12 Where experience, examination, and available evidence indicate that particular substances are consistently absent from a water supply or below levels of concern, semiannual examinations for those substances may be omitted when approved by the Reporting Agency and the Certifying Authority.

5.13 The burden of analysis may be reduced in many cases by using data from acceptable sources. Judgment concerning the quality of water supply and the need for performing specific local analyses may depend in part on information produced by such agencies as: (1) The U.S. Geological Survey, which determines chemical quality of surface and ground waters of the United States and publishes these data in "Water Supply Papers" and other reports, and (2) The U.S. Public Health Service which determines water quality related to pollution (or the absence of pollution) in the principal rivers of the Nation and publishes these data annually in "National Water Quality Network." Data on pollution of waters as measured by carbon chloroform extracts (CCE) may be found in the latter publication.

5.2 *Limits.*—Drinking water shall not contain impurities in concentrations which may be hazardous to the health of the consumers. It should not be excessively corrosive to the water supply system. Substances used in its treatment shall not remain in the water in concentrations greater than required by good practice. Substances which may have deleterious physiological effect, or for which physiological effects are not known, shall not be introduced into the system in a manner which would permit them to reach the consumer.

5.21 The following chemical substances should not be present in a water supply in excess of the listed concentrations where, in the judgment of the Reporting Agency and the Certifying Authority, other more suitable supplies are or can be made available.

<i>Substance</i>	<i>Concentration in mg/l</i>
Alkyl Benzene Sulfonate (ABS)-----	0.5
Arsenic (As)-----	0.01
Chloride (Cl)-----	250.
Copper (Cu)-----	1.
Carbon Chloroform Extract (CCE)-----	0.2
Cyanide (CN)-----	0.01
Fluoride (F)-----	(See 5.23)
Iron (Fe)-----	0.3
Manganese (Mn)-----	0.05
Nitrate <sup>1</sup> (No <sub>3</sub> )-----	45.
Phenols-----	0.001
Sulfate (SO <sub>4</sub> )-----	250.
Total Dissolved Solids-----	500.
Zinc (Zn)-----	5.

<sup>1</sup> In areas in which the nitrate content of water is known to be in excess of the listed concentration, the public should be warned of the potential dangers of using the water for infant feeding.

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5.22 The presence of the following substances in excess of the concentrations listed shall constitute grounds for rejection of the supply:

Substance	Concentration in mg/l
Arsenic (As) -----	0.05
Barium (Ba) -----	1.0
Cadmium (Cd) -----	0.01
Chromium (Hexavalent) (Cr <sup>6+</sup> ) -----	0.05
Cyanide (CN) -----	0.2
Fluoride (F) -----	(See 5.23)
Lead (Pb) -----	0.05
Selenium (Se) -----	0.01
Silver (Ag) -----	0.05

5.23 *Fluoride*.—When fluoride is naturally present in drinking water, the concentration should not average more than the appropriate upper limit in Table I. Presence of fluoride in average concentrations greater than two times the optimum values in Table I shall constitute grounds for rejection of the supply.

Where fluoridation (supplementation of fluoride in drinking water) is practiced, the average fluoride concentration shall be kept within the upper and lower control limits in Table I.

TABLE I.

Annual average of maximum daily air temperatures <sup>1</sup>	Recommended control limits— Fluoride concentrations in mg/l		
	Lower	Optimum	Upper
50.0–53.7 -----	0.9	1.2	1.7
53.8–58.3 -----	0.8	1.1	1.5
58.4–63.8 -----	0.8	1.0	1.3
63.9–70.6 -----	0.7	0.9	1.2
70.7–78.2 -----	0.7	0.8	1.0
78.3–90.5 -----	0.6	0.7	0.8

<sup>1</sup> Based on temperature data obtained for a minimum of five years.

In addition to the sampling required by paragraph 5.1 above, fluoridated and defluoridated supplies shall be sampled with sufficient frequency to determine that the desired fluoride concentration is maintained.

## 6. RADIOACTIVITY

### 6.1 Sampling.

6.11 The frequency of sampling and analysis for radioactivity shall be determined by the Reporting Agency and the Certifying Authority after consideration of the likelihood of significant amounts being present. Where concentrations of Ra<sup>226</sup> or Sr<sup>90</sup> may vary considerably, quarterly samples composited over a period of three months are recommended. Samples for determina-

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4. Symons, C. E., Simpson, R. W. Report on fish destruction in the Niagara River in 1937. *Trans. Am. Fish. Soc.* 68: 246 (1938).
5. Smith, O. M. The detection of poisons in public water supplies. *Water Works Eng.* 97: 1293-1312, Nov. 1, 1944.
6. Bodansky, M., and Levy, M. D. I: Some factors influencing the detoxication of cyanides in health and disease. *Arch. Int. Med.* 31: 373-389 (1923).
7. Stokinger, H. E., and Woodward, R. L. Toxicologic methods for establishing drinking water standards. *J. Am. Water Works A.* 50: 515-529, April 1958.
8. Anon. The Merck Index, Ed. 6. Rahway, N.J., Merck & Co., Inc. 1952, p. 508.
9. Spector, W. S. Handbook of toxicology. Tech. Rept. No. 55-16, Wright-Patterson Air Force Base, Ohio, Wright Air Devel. Center, Air Res. and Devel. Command, April 1955.

Literature  
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(7)  
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Literature  
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### FLUORIDE

Fluoride in drinking water will prevent dental caries. When the concentration is optimum, no ill effects will result and caries rates will be 60-65 percent below the rates in communities using water supplies with little or no fluoride (1, 2).

Excessive fluoride in drinking water supplies produces objectionable dental fluorosis which increase with increasing fluoride concentration above the recommended upper control limits.<sup>1</sup> In the United States, this is the only harmful effect observed to result from fluoride found in drinking water (3, 4, 5, 6, 7, 8, 9). Other expected effects from excessively high intake levels are: (a) bone changes when water containing 8-20 mg fluoride per liter (8-20 ppm) is consumed over a long period of time (5); (b) crippling fluorosis when 20 or more mg of fluoride from all sources is consumed per day for 20 or more years (10); (c) death when 2,250-4,500 mg of fluoride (5,000-10,000 mg sodium fluoride) is consumed in a single dose (5).

The optimum fluoride level for a given community depends on climatic conditions because the amount of water (and consequently the amount of fluoride) ingested by children is primarily influenced by air temperature (11, 12, 13, 14). Many communities with water supplies containing less fluoride than the concentration shown as the lower limit for the appropriate air temperature range<sup>1</sup> have provided fluoride supplementation (15, 16, 17). Other communities with excessively high natural fluoride levels have effectively reduced fluorosis by partial defluoridation and by change to a water source with more acceptable fluoride concentration (18, 19).

### LITERATURE CITATIONS

1. Dean, H. T., Arnold, F. A., Jr., and Elvove, E. Domestic water and dental caries. V. Additional studies of the relation of fluoride in domestic waters to dental caries experience in 4,425 white children, age 12 to 14 years, of 13 cities in 4 States. *Pub. Health Rep.* 57: 1155-1179, Aug. 7, 1942.

<sup>1</sup> See Table 1, p. 8 of the Drinking Water Standards.

2. Dean, H. T., Jay, P., Arnold, F. A., Jr., and Elvove, E. Domestic water and dental caries. II. A study of 2,832 white children, aged 12 to 14 years, of 8 suburban Chicago communities, including lactobacillus acidophilus studies of 1,761 children. *Pub. Health Rep.* 56: 761-792, Apr. 11, 1941.
3. Moulton, F. R., Editor. Fluorine and dental health. A.A.A.S. Pub. No. 19, Washington, D.C., 1946, pp. 6-11, 23-31.
4. Dean, H. T. Chronic endemic dental fluorosis (mottled enamel). *J.A.M.A.* 107: 1269-1273 (1936).
5. Shaw, J., Editor. Fluoridation as a public health measure. A.A.A.S. Pub. No. 38, Washington, D.C., 1954, pp. 79-109.
6. Heyroth, F. F. Toxicologic evidence for the safety of fluoridation of public water supplies. *Am. J. Pub. Health* 42: 1568-1575 (1952).
7. McClure, F. J. Fluorine in food and drinking water. *J. J. Am. Diet. A.* 29: 560-564 (1953).
8. U.S. Public Health Service. Natural fluoride content of communal water supplies in the United States. Public Health Service Pub. No. 655, Washington, D.C., U.S. Government Printing Office, 1959.
9. Leoné, N. C., Shimkin, M. B., Arnold, F. A., Stevenson, C. A., Zimmermann, E. B., Geiser, P. B., and Lieberman, J. E. Medical aspects of excessive fluoride in a water supply. *Pub. Health Rep.* 69: 925-936, October 1954.
10. Roholm, K. Fluorine intoxication. A clinical-hygienic study. London, H. K. Lewis & Co., Ltd. (1937).
11. Galagan, D. J., and Lamson, G. G. Climate and endemic dental fluorosis. *Pub. Health Rep.* 68: 497-508, May 1953.
12. Galagan, D. J. Climate and controlled fluoridation. *J. Am. Dent. A.* 47: 159-170, August 1953.
13. Galagan, D. J., Vermillion, J. R., Nevitt, G. A., Stadt, A. M., and Dart, R. E. Climate and fluid intake. *Pub. Health Rep.* 72: 484-490, June 1957.
14. Galagan, D. J., and Vermillion, J. R. Determining optimum fluoride concentrations. *Pub. Health Rep.* 72: 491-493, June 1957.
15. Pelton, W. J., and Wisan, J. M. Dentistry in public health. Philadelphia, Pa., W. B. Saunders Co., 1949, pp. 136-162.
16. Arnold, F. A., Jr., Dean, H. T., Jay, P., and Knutson, J. W. Effect of fluoridated public water supplies on dental caries prevalence. *Pub. Health Rep.* 71: 652-658, July 1956.
17. Anon. Status of fluoridation in community water supplies. *Pub. Health Rep.* 74: 427, May 1959.
18. Dean, H. T., and McKay, F. S. Production of mottled enamel halted by a change in common water supply. *Am. J. Pub. Health* 29: 590-596, June 1939.
19. Dean, H. T., McKay, F. S., and Elvove, E. Mottled enamel survey of Bouxite, Ark., 10 years after a change in the common water supply. *Pub. Health Rep.* 53: 1736-1748, Sept. 30, 1938.

### IRON

Both iron and manganese are highly objectionable constituents in water supplies for either domestic or industrial use. The domestic consumer complains of the brownish color which iron imparts to laundered goods. Iron appreciably affects the taste of beverages (1).

The taste which iron imparts to water may be described as bitter and astringent. Individuals vary in their acuity of taste perception,

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