COMMUNITY WATER SUPPLY STUDY

CHARLESTON, WEST VIRGINIA

STANDARD METROPOLITAN STATISTICAL AREA

BY

Bureau of Water Hygiene

Environmental Control Administration

Environmental Health Service

Public Health Service

DHEW Region III

July 1970

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
REGION III
220 7TH STREET N.E.
CHARLOTTESVILLE, VIRGINIA 22901
July 20, 1970

PUBLIC HEALTH SERVICE
XXXXXXXXXXXXXXXXXXXXX
ENVIRONMENTAL HEALTH SERVICE

THROUGH: N. H. Dyer, M.D., M.P.H.
State Director of Health

Mr. Robert McCall, Director
Environmental Health Services
State Department of Health
State Office Building No. 1
1800 Washington Street, East
Charleston, West Virginia 25305

Dear Mr. McCall:

I am pleased to submit to you our Report on the "Community Water Supply Study - Charleston, West Virginia, Standard Metropolitan Statistical Area". As you know, the Study included thirty (30) water supply systems in Kanawha County, and was part of a national study effort which encompassed seven (7) other metropolitan areas and one (1) entire State.

The field work for the Study was completed in March 1969, however, some of the laboratory analytical results were not available until the Fall. Further delay in presenting a final report was caused by many factors. In the interim period we have forwarded the laboratory results to you, and attempted to keep you informed of findings of the Study.

Because the Report basically includes information on conditions as they existed in March, 1969, we feel that it is important to acknowledge the improvements that have been made to some water supply systems, and the changes that have occurred which affect water supply activities in the Division of Sanitary Engineering.

System Improvements

1. The West Virginia Water Company has extended the Montgomery system to serve the Community of Handley at a cost of $200,000. The water supply system operated by the Chesapeake and Ohio Railway will discontinue supplying water to the Community as soon as service is provided from the Montgomery system.

2. Saint Albans completed installation of tubular settling units in their sedimentation basins providing a significant improvement in clarification. They are proceeding with installation of mixed media filters to expand plant capacity.

3. Charleston system pressures and capacities are being improved by a series of actions. These include new reservoirs, booster stations, and enlargement of mains in conjunction with interstate highway construction.

   Water treated at the Charleston plant is now delivered to Dunbar and the Spring Hill section of South Charleston which were formerly served from the Nitro plant.

4. A new well has been drilled resulting in better quality water and now serves as a source of supply for the Community of Ronda. Samples collected from the Ronda system during the Study showed excessive concentrations of iron, manganese and total dissolved solids.

Changes Affecting Water Supply Activities in the Division of Sanitary Engineering

1. Revised "Public Water Supply Regulations" were adopted by the Department of Health effective December 1, 1969. The Regulations represent an improvement in that they contain provisions for increased bacteriological, chemical, and radiochemical surveillance and include limits for certain chemical constituents.

   It should be emphasized that the regulations in force prior to adoption of present regulations required a substantially lower level of bacteriological surveillance than that required by the Public Health Service "Drinking Water Standards." Since the Public Health Service "Drinking Water Standards" were utilized in the Study to evaluate bacteriological surveillance, some of the communities listed in the Report in Appendix C as not collecting sufficient bacteriological samples, were actually complying with the State regulations.

2. Professional positions authorized by the Legislature in January, 1969, and effective July 1, 1969, were recently filled. The State Health Department's professional staff had decreased in July, 1968, to one engineer working part time on water supply activities plus bacteriological laboratory support. By the time of the Community Water Supply Study, one engineer had been added. The next change was in January, 1970, when two (2) chemists were employed. The professional

staff now assigned to public water supply activities includes two and one-half ($2\frac{1}{2}$) engineers, one and one-half ($1\frac{1}{2}$) chemists, and two (2) bacteriologists for a total of six, contrasting with an estimated requirement of at least 15.

3. Improvement of the State Health Department's surveillance program has been on a statewide basis and was predicated upon completing preparation of the new regulation and meeting its requirements. The water supply files were completely revamped to enable prompt recall of data, including bacteriological results, operating reports, plan reviews, chemical analyses, and plant inspections. When the regulation became effective on December 1, 1969, a copy was sent to each system in the State and advice given on the number of samples required and the number of samples received as of that date. Beginning with the third quarter of Fiscal Year 1970, a quarterly summary was initiated and will continue to be provided to each water supply system indicating their compliance or non-compliance with bacteriological and operating report requirements. Each system is now required to submit detailed plant data in support of an application for an operating permit. With the employment of two chemists in January, 1970, progress is being made to enable complete chemical and radiochemical analysis for all systems in the State. Limited analyses have been accomplished during the staffing, equipping, and organization of the laboratory. Routine analyses of all State water supplies should commence in the first quarter of Fiscal Year 1971.

4. The improvement in surveillance over water supply systems in Kanawha County is illustrated in tabulated form below for the past two (2) fiscal years:

	FISCAL YEAR 1969	FISCAL YEAR 1970
BACTERIOLOGICAL FREQUENCY MET	3	15
COMPLETE CHEMICAL ANALYSIS	0	10
SYSTEMS WITH LICENSED OPERATORS	17	18
PLANT INSPECTIONS	1	14

Mr. Gerald Ferguson and I are very pleased to note the above improvements to the systems in Kanawha County, and to water supply activities in the

Division of Sanitary Engineering. We wish you success in further strengthening of the Division, and implementing recommendations contained in the Report on the Community Water Supply Study - Charleston, West Virginia, Standard Metropolitan Statistical Area.

We would like to take this opportunity to express our appreciation for the cooperation and assistance extended to us by employees of the Division of Sanitary Engineering, the Charleston-Kanawha County Health Department, and especially to the water supply system operators who participated in the Study.

Sincerely yours,

Edwin C. Lippy

Edwin C. Lippy, P.E.
Acting Regional Representative
Bureau of Water Hygiene

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SUMMARY OF FINDINGS AND CONCLUSIONS

As part of the Community Water Supply Study (CWSS), the Bureau of Water Hygiene of the U.S. Public Health Service, Region III, Office of the Department of Health, Education, and Welfare (DHEW) in cooperation with the West Virginia State Department of Health and the Charleston-Kanawha County Health Department, conducted a study of water systems in the Charleston Standard Metropolitan Statistical Area (SMSA) during March 1969. The study included thirty (30) public water supplies serving about 229,000 people or 91 percent of the SMSA population, and was designed to assess: (a) the status of drinking water quality, (b) water supply system facilities, and (c) bacteriological surveillance programs in urban and suburban areas.

The following are the principal findings of the study.

A. Drinking Water Quality

1. To determine the quality of the drinking water in the 30 communities studied, samples were taken at various places in the distribution systems. The data were averaged for each system and constituent concentrations compared to the bacteriological, chemical, and physical constituent limits of the 1962 U.S. Public Health Service Drinking Water Standards (DWS). On this basis:

(a) Fourteen (14) or forty-seven (47) percent of the systems delivered drinking water that did not exceed any of the constituent limits.

(b) Additionally, thirteen (13) or forty-three (43) percent of the systems delivered drinking water that exceeded at least one of the DWS "recommended limits" (Defined on Page 12) but did not exceed any of the DWS "mandatory limits" (Defined on Page 13).

(c) Finally, three (3) or ten (10) percent of the systems delivered drinking water that exceeded one or more of the DWS mandatory limits.

2. The quality of drinking water delivered to the smaller and larger population groups is compared and summarized below:

	LESS THAN 5000 Population (25 Systems Total)	GREATER THAN 5000 Population (5 Systems Total)	ALL SYSTEMS (30 Systems)
DOES NOT EXCEED CONSTITUENT LIMITS	11 (44%)	3 (60%)	14 (47%)
EXCEEDED RECOMMENDED LIMITS	12 (48%)	1 (20%)	13 (43%)
EXCEEDED MANDATORY LIMITS	2 (8%)	1 (20%)	3 (10%)

3. Of the thirteen (13) systems that delivered water that exceeded the recommended constituent limits, iron, manganese, turbidity, and total solids were the constituents most often exceeded.

4. Of the three (3) systems that delivered water that exceeded the mandatory limits, two (2) exceeded the bacteriological limits and one (1) the chemical limits.

5. Samples of water from surface water supplies were analyzed for pesticides and only insignificant traces were found.

6. Sixty-three (63) percent of the total population served or 144,000 people were served water that met the constituent limits,

twenty-eight (28) percent or 64,000 people were served water that did not meet the recommended limits and nine (9) percent or 21,000 people were served water that did not meet the mandatory limits.

7. The most common consumer complaints reported by operators were from taste and odors and plumbing fixture staining resulting from deposition of iron and manganese.

B. Water Supply System Facilities

1. To determine the status of the facilities used to treat, distribute, and store public drinking water, site surveys and interviews with operators were conducted regarding the water supply system. Based on this information only two (2) systems or six (6) percent did not have any major deficiencies while twenty-eight (28) systems or ninety-four (94) percent had one or more of the following major deficiencies: (1) Inadequate source protection, (2) inadequate disinfection and/or control of disinfection, (3) inadequate clarification (removal of suspended matter) and/or control of clarification and, (4) inadequate pressure in the distribution system.

2. Four (4) systems or thirteen (13) percent did not provide chlorination, and twelve (12) or forty (40) percent practiced inadequate chlorination.

3. Twelve (12) or forty (40) percent did not have adequate clarification, and of these seven (7) or twenty-three (23)

percent did not have adequate control of the clarification.

4. Inadequate pressure (less than 20 psi) in the distribution system was found in twelve (12) systems or forty (40) percent of the systems surveyed.

5. Eight (8) systems are providing fluoridated water to the consumers. These are the larger systems and serve 215,000 people of the 229,000 served by public water systems.

6. Reliable data regarding safe yield for surface sources and maximum dependable draft for groundwater sources was not available or unknown for most of the communities surveyed.

C. Bacteriological Surveillance Programs

1. The bacteriological records both in the utilities and in the State Department of Health were not carefully maintained, and in some cases it was difficult or impossible to find them. (Since the field survey, the State Department of Health has made considerable improvements in the maintenance of records.)

2. To determine the status of the bacteriological surveillance over each water supply system surveyed, records in the State Department of Health and the utilities were examined for the number of samples collected and their results during the last twelve (12) months of record. Based on this information, only three (3) systems or ten (10 percent) had bacteriological surveillance that met the criteria (see page 13) while twenty seven (27) or ninety (90) percent either did not collect sufficient samples or samples showed poor bacterial quality, or both.

3. The data on the adequacy of bacteriological surveillance programs related to system size are summarized below:

	LESS THAN 5000 Population (25 Systems Total)	GREATER THAN 5000 Population (5 Systems Total)	ALL SYSTEMS (30 Systems)
MET CRITERIA	1 (4%)	2 (40%)	3 (10%)
DID NOT MEET CRITERIA	24 (96%)	3 (60%)	27 (90%)

4. During the previous twelve (12) months sufficient samples were collected from four (4) systems. Of these four (4) systems, three (3) had satisfactory results.

D. Other Major Findings and Conclusions

1. Data were collected on the date of the previous sanitary survey, last complete chemical analysis, and the status of a program to eliminate and control cross-connections and hazardous plumbing conditions. Results indicate that in most cases there was no record of the last sanitary survey, and that a survey had not been conducted within the past three years; that a complete chemical analysis had not been conducted for any system; and, that none of the systems had a cross-connection control program.

2. All plant operators are required by State regulation to be registered and certified. Seventeen of the thirty (30) community water supply systems surveyed have complied with this regulation. Of the thirteen (13) systems that are operated by uncertified operators, twelve (12) are in

the population group serving less than 1000 people. The State Department of Health has a training program to certify and upgrade operators and is proceeding with the examination of operators and issuing certificates to successful candidates.

3. Twelve (12) of the fourteen (14) systems serving population groups of less than 1000 people are operated on a part-time basis. Eighteen (18) systems are operated by personnel on a full-time basis.

4. In some cases, the quality of water delivered, operation and maintenance of facilities, and surveillance could be improved if the systems serving several small communities merged to form a public service district or one utility.

5. In general, the larger systems delivered water of better quality, are better operated and maintained, and exhibited a better degree of surveillance than the smaller systems.

RECOMMENDATIONS

Based on results of the Community Water Supply Study conducted in the Charleston, West Virginia Standard Metropolitan Statistical Area, the following recommendations are presented:

1. Surveillance by the Division of Sanitary Engineering, West Virginia State Department of Health over water supply systems be drastically improved. This improvement should consist of the following:

(a) surveillance be improved for those twenty-seven (27) systems not in compliance with bacteriological requirements of the Drinking Water Standards.

(b) surveillance be improved for the thirty (30) systems not in compliance with chemical requirements of the Drinking Water Standards.

(c) periodic site visits or sanitary survey of water supply systems be increased to an acceptable frequency, but not less than once per year.

(If results of the Study of one County are applicable state-wide, a significant increase in manpower for surveillance-type activities in the Division of Sanitary Engineering is indicated)

2. Necessary improvements be initiated for each system which exhibited bacteriological and chemical concentration in excess of the Drinking Water Standards and priority be given to improving

those three (3) systems not in compliance with the mandatory constituent limits.

3. Improvements be made to those twenty-eight (28) systems where deficiencies were found in the storage, treatment, and distribution of water.

4. Safe yield for surface sources and maximum dependable draft for groundwater sources be computed for each system where applicable, so that planning and future expansion as well as daily reliability to meet demands is based upon known capability of the source.

5. The feasibility of mergingsmaller systems into a public service district or one utility to improve operation and maintenance, surveillance, and quality of water, and to reduce costs be investigated. If merging does not prove feasible, consideration be given to utilizing the resources of several small systems in a cooperative effort to employ full-time certified operators for these thirteen (13) systems currently operated by personnel who are not certified.

6. The Division of Sanitary Engineering of the State Department of Health assist the management of water supply systems in implementing programs to eliminate and control cross-connections and hazardous plumbing conditions.

INTRODUCTION

The purpose of the Community Water Supply Study (CWSS) was to determine if the American consumer's drinking water met the Drinking Water Standards. To obtain nationwide coverage, the Bureau of Water Hygiene of the U. S. Public Health Service initiated the CWSS in February of 1969 in nine areas across the country. The field work for the CWSS was conducted by the Bureau of Water Hygiene in cooperation with the state and local health departments and the water utilities.

This study was designed to give an assessment of drinking water quality, water supply systems, and surveillance programs in urban and suburban areas in each of the nine regions of the Department of Health, Education, and Welfare. These areas were selected to give examples of the several types of water supplies in the country. A whole Standard Metropolitan Statistical Area (SMSA) was the basis of each study, except in Region I where the entire State of Vermont was included, with evaluations made on all public water supply systems, as defined herein, in each study area. This coverage allowed an assessment of the drinking water quality of the large central city, the suburbs, and the smaller communities located in the counties in the SMSA, and the interaction between them.

The definition of Standard Metropolitan Statistical Area (SMSA) is given below:

> Standard Metropolitan Statistical Area - The boundaries and titles of standard metropolitan statistical areas are established by the Bureau of the Budget with the advice

of the Federal Committee on Standard Metropolitan Statistical Areas. An SMSA is a county or group of contiguous counties, which contains at lease one city of 50,000 inhabitants or more or "twin cities" with a combined population of at lease 50,000. In addition to the county, or counties, containing such a city or cities, contiguous counties are included in an SMSA if, according to certain criteria, they are essentially metropolitan in character and are socially and economically integrated with the central city.

Specifically, the objectives of this study were accomplished by determining whether:

1. The quality of the urban and suburban American consumer's drinking water in the selected study areas does not exceed the constituent limits of the Drinking Water Standards (DWS);*

2. The water supply systems supplying this drinking water to the consumers are essentially free from major deficiencies; and

3. The surveillance programs over these water supply systems meet the bacteriological surveillance criteria.

The authority for the Community Water Supply Study is found in Title III, Part A, Section 301, Public Health Service Act, as amended (42 U.S.C. 241).

"Sec. 301 - The Surgeon General shall conduct in the Service, and encourage, cooperate with, and render assistance to other appropriate public authorities, scientific institutions, and scientists in the conduct of, and promote the coordination of, research, investigations, experiments, demonstrations, and studies relating to the causes, diagnosis, treatment, control, and prevention of physical and mental diseases and impairments of man, including water purification..."

*1962 U.S. Public Health Service Drinking Water Standards; PHS Publ. No. 956, Superintendent of Documents, Government Printing Office, Washington, D. C. 20402, 61 pp.

In Region III, the Charleston, West Virginia, Standard Metropolitan Statistical Area was selected for the Study. It includes all of Kanawha County. All water supplies serving 25 or more people, or having at lease 15 services, were surveyed. The field work began on March 17, 1969, and terminated on March 27, 1969.

In the conduct of this study cooperation was received from the West Virginia State Department of Health and the Charleston-Kanawha County Health Department.

SCOPE

Public water supplies in the United States numbered 19,236 serving some 150,000,000 when last inventoried in 1963.* The remaining 50,000,000 people had private water supplies. Most of the public water supplies were small, about 85 percent serving 5,000 or less people. About half of the public was served by the 18,837 supplies that each served 100,000 or less persons and the other half (77,000,000) were served by the 399 larger supplies. About 75 percent of these public water supplies have ground water as a source, while 18 percent use surface water. The remaining 7 percent have a mixture of ground and surface water source.

A. Systems Studied

This study covered 969 public water supply systems, including 894 community water supply systems (91.4% of the total) and 75 special water supply systems (9.6% of the total). For this study the following definitions of the systems were used.

PUBLIC WATER SUPPLY SYSTEM - A water supply system includes the works and auxiliaries for collection, treatment, storage, and distribution of water from the sources of supply to the free-flowing outlet of the ultimate consumer. Water supply systems were included in this study, if they had 15 or more service connections and/or served 25 or more consumers.

Special Water Supply Systems - are those systems serving trailer and mobile home parks, and institutions with resident populations.

Community Water Supply Systems - are all other systems studied in an SMSA.

*Statistical summary of Municipal Water Facilities in the United States, January 1, 1963: PHS Publ. No. 1039, Government Printing Office, Washington, D. C. 1965, 66 pp.

B. Study Area

In the Charleston (SMSA) 30 public water supply systems were studied serving about 229,000 persons. They consisted of 13 ground water systems (wells and springs), 14 surface water systems, and 3 systems buying finished water from another system, hereafter called wholesale finished water source systems.

For the purpose of this report, water supply systems were divided into four categories; 1) those using surface water or a mixture of surface and ground water as a source; 2) those using ground water as a source (this category was further divided into; a) wells, b) springs, and c) springs and wells); and 3) those purchasing finished water as a source; and 4) special water supply systems.

Table 1 gives data on type, population, average daily demand, and source for the supplies included in this study. Table 3a and 3b (pages 25 and 26) show the number of systems in each category and the populations served.

TABLE 1

Community	Type	Population Served	Average Daily Demand (M.G.)	Source
Acme	2a	120	0.005	ground
Alum Creek	1	2,000	0.075	Coal River
Belle	1	8,700	0.950	Kanawha River
Burnwell	2a	100	?	ground
Carbon	2a	130	0.007	ground
Cedar Grove	1	1,750	0.075	Kanawha River
Charleston	1	121,000	18.000	Elk River
Chelyan	1	2,100	0.108	Kanawha River
Clendenin	1	3,500	0.185	Elk River
Corton	1	36	0.010	Elk River
Crown Hill	3	250	0.020	Pratt
Decota	2a	320	0.020	ground
Eastbank	3	1,200	0.080	Cedar Grove
Glasgow	3	1,000	0.100	Cedar Grove
Handley	1	1,000	0.170	Kanawha
Kayford	2b	100	?	ground
Leewood	2a	150	0.010	ground
Miami	2a	1,100	0.050	ground
Montgomery	1	6,500	0.276	Kanawha River
Nitro	1	52,000	9.000	Kanawha River
Pinch	1	1,025	0.050	Elk River

Table 1 - Continued

Community	Type	Population Served	Average Daily Demand (M.G.)	Source
Pratt	1	1,250	0.080	Kanawha River
Rensford	2a	100	0.010	ground
Republic	2a	90	0.003	ground
Ronda	2a	256	0.014	ground
St. Albans	1	20,000	1.210	Coal River
Sissonville	1	2,500	0.107	Pocatalico River
Shrewsbury	2a	640	0.045	ground
Ward	2a	45	0.025	ground
Winifrede	2a	60	0.010	ground

C. General Description of Area

The Charleston, West Virginia, Standard Metropolitan Statistical Area includes all of Kanawha County. The terrain of this area is extremely hilly and land with a gentle slope is at a premium, or already developed. The majority of the development is along major drainage channels or the flood plain, as shown by the map on the following page. This type of development is possible by the use of reservoirs and levees for the control of flood flows.

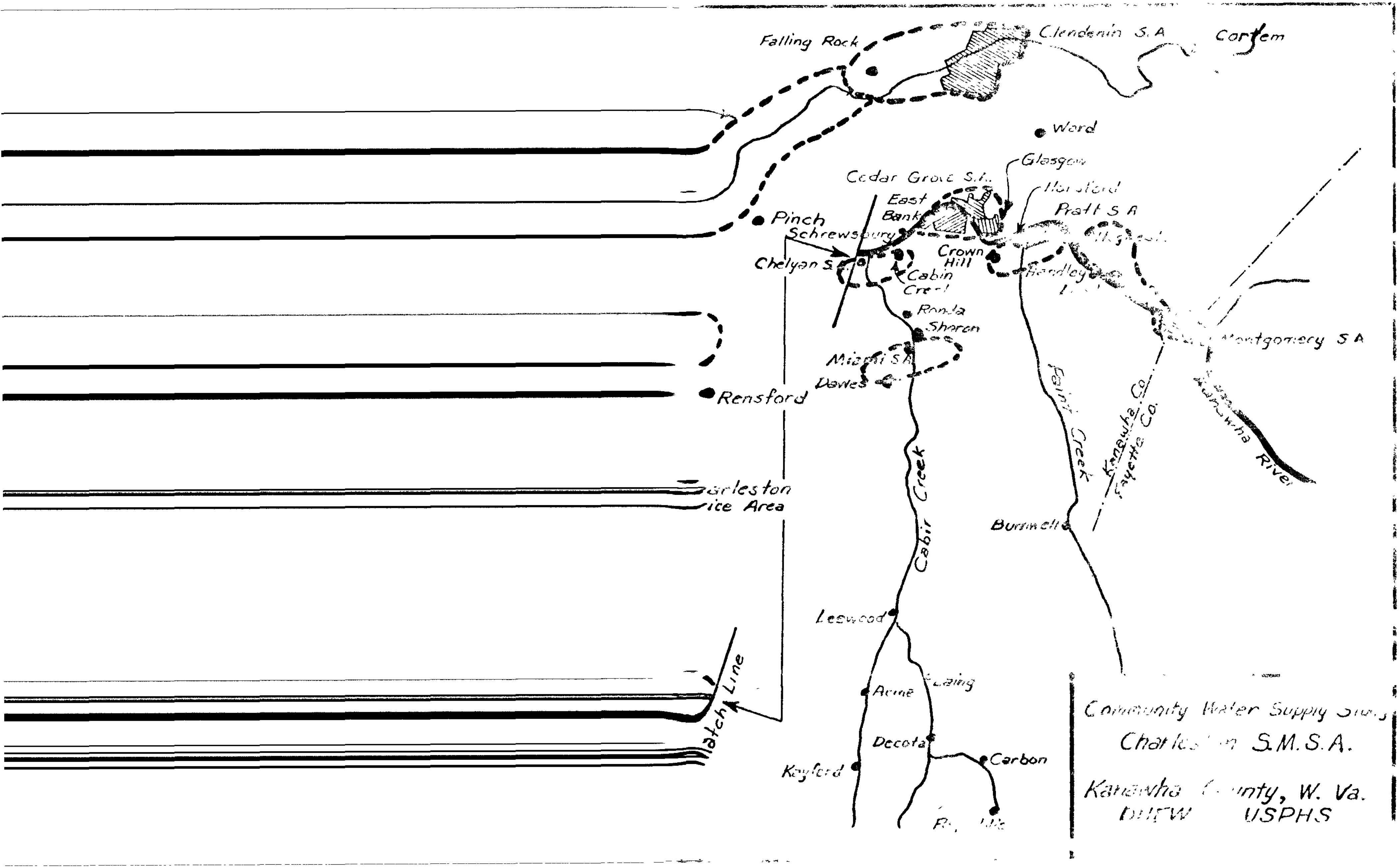
Industrial, commercial, and residential development in the Charleston area is along the Kanawha and Elk Rivers. Other development is generally confined to the banks of small tributaries of these rivers.

The 1960 Census indicates that Kanawha County population was 252,900. The population was projected for the purpose of a water resource study of the Kanawha River Basin as follows:

1960	1970	1980	1990	2000	2010	2020
252,900	251,000	251,200	257,100	262,000	282,100	292,300

These projections were later revised to reflect the philosophy of expanded development under the Appalachian Regional Development Act, and were termed "developmental benchmarks." They are as follows:

1960	1980	2000	2020
252,900	334,100	453,900	589,900



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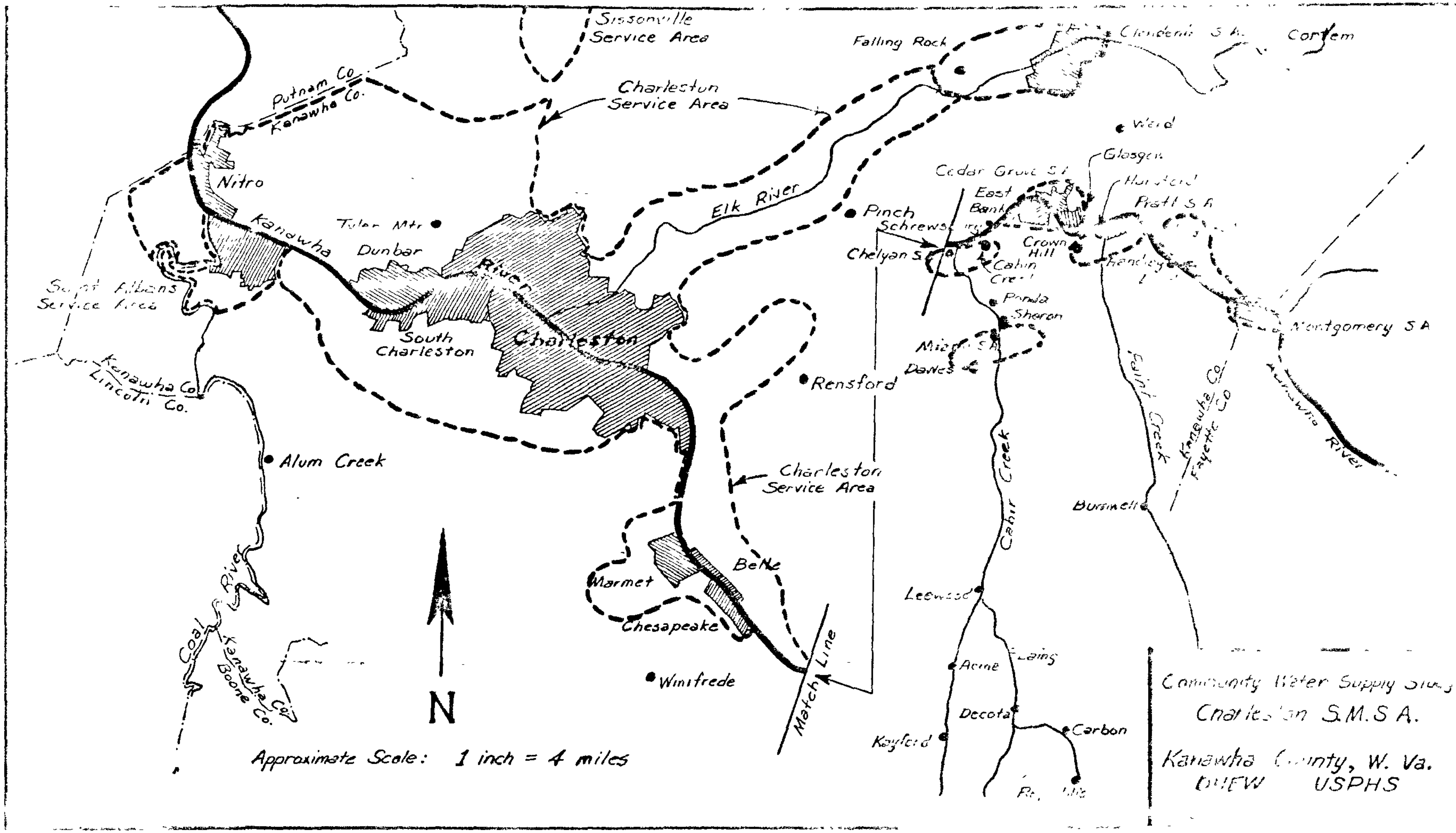
Kanawha County, W. Va.
DHEW USPHS


Sissonville
Service Area
Charleston
Service Area
Charleston
Service Area
Falling Rock
Cortem
Putnam Co.
Kanawha Co.
Nitro
Kanawha
River
Tyler Mtn
Dunbar
South
Charleston
Charleston
Elk River
Pinch
Chelyan
Cedar Grove
East
Bank
Glasgow
Pratt
Crown
Hill
Cabin
Creek
Sharon
Montgomery
Rensford
Kanawha Co.
Lincoln Co.
Alum Creek
Cabin Creek
Paint Creek
Kanawha Co.
Fayette Co.
Kanawha River
Burnwell
Leewood
Belle
Marmet
Chesapeake
Winifrede
Match Line
Acme
Decota
Carbon
Kayford
Coal River
Kanawha Co.
Boone Co.
N
Approximate Scale: 1 inch = 4 miles
Charleston S.M.S.A.
Kanawha County, W. Va.
USPHS

Development under the Act has not influenced population growth in the Charleston Area, mainly because sufficient time has not elapsed since its inception.

Assuming that population has followed the earlier projections, the present population should be approximately 252,000.

The Kanawha River is heavily relied upon by industry in the Charleston Area. Manufacturing employs approximately 25% of the labor force, with almost one half of this number working in chemicals and allied products. Approximately 40% of the labor force is evenly divided between wholesale and retail trade, and personal and business service. Mining and construction account for another 10% with the remainder going to other forms of employment. The Kanawha River Basin has been referred to as the "Ruhr Valley of America."

EVALUATION CRITERIA

Each water supply system was investigated on three bases: 1) drinking water quality was determined by sampling the finished and distributed water and returning these samples to the laboratories of the Bureau of Water Hygiene for bacteriological, chemical, and trace metal analyses, 2) the status of the water supply system facilities was determined by a field survey of the system and the gathering of data on three standard forms (four items were chosen to represent major problems; a) source(s), b) treatment, if any, c) distribution system pressures, and d) operation); 3) the status of the surveillance program over the water supply system was evaluated by obtaining bacteriological water quality data for the previous 12 months of record from State and county health department files.

A. Water Quality Criteria

Water quality was judged either:

(1) Not to exceed the Constituent Limits of the DWS (hereafter called Does not exceed limits), or,

(2) To exceed at least one "recommended" Constituent Limit (some are aesthetic parameters), but does not exceed any "mandatory" Constituent Limit (hereafter called Exceed recommended, but not mandatory limits) or,

(3) To exceed at least one "mandatory" Constituent Limit (hereafter called Exceed mandatory limits).

The limits for the constituents measured in this study are summarized in Table 2.

TABLE 2

Partial List of Bacteriological, Chemical, and Physical Constituent Concentration Limits Taken from the 1962 U. S. Public Health Service Drinking Water Standards

RECOMMENDED LIMITS

Constituent	Limit
Alkyl Benzene Sulfonate	
(Measured as methylene-blue-active substances)	0.5 mg/l
Arsenic	0.01 mg/l*
Boron	1.0 mg/l**
Chloride	250 mg/l
Color	15 Units
Copper	1.0 mg/l
Carbon-Chloroform Extract (CCE)	0.200 mg/l
Cyanide	0.01 mg/l
Fluoride	
Temp. (Ann.Avg.Max.Day, 5 years or more	
50.0-53.7	1.7 mg/l
53.8-58.3	1.5 mg/l
58.4-63.8	1.3 mg/l
63.9-70.6	1.2 mg/l
70.7-79.2	1.0 mg/l
79.3-90.5	0.8 mg/l
Iron	0.3 mg/l
Manganese	0.05 mg/l
Nitrate	45 mg/l
Radium-226	3 uuc/l (pc/l)***
Strontium-90	10 uuc/l (pc/l)***
Sulfate	250 mg/l
Total Dissolved Solids (TDS)	500 mg/l
Turbidity	
Untreated	5 Units
Treated by more than disinfection	1 Unit
Zinc	5 mg/l

TABLE 2 (Cont'd)

MANDATORY LIMITS

(If the concentration of any of these constituents are exceeded, the further use of this water for drinking and culinary purposes should be evaluated by the appropriate health authority because water of this quality represents a potential hazard to the health of consumers.)

Constituent	Limit
Arsenic	0.05 mg/l
Barium	1.0 mg/l
Boron	5.0 mg/l**
Cadmium	0.01 mg/l
Chromium (hexavalent)	0.05 mg/l
Coliform organisms (Measured by membrane filter technique)	Fails std. if: a) Arithmetic average of samples collected greater than 1 per 100 ml b) Two or more samples (5% or more if more than 20 examined) contain densities more than 4/100 ml
	0.2 mg/l
Cyanide	0.2 mg/l
Fluoride	
Temp. (Ann.Avg.Max.Day - 5 years or more)	
50.0-53.7	2.4 mg/l
53.8-58.3	2.2 mg/l
58.4-63.8	2.0 mg/l
63.9-70.6	1.8 mg/l
70.7-79.2	1.6 mg/l
79.3-90.5	1.4 mg/l
Gross Beta activity (in the absence of alpha or Sr-90)	1,000 uuc/l (pc/l)***
Lead	0.05 mg/l
Selenium	0.01 mg/l
Silver	0.05 mg/l

*Although the recommended arsenic concentration is 0.01 mg/l, because of interferences in some waters, the concentration of arsenic was only determined to be less than 0.03 mg/l. For the purposes of this study, these waters were considered not to exceed the recommended standard.
**Proposed for inclusion in the Drinking Water Standards.
***If these limits are exceeded, refer to Section 6.2 of the DWS.

B. <u>Facilities Criteria</u>

Source, treatment, operation, and distribution facilities were judged either:

1) To be essentially free from major deficiencies, or

2) To have one or more of the following major deficiencies (where applicable)

a) Inadequate source protection (in absence of disinfection or buying chlorinated water)

b) Inadequate disinfection (if disinfection practiced)

c) Inadequate control of disinfection (if practiced or if purchasing chlorinated water)

d) Inadequate clarification capabilities (if clarification practiced)

e) Inadequate control of clarification (if clarification practiced)

f) Inadequate pressure ($<$20 psi) in some or all areas of the distribution system

C. <u>Bacteriological Surveillance Program Criteria</u>

The bacteriological surveillance program over the water supply system was judged either:

1) To meet the following criteria or,

2) Not to meet one or both of the following,

a) Collection of the required number* of bacteriological

*See pages 3-6 of the Drinking Water Standards.

samples for no less than 11 months during the previous 12 months of record.

b) Passing the bacteriological quality standard* for no less than 11 months during the previous 12 months of record.

*See pages 3-6 of the Drinking Water Standards.

METHODS

A. Field Survey

The regional office staff, in cooperation with the West Virginia State Department of Health and the Charleston-Kanawha County Health Department officials prepared a listing of all known water supplies meeting the definition adopted for this study. The list contained the supply name, address, name of the superintendent or person in charge, and the telephone number. The list was cross-checked with community and subdivision names to eliminate duplication and establish those areas for which the water supply facilities were apparently unknown. A Form PHS-682, Report of Water Supply Used on Interstate Carriers, was prepared for each supply from State records. The completed list became the basis for work schedules for the field engineers. Actual field surveys were made by a staff of 4 PHS engineers from headquarters and the regional office.

During the field survey, the engineer completed Forms ECA-18, Inventory of Municipal Water Facilities, and ECA-19 Municipal Water Supply Sanitary Survey, to provide information on source; treatment; operation; laboratory control; personnel; distribution; surveillance practices; planning for improvements; and water rates. Examples of the standard forms are in the Appendix B.

B. Sampling Program

The following samples were collected and dispatched to various Bureau of Water Hygiene laboratories:

1) Raw water - 1 sample for bacteriological analysis

2) Finished water ready for distribution - 4 or 5 samples for chemical analyses as follows:

   a) 2 1/2-gallon sample to the Northeast Water Hygiene Laboratory. This was a grab sample for most ground water and small surface water treatment plants, but where possible a 14-day composite was taken. The following analyses were made on this sample:

Arsenic	Cyanide	Sulfate
Boron	MBAS	TDS
Chloride	Nitrate	Turbidity
Color	Selenium	

   b) 8-oz. aliquot sample for trace metals analysis was taken out of sample 2)a) above and sent to the Cincinnati Laboratory. The following analyses were made on this sample:

Barium	Copper	Manganese
Cadmium	Fluoride	Nickel
Chromium	Iron	Silver
Cobalt	Lead	Specific Conductance
		Zinc

   c) 1-gallon sample for radioactivity analyses was sent to one of the three Bureau of Radiological Health laboratories. It was collected in the same manner as sample 2)a) above. The following analyses were made on this sample:

Specific gamma emitting radionuclides
(I^{131}, Cs^{137}, Ba^{140})

Gross Alpha

Gross Beta

Radium-226, if gross alpha exceeded 3 pc/l

Strontium-90, if gross beta exceeded 10 pc/l

Tritium - (run on 10% of samples)

d) 1-gallon sample for pesticide analysis to the Gulf Coast Water Hygiene Laboratory from surface water supplies. It was collected in the same manner as sample 2)a) above. The following analyses were made on this sample:

Aldrin	Dieldrin	Heptachlor Epoxide
Chlordane	Endrin	Lindane
DDT	Heptachlor	Methoxychlor
		Toxaphene

e) 1 activated carbon monitor sample to the Cincinnati Laboratory from twelve systems having surface sources. Two systems that had surface sources were not sampled because the sources were considered similar to ones being sampled. Carbon chloroform extract (CCE) and carbon alcohol extract (CAE) concentrations were determined from this monitor.

3) Distribution System

Samples for bacteriological and trace metal analyses at the rate of 10 percent of the number required by Figure 1, of the DWS, with a minimum of 2 each from any water supply.

C. Laboratory Procedures

Bacteriological

All samples were collected in 8-oz. sterile, plastic, wide-mouth, screw-capped bottles which contained 0.2 ml of a 10% solution of sodium thiosulfate as a dechlorinating agent. This concentration of thiosulfate was sufficient to neutralize a sample containing about 15 mg/l residual chlorine, an amount above any residual that was present. Refrigeration of all samples was required during transportation back to the laboratory. Maximum time between collection and analysis did not exceed 30 hours. The bacteriological procedures were those of Standard Methods.*

The membrane filter (MF) procedure was used for total coliform detection in this study for three reasons. One, larger volumes (100-ml portions) of distributed water could be examined than with the MPN technique; two, the MF procedure yields more precise results; and three, less processing time would be involved per sample, so reexamination of many of the samples could have been made within the 30-hour time limit if required. All potable and source water samples were examined for total coliforms using M-Endo MF broth, incubated at 35°C for 20-24 hours. Because raw water quality varied with its source, three decimal sample portions were filtered, the volume being determined by the estimated water quality.

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*Standard Methods for the Examination of Water and Wastewater, 12th Ed., APHA, AWWA, and WPCF. American Public Health Assoc. New York, N.Y., 1965. 796 pp.

Any coliform colonies detected in the examination of a sample were further verified by transfer to phenol red lactose for 24- and 48-hour periods at 35°C incubation. All positive phenol red lactose broth tubes then were confirmed in brilliant green lactose at 35°C for verification of total coliforms and in EC medium at 44.5°C for detection of fecal coliforms. This procedure further confirmed the standard total coliform MF test and supplied additional information on the potentially hazardous occurrence of fecal coliform in those potable water supplies.

Basic knowledge was also needed on the general bacterial population of potable water. Therefore, the general population of bacterial count (plate count) was also made on all distribution system samples. Sample portions of 1 ml and 0.1 ml in plate count agar (Tryptone-Glucose-Yeast Agar), incubated 48 hours at 35°C were sufficient to yield the desired data.

Chemical

The five samples, as noted above, taken to determine the chemical quality of the finished and/or distributed water were analyzed as follows:

Sample 2)a). General Chemistry.

These constituents were generally determined by Standard Methods, except as listed below.

Barium

No standard method existed at the time this study was undertaken. An atomic absorption procedure, which will appear in the next edition of Standard

Methods, was used and was found acceptable. The analysis was made only on those samples that had less than 2 mg/l because above that concentration the barium precipitates out of solution.

Chloride

A variation of the potentiometric titration procedure was used, which is a tentative method in Standard Methods, page 372. Rather than titrate with silver nitrate to a specified end-point in millivolts, using a glass electrode and a silver-silver chloride electrode, a standard curve was prepared that related millivolts to chloride concentration. The concentration of an unknown is then determined from the standard curve. The procedure was just as accurate as the titration method and was simpler to carry out.

Fluoride

A fluoride electrode method, which will appear in the next edition of Standard Methods, was used. Precision and accuracy was generally better than any other method and the method was simpler to carry out.

Sample 2)b), Trace Metals.

The atomic absorption spectrophotometer method was used for all heavy metals (cadmium, chromium, copper, iron, lead, manganese, silver, zinc, nickel, and cobalt) because its sensitivity, specificity, simplicity and speed of analysis far exceeded the usual wet chemical methods. An atomic absorption method for these metals will appear in the next edition of Standard Methods.

Sample 2)c), Radioactivity.

These radiological constituents were determined using standard radiological counting techniques.

Sample 2)d), Pesticides.

No standard procedure for pesticide determinations existed at the time the CWSS was undertaken. Gas chromatography is generally the accepted method of analysis and will appear in the next edition of Standard Methods. Therefore, this technique was used.

Sample 2)e), Organics (CCE and CAE).

These organic constituents were determined using standard extraction techniques.

SUMMARY OF RESULTS

This Summary of Results section contains data on the three major objectives of this study, a determination of: 1) the drinking water quality in the study areas, 2) the status of the water supply systems providing this drinking water, and 3) the status of the surveillance programs over these water supply systems. The evaluation of each system for various categories is shown on the summary table in Appendix C.

A. Study Sample

In an attempt to study a variety of water supply problems, and a variety of types of water supply systems of various sizes, the decision was made, in the design of the national study, to investigate all of the public water supplies in nine geographically distributed study areas. While this technique was not expected to provide a "perfect" random sample of water supply systems throughout the country, the results were expected to be reasonably representative of the status of the water supply industry in the United States.

The Charleston, West Virginia SMSA included all of Kanawha County. It was selected to represent those supplies using surface waters that receive the wastes from a highly industralized area, and the small coal mine town supplies represent supplies in economically depressed areas of the northern Appalachian area.

B. Water Treatment Practices

Table 3a and 3b indicate that there are four(4) systems that do not disinfect, clarify, or buy chlorinated water, ten(10) that disinfect or buy chlorinated water, fifteen(15) that clarify and disinfect, and one(1) that clarifies but does not disinfect the water. There are five(5) systems that do not chlorinate.

Table 3b indicates, as would be expected, that most of the smaller systems do not treat the water before distribution, and most of those that do apply chlorination only.

C. Water Quality

Tables 4 and 5 show that fourteen(14) or 47 per cent of the water supply systems do not exceed the constituent limits of the Drinking Water Standards. Included in the remaining 53 per cent or sixteen(16) water systems, there were 10 per cent or three(3) that exceeded one or more of the mandatory limits while the remaining 43 per cent or thirteen(13) water systems exceeded one or more of the recommended constituent limits.

Two constituents, iron and manganese were the principal causes for a system to exceed the recommended limits. Coliform organism densities, and barium were the causes for the three supplies to exceed the mandatory limits.

TABLE 3a

WATER TREATMENT PRACTICES IN THE SYSTEMS STUDIED

Treatment Practice	Type of System (Number of Systems of each)						Overall System Totals	
	Surface Water & Mixed Source	Ground Water Source			Wholesale Finished Water Source	Special Systems		
		Springs	Wells	Mixture of Both			Number	Percent
Do not disinfect, clarify, or buy, chlorinated water	0	0	4	0	0	0	4	13
Disinfection only or buy chlorinated water	0	1	6	0	3	0	10	33
Clarification* and disinfection	13	0	2	0	0	0	15	50
Clarification* without disinfection	1	0	0	0	0	0	1	4
System Totals - Number	14	1	12	0	3	0	30	100

*Clarification is the removal of suspended material by coagulation, sedimentation and/or filtration.

TABLE 3b

WATER TREATMENT PRACTICES IN THE SYSTEMS STUDIED

Treatment Practice	Population Served in Thousands (Number of Systems of Each)							Overall System Totals	
	<.5	.5-5	5-10	10-25	25-50	50-100	> 100	Number	Percent
Do not disinfect, clarify, or buy chlorinated water	4	0	0	0	0	0	0	4	13
Disinfection only or buy chlorinated water	8	2	0	0	0	0	0	10	33
Clarification* and disinfection	1	9	2	1	0	1	1	15	50
Clarification* without disinfection	0	1	0	0	0	0	0	1	4
System totals Number	13	12	2	1	0	1	1	30	100

*Clarification is the removal of suspended material by coagulation, sedimentation and/or filtration.

TABLE 4

WATER QUALITY EVALUATION BY SOURCE

	Type of System (All data are percent of System Totals)						Overall System Totals	
	Surface Water & Mixed Source	Ground Water			Wholesale Finished Water Source	Special Systems		
		Springs	Wells	Mixture of Both			Number	Percent
Did not exceed Constituent Limits*	57	100	17	0	100	0	14	47
Exceed Constituent Limits*	43	0	83	0	0	0	16	53
Exceed recommended but not mandatory limits	36	0	67	0	0	0	13	43
Exceed mandatory limits	7	0	16	0	0	0	3	10
System Totals - Number	14	1	12	0	3	0	30	0

Note: 63 percent of the study population was served drinking water that essentially met the Constituent Limits.

*See pages 11-13 for definition of Constituent Limits.

TABLE 5

WATER QUALITY EVALUATION BY COMMUNITY SIZE

	Population Served in Thousands (All data are percent of Size Totals)							Overall System Totals	
	<.5	.5-5	5-10	10-25	25-50	50-100	>100	Number	Percent
Did not exceed Constituent Limits*	38	50	100	0	0	0	100	14	47
Exceed Constituent Limits*	62	50	0	100	0	100	0	16	53
Exceed recommended but not mandatory limits	54	42	0	0	0	100	0	13	43
Exceed mandatory limits	8	8	0	100	0	0	0	3	10
System Totals - Number	13	12	2	1	0	1	1	30	0

Note: 63 percent of the study population was served drinking waterwith quality that did not exceed the Constituent Limits*

*See pages 11-13 for definition of Constituent Limits.

Table 4 indicates that the well sources produced the poorest quality of water. This was because of inadequate protection and high inorganics in the water that were not removed by treatment. Systems utilizing surface water; although often drawn from polluted sources, usually improve the quality of their distributed water by treatment. Because of this treatment the overall quality of finished water from surface and mixed sources was usually better than well source systems.

The footnote on Table 4 indicates that 63 percent of the study population was served water that essentially met the constituent limits. Most of the remaining 37 percent of the population were furnished water that exceeded the recommended limits. However, bacteriological samples from Leewood and St. Albans showed the presence of coliform organisms in excess of the limits. A sample from Miami exceeded the mandatory limits for barium. The population of these three communities was 21,250 or about 9 percent of the study population.

Table 5 shows that, in general the larger communities produce better quality water than the smaller ones. The percentage not meeting one or more recommended or mandatory limits also varies inversely with size.

D. Facilities Evaluation

Table 6 and 7 show that two (2) or 7 percent of the water systems investigated were essentially free from major deficiencies.

TABLE 6

FACILITIES EVALUATION BY SOURCE

	Type of System (All data are percent of System Totals)						Overall System Totals	
	Surface Water & Mixed Source	Ground Water			Wholesale Finished Water Source	Special Systems		
		Springs	Wells	Mixture of Both			Number	Percent
Essentially free of major deficiencies	7	100	0	0	0	0	2	7
Major Deficiencies	93	0	100	0	100	0	28	93
Inadequate source protection, in the absence of disinfection or buying chlorinated water	7	0	17	0	100	0	6	20
Inadequate disinfection, if practiced	29	0	67	0	0	0	12	40
Inadequate control of disinfection, if practiced or if buying chlorinated water	0	0	0	0	0	0	0	0
Inadequate clarification, if practiced	79	0	8	0	0	0	12	40
Inadequate control of clarification, if practiced	50	0	0	0	0	0	7	23
Low (<20 psi) pressure in some or all areas of the dist. system	43	0	33	0	67	0	12	40
System Totals - Number	14	1	12	0	3	0	30	0

COMMUNITY WATER SUPPLY STUDY

CHARLESTON, WEST VIRGINIA

STANDARD METROPOLITAN STATISTICAL AREA

BY

Bureau of Water Hygiene

Environmental Control Administration

Environmental Health Service

Public Health Service

DHEW Region III

July 1970

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
REGION III
220 7TH STREET N.E.
CHARLOTTESVILLE, VIRGINIA 22901

July 20, 1970

PUBLIC HEALTH SERVICE
ENVIRONMENTAL HEALTH SERVICE

THROUGH: N. H. Dyer, M.D., M.P.H.
State Director of Health

Mr. Robert McCall, Director
Environmental Health Services
State Department of Health
State Office Building No. 1
1800 Washington Street, East
Charleston, West Virginia 25305

Dear Mr. McCall:

I am pleased to submit to you our Report on the "Community Water Supply Study - Charleston, West Virginia, Standard Metropolitan Statistical Area". As you know, the Study included thirty (30) water supply systems in Kanawha County, and was part of a national study effort which encompassed seven (7) other metropolitan areas and one (1) entire State.

The field work for the Study was completed in March 1969, however, some of the laboratory analytical results were not available until the Fall. Further delay in presenting a final report was caused by many factors. In the interim period we have forwarded the laboratory results to you, and attempted to keep you informed of findings of the Study.

Because the Report basically includes information on conditions as they existed in March, 1969, we feel that it is important to acknowledge the improvements that have been made to some water supply systems, and the changes that have occurred which affect water supply activities in the Division of Sanitary Engineering.

System Improvements

1. The West Virginia Water Company has extended the Montgomery system to serve the Community of Handley at a cost of $200,000. The water supply system operated by the Chesapeake and Ohio Railway will discontinue supplying water to the Community as soon as service is provided from the Montgomery system.

2. Saint Albans completed installation of tubular settling units in their sedimentation basins providing a significant improvement in clarification. They are proceeding with installation of mixed media filters to expand plant capacity.

3. Charleston system pressures and capacities are being improved by a series of actions. These include new reservoirs, booster stations, and enlargement of mains in conjunction with interstate highway construction.

   Water treated at the Charleston plant is now delivered to Dunbar and the Spring Hill section of South Charleston which were formerly served from the Nitro plant.

4. A new well has been drilled resulting in better quality water and now serves as a source of supply for the Community of Ronda. Samples collected from the Ronda system during the Study showed excessive concentrations of iron, manganese and total dissolved solids.

Changes Affecting Water Supply Activities in the Division of Sanitary Engineering

1. Revised "Public Water Supply Regulations" were adopted by the Department of Health effective December 1, 1969. The Regulations represent an improvement in that they contain provisions for increased bacteriological, chemical, and radiochemical surveillance and include limits for certain chemical constituents.

   It should be emphasized that the regulations in force prior to adoption of present regulations required a substantially lower level of bacteriological surveillance than that required by the Public Health Service "Drinking Water Standards." Since the Public Health Service "Drinking Water Standards" were utilized in the Study to evaluate bacteriological surveillance, some of the communities listed in the Report in Appendix C as not collecting sufficient bacteriological samples, were actually complying with the State regulations.

2. Professional positions authorized by the Legislature in January, 1969, and effective July 1, 1969, were recently filled. The State Health Department's professional staff had decreased in July, 1968, to one engineer working part time on water supply activities plus bacteriological laboratory support. By the time of the Community Water Supply Study, one engineer had been added. The next change was in January, 1970, when two (2) chemists were employed. The professional

staff now assigned to public water supply activities includes two and one-half ($2\frac{1}{2}$) engineers, one and one-half ($1\frac{1}{2}$) chemists, and two (2) bacteriologists for a total of six, contrasting with an estimated requirement of at least 15.

3. Improvement of the State Health Department's surveillance program has been on a statewide basis and was predicated upon completing preparation of the new regulation and meeting its requirements. The water supply files were completely revamped to enable prompt recall of data, including bacteriological results, operating reports, plan reviews, chemical analyses, and plant inspections. When the regulation became effective on December 1, 1969, a copy was sent to each system in the State and advice given on the number of samples required and the number of samples received as of that date. Beginning with the third quarter of Fiscal Year 1970, a quarterly summary was initiated and will continue to be provided to each water supply system indicating their compliance or non-compliance with bacteriological and operating report requirements. Each system is now required to submit detailed plant data in support of an application for an operating permit. With the employment of two chemists in January, 1970, progress is being made to enable complete chemical and radiochemical analysis for all systems in the State. Limited analyses have been accomplished during the staffing, equipping, and organization of the laboratory. Routine analyses of all State water supplies should commence in the first quarter of Fiscal Year 1971.

4. The improvement in surveillance over water supply systems in Kanawha County is illustrated in tabulated form below for the past two (2) fiscal years:

	FISCAL YEAR 1969	FISCAL YEAR 1970
BACTERIOLOGICAL FREQUENCY MET	3	15
COMPLETE CHEMICAL ANALYSIS	0	10
SYSTEMS WITH LICENSED OPERATORS	17	18
PLANT INSPECTIONS	1	14

Mr. Gerald Ferguson and I are very pleased to note the above improvements to the systems in Kanawha County, and to water supply activities in the

Division of Sanitary Engineering. We wish you success in further strengthening of the Division, and implementing recommendations contained in the Report on the Community Water Supply Study - Charleston, West Virginia, Standard Metropolitan Statistical Area.

We would like to take this opportunity to express our appreciation for the cooperation and assistance extended to us by employees of the Division of Sanitary Engineering, the Charleston-Kanawha County Health Department, and especially to the water supply system operators who participated in the Study.

Sincerely yours,

Edwin C. Lippy

Edwin C. Lippy, P.E.
Acting Regional Representative
Bureau of Water Hygiene

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SUMMARY OF FINDINGS AND CONCLUSIONS

As part of the Community Water Supply Study (CWSS), the Bureau of Water Hygiene of the U.S. Public Health Service, Region III, Office of the Department of Health, Education, and Welfare (DHEW) in cooperation with the West Virginia State Department of Health and the Charleston-Kanawha County Health Department, conducted a study of water systems in the Charleston Standard Metropolitan Statistical Area (SMSA) during March 1969. The study included thirty (30) public water supplies serving about 229,000 people or 91 percent of the SMSA population, and was designed to assess: (a) the status of drinking water quality, (b) water supply system facilities, and (c) bacteriological surveillance programs in urban and suburban areas.

The following are the principal findings of the study.

A. Drinking Water Quality

1. To determine the quality of the drinking water in the 30 communities studied, samples were taken at various places in the distribution systems. The data were averaged for each system and constituent concentrations compared to the bacteriological, chemical, and physical constituent limits of the 1962 U.S. Public Health Service Drinking Water Standards (DWS). On this basis:

(a) Fourteen (14) or forty-seven (47) percent of the systems delivered drinking water that did not exceed any of the constituent limits.

(b) Additionally, thirteen (13) or forty-three (43) percent of the systems delivered drinking water that exceeded at least one of the DWS "recommended limits" (Defined on Page 12) but did not exceed any of the DWS "mandatory limits" (Defined on Page 13).

(c) Finally, three (3) or ten (10) percent of the systems delivered drinking water that exceeded one or more of the DWS mandatory limits.

2. The quality of drinking water delivered to the smaller and larger population groups is compared and summarized below:

	LESS THAN 5000 Population (25 Systems Total)	GREATER THAN 5000 Population (5 Systems Total)	ALL SYSTEMS (30 Systems)
DOES NOT EXCEED CONSTITUENT LIMITS	11 (44%)	3 (60%)	14 (47%)
EXCEEDED RECOMMENDED LIMITS	12 (48%)	1 (20%)	13 (43%)
EXCEEDED MANDATORY LIMITS	2 (8%)	1 (20%)	3 (10%)

3. Of the thirteen (13) systems that delivered water that exceeded the recommended constituent limits, iron, manganese, turbidity, and total solids were the constituents most often exceeded.

4. Of the three (3) systems that delivered water that exceeded the mandatory limits, two (2) exceeded the bacteriological limits and one (1) the chemical limits.

5. Samples of water from surface water supplies were analyzed for pesticides and only insignificant traces were found.

6. Sixty-three (63) percent of the total population served or 144,000 people were served water that met the constituent limits,

twenty-eight (28) percent or 64,000 people were served water that did not meet the recommended limits and nine (9) percent or 21,000 people were served water that did not meet the mandatory limits.

7. The most common consumer complaints reported by operators were from taste and odors and plumbing fixture staining resulting from deposition of iron and manganese.

B. Water Supply System Facilities

1. To determine the status of the facilities used to treat, distribute, and store public drinking water, site surveys and interviews with operators were conducted regarding the water supply system. Based on this information only two (2) systems or six (6) percent did not have any major deficiencies while twenty-eight (28) systems or ninety-four (94) percent had one or more of the following major deficiencies: (1) Inadequate source protection, (2) inadequate disinfection and/or control of disinfection, (3) inadequate clarification (removal of suspended matter) and/or control of clarification and, (4) inadequate pressure in the distribution system.

2. Four (4) systems or thirteen (13) percent did not provide chlorination, and twelve (12) or forty (40) percent practiced inadequate chlorination.

3. Twelve (12) or forty (40) percent did not have adequate clarification, and of these seven (7) or twenty-three (23)

percent did not have adequate control of the clarification.

4. Inadequate pressure (less than 20 psi) in the distribution system was found in twelve (12) systems or forty (40) percent of the systems surveyed.

5. Eight (8) systems are providing fluoridated water to the consumers. These are the larger systems and serve 215,000 people of the 229,000 served by public water systems.

6. Reliable data regarding safe yield for surface sources and maximum dependable draft for groundwater sources was not available or unknown for most of the communities surveyed.

C. Bacteriological Surveillance Programs

1. The bacteriological records both in the utilities and in the State Department of Health were not carefully maintained, and in some cases it was difficult or impossible to find them. (Since the field survey, the State Department of Health has made considerable improvements in the maintenance of records.)

2. To determine the status of the bacteriological surveillance over each water supply system surveyed, records in the State Department of Health and the utilities were examined for the number of samples collected and their results during the last twelve (12) months of record. Based on this information, only three (3) systems or ten (10 percent) had bacteriological surveillance that met the criteria (see page 13) while twenty seven (27) or ninety (90) percent either did not collect sufficient samples or samples showed poor bacterial quality, or both.

3. The data on the adequacy of bacteriological surveillance programs related to system size are summarized below:

	LESS THAN 5000 Population (25 Systems Total)	GREATER THAN 5000 Population (5 Systems Total)	ALL SYSTEMS (30 Systems)
MET CRITERIA	1 (4%)	2 (40%)	3 (10%)
DID NOT MEET CRITERIA	24 (96%)	3 (60%)	27 (90%)

4. During the previous twelve (12) months sufficient samples were collected from four (4) systems. Of these four (4) systems, three (3) had satisfactory results.

D. Other Major Findings and Conclusions

1. Data were collected on the date of the previous sanitary survey, last complete chemical analysis, and the status of a program to eliminate and control cross-connections and hazardous plumbing conditions. Results indicate that in most cases there was no record of the last sanitary survey, and that a survey had not been conducted within the past three years; that a complete chemical analysis had not been conducted for any system; and, that none of the systems had a cross-connection control program.

2. All plant operators are required by State regulation to be registered and certified. Seventeen of the thirty (30) community water supply systems surveyed have complied with this regulation. Of the thirteen (13) systems that are operated by uncertified operators, twelve (12) are in

the population group serving less than 1000 people. The State Department of Health has a training program to certify and upgrade operators and is proceeding with the examination of operators and issuing certificates to successful candidates.

3. Twelve (12) of the fourteen (14) systems serving population groups of less than 1000 people are operated on a part-time basis. Eighteen (18) systems are operated by personnel on a full-time basis.

4. In some cases, the quality of water delivered, operation and maintenance of facilities, and surveillance could be improved if the systems serving several small communities merged to form a public service district or one utility.

5. In general, the larger systems delivered water of better quality, are better operated and maintained, and exhibited a better degree of surveillance than the smaller systems.

RECOMMENDATIONS

Based on results of the Community Water Supply Study conducted in the Charleston, West Virginia Standard Metropolitan Statistical Area, the following recommendations are presented:

1. Surveillance by the Division of Sanitary Engineering, West Virginia State Department of Health over water supply systems be drastically improved. This improvement should consist of the following:

(a) surveillance be improved for those twenty-seven (27) systems not in compliance with bacteriological requirements of the Drinking Water Standards.

(b) surveillance be improved for the thirty (30) systems not in compliance with chemical requirements of the Drinking Water Standards.

(c) periodic site visits or sanitary survey of water supply systems be increased to an acceptable frequency, but not less than once per year.

(If results of the Study of one County are applicable state-wide, a significant increase in manpower for surveillance-type activities in the Division of Sanitary Engineering is indicated)

2. Necessary improvements be initiated for each system which exhibited bacteriological and chemical concentration in excess of the Drinking Water Standards and priority be given to improving

those three (3) systems not in compliance with the mandatory constituent limits.

3. Improvements be made to those twenty-eight (28) systems where deficiencies were found in the storage, treatment, and distribution of water.

4. Safe yield for surface sources and maximum dependable draft for groundwater sources be computed for each system where applicable, so that planning and future expansion as well as daily reliability to meet demands is based upon known capability of the source.

5. The feasibility of mergingsmaller systems into a public service district or one utility to improve operation and maintenance, surveillance, and quality of water, and to reduce costs be investigated. If merging does not prove feasible, consideration be given to utilizing the resources of several small systems in a cooperative effort to employ full-time certified operators for these thirteen (13) systems currently operated by personnel who are not certified.

6. The Division of Sanitary Engineering of the State Department of Health assist the management of water supply systems in implementing programs to eliminate and control cross-connections and hazardous plumbing conditions.

INTRODUCTION

The purpose of the Community Water Supply Study (CWSS) was to determine if the American consumer's drinking water met the Drinking Water Standards. To obtain nationwide coverage, the Bureau of Water Hygiene of the U. S. Public Health Service initiated the CWSS in February of 1969 in nine areas across the country. The field work for the CWSS was conducted by the Bureau of Water Hygiene in cooperation with the state and local health departments and the water utilities.

This study was designed to give an assessment of drinking water quality, water supply systems, and surveillance programs in urban and suburban areas in each of the nine regions of the Department of Health, Education, and Welfare. These areas were selected to give examples of the several types of water supplies in the country. A whole Standard Metropolitan Statistical Area (SMSA) was the basis of each study, except in Region I where the entire State of Vermont was included, with evaluations made on all public water supply systems, as defined herein, in each study area. This coverage allowed an assessment of the drinking water quality of the large central city, the suburbs, and the smaller communities located in the counties in the SMSA, and the interaction between them.

The definition of Standard Metropolitan Statistical Area (SMSA) is given below:

> Standard Metropolitan Statistical Area - The boundaries and titles of standard metropolitan statistical areas are established by the Bureau of the Budget with the advice

of the Federal Committee on Standard Metropolitan Statistical Areas. An SMSA is a county or group of contiguous counties, which contains at lease one city of 50,000 inhabitants or more or "twin cities" with a combined population of at lease 50,000. In addition to the county, or counties, containing such a city or cities, contiguous counties are included in an SMSA if, according to certain criteria, they are essentially metropolitan in character and are socially and economically integrated with the central city.

Specifically, the objectives of this study were accomplished by determining whether:

1. The quality of the urban and suburban American consumer's drinking water in the selected study areas does not exceed the constituent limits of the Drinking Water Standards (DWS);*

2. The water supply systems supplying this drinking water to the consumers are essentially free from major deficiencies; and

3. The surveillance programs over these water supply systems meet the bacteriological surveillance criteria.

The authority for the Community Water Supply Study is found in Title III, Part A, Section 301, Public Health Service Act, as amended (42 U.S.C. 241).

"Sec. 301 - The Surgeon General shall conduct in the Service, and encourage, cooperate with, and render assistance to other appropriate public authorities, scientific institutions, and scientists in the conduct of, and promote the coordination of, research, investigations, experiments, demonstrations, and studies relating to the causes, diagnosis, treatment, control, and prevention of physical and mental diseases and impairments of man, including water purification..."

*1962 U.S. Public Health Service Drinking Water Standards; PHS Publ. No. 956, Superintendent of Documents, Government Printing Office, Washington, D. C. 20402, 61 pp.

In Region III, the Charleston, West Virginia, Standard Metropolitan Statistical Area was selected for the Study. It includes all of Kanawha County. All water supplies serving 25 or more people, or having at lease 15 services, were surveyed. The field work began on March 17, 1969, and terminated on March 27, 1969.

In the conduct of this study cooperation was received from the West Virginia State Department of Health and the Charleston-Kanawha County Health Department.

SCOPE

Public water supplies in the United States numbered 19,236 serving some 150,000,000 when last inventoried in 1963.* The remaining 50,000,000 people had private water supplies. Most of the public water supplies were small, about 85 percent serving 5,000 or less people. About half of the public was served by the 18,837 supplies that each served 100,000 or less persons and the other half (77,000,000) were served by the 399 larger supplies. About 75 percent of these public water supplies have ground water as a source, while 18 percent use surface water. The remaining 7 percent have a mixture of ground and surface water source.

A. Systems Studied

This study covered 969 public water supply systems, including 894 community water supply systems (91.4% of the total) and 75 special water supply systems (9.6% of the total). For this study the following definitions of the systems were used.

PUBLIC WATER SUPPLY SYSTEM - A water supply system includes the works and auxiliaries for collection, treatment, storage, and distribution of water from the sources of supply to the free-flowing outlet of the ultimate consumer. Water supply systems were included in this study, if they had 15 or more service connections and/or served 25 or more consumers.

Special Water Supply Systems - are those systems serving trailer and mobile home parks, and institutions with resident populations.

Community Water Supply Systems - are all other systems studied in an SMSA.

*Statistical summary of Municipal Water Facilities in the United States, January 1, 1963: PHS Publ. No. 1039, Government Printing Office, Washington, D. C. 1965, 66 pp.

B. Study Area

In the Charleston (SMSA) 30 public water supply systems were studied serving about 229,000 persons. They consisted of 13 ground water systems (wells and springs), 14 surface water systems, and 3 systems buying finished water from another system, hereafter called wholesale finished water source systems.

For the purpose of this report, water supply systems were divided into four categories; 1) those using surface water or a mixture of surface and ground water as a source; 2) those using ground water as a source (this category was further divided into; a) wells, b) springs, and c) springs and wells); and 3) those purchasing finished water as a source; and 4) special water supply systems.

Table 1 gives data on type, population, average daily demand, and source for the supplies included in this study. Table 3a and 3b (pages 25 and 26) show the number of systems in each category and the populations served.

TABLE 1

Community	Type	Population Served	Average Daily Demand (M.G.)	Source
Acme	2a	120	0.005	ground
Alum Creek	1	2,000	0.075	Coal River
Belle	1	8,700	0.950	Kanawha River
Burnwell	2a	100	?	ground
Carbon	2a	130	0.007	ground
Cedar Grove	1	1,750	0.075	Kanawha River
Charleston	1	121,000	18.000	Elk River
Chelyan	1	2,100	0.108	Kanawha River
Clendenin	1	3,500	0.185	Elk River
Corton	1	36	0.010	Elk River
Crown Hill	3	250	0.020	Pratt
Decota	2a	320	0.020	ground
Eastbank	3	1,200	0.080	Cedar Grove
Glasgow	3	1,000	0.100	Cedar Grove
Handley	1	1,000	0.170	Kanawha
Kayford	2b	100	?	ground
Leewood	2a	150	0.010	ground
Miami	2a	1,100	0.050	ground
Montgomery	1	6,500	0.276	Kanawha River
Nitro	1	52,000	9.000	Kanawha River
Pinch	1	1,025	0.050	Elk River

Table 1 - Continued

Community	Type	Population Served	Average Daily Demand (M.G.)	Source
Pratt	1	1,250	0.080	Kanawha River
Rensford	2a	100	0.010	ground
Republic	2a	90	0.003	ground
Ronda	2a	256	0.014	ground
St. Albans	1	20,000	1.210	Coal River
Sissonville	1	2,500	0.107	Pocatalico River
Shrewsbury	2a	640	0.045	ground
Ward	2a	45	0.025	ground
Winifrede	2a	60	0.010	ground

C. General Description of Area

The Charleston, West Virginia, Standard Metropolitan Statistical Area includes all of Kanawha County. The terrain of this area is extremely hilly and land with a gentle slope is at a premium, or already developed. The majority of the development is along major drainage channels or the flood plain, as shown by the map on the following page. This type of development is possible by the use of reservoirs and levees for the control of flood flows.

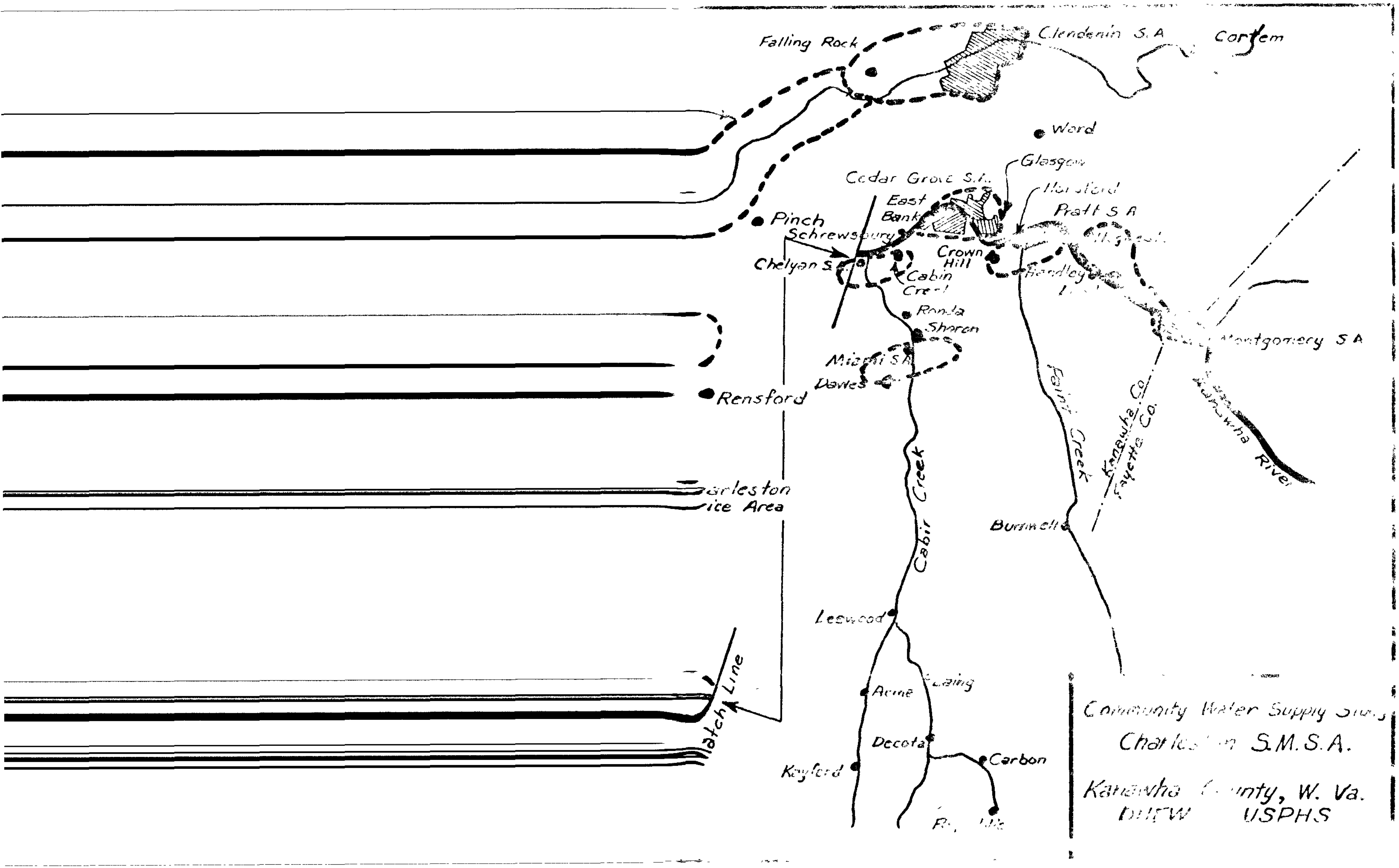
Industrial, commercial, and residential development in the Charleston area is along the Kanawha and Elk Rivers. Other development is generally confined to the banks of small tributaries of these rivers.

The 1960 Census indicates that Kanawha County population was 252,900. The population was projected for the purpose of a water resource study of the Kanawha River Basin as follows:

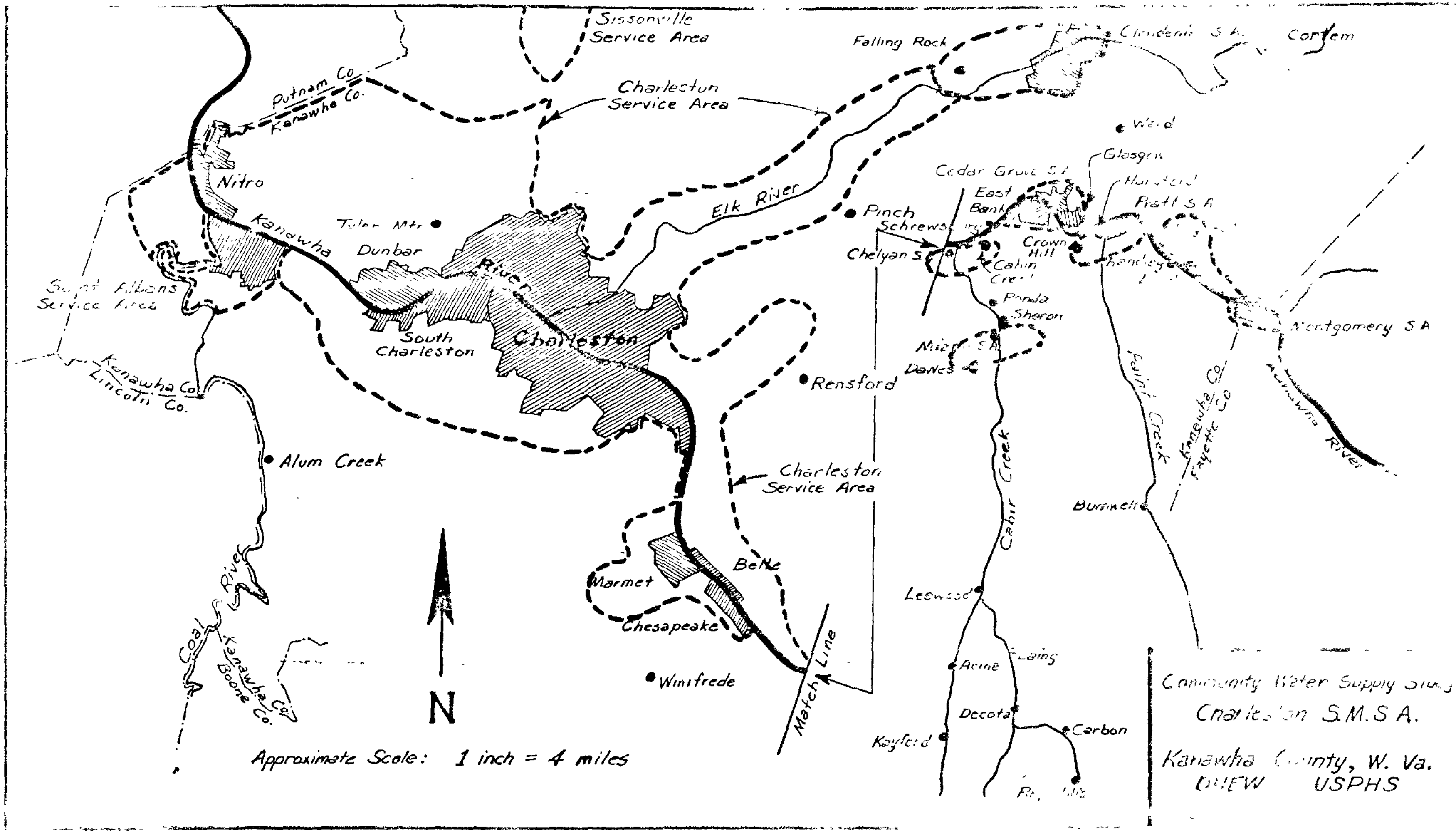
1960	1970	1980	1990	2000	2010	2020
252,900	251,000	251,200	257,100	262,000	282,100	292,300

These projections were later revised to reflect the philosophy of expanded development under the Appalachian Regional Development Act, and were termed "developmental benchmarks." They are as follows:

1960	1980	2000	2020
252,900	334,100	453,900	589,900



Falling Rock
Clendenin S.A
Cortem
Ward
Glasgow
Cedar Grove S.A.
East Bank
Pratt S A
Pinch
Schrewsbury
Crown Hill
Chelyan S.A.
Cabin Creek
Ronda
Sharon
Miami S.A
Dawes
Rensford
Montgomery S A
Kanawha River
Kanawha Co.
Fayette Co.
Paint Creek
Burnwell
Cabin Creek
Leewood
Acme
Decota
Carbon
Kayford
Match Line
Charleston S.M.S.A.
DHEW
USPHS


Sissonville Service Area
Charleston Service Area
Charleston Service Area
Saint Albans Service Area
Falling Rock
Cortem
Weird
Glasgow
Cedar Grove
East Bank
Pratt S.A.
Pinch
Chelyan
Crown Hill
Cabin Creek
Sharon
Montgomery S.A.
Putnam Co.
Kanawha Co.
Nitro
Kanawha
Tyler Mtn
Dunbar
River
Elk River
South Charleston
Charleston
Rensford
Kanawha Co.
Lincoln Co.
Alum Creek
Paint Creek
Kanawha Co.
Fayette Co.
Kanawha River
Burnwell
Cabin Creek
Leewood
Belle
Marmet
Chesapeake
Winifrede
Match Line
Coal River
Kanawha Co.
Boone Co.
Acme
Decota
Carbon
Kayford
N
Approximate Scale: 1 inch = 4 miles
Charleston S.M.S.A.
Kanawha County, W. Va.
USPHS

Development under the Act has not influenced population growth in the Charleston Area, mainly because sufficient time has not elapsed since its inception.

Assuming that population has followed the earlier projections, the present population should be approximately 252,000.

The Kanawha River is heavily relied upon by industry in the Charleston Area. Manufacturing employs approximately 25% of the labor force, with almost one half of this number working in chemicals and allied products. Approximately 40% of the labor force is evenly divided between wholesale and retail trade, and personal and business service. Mining and construction account for another 10% with the remainder going to other forms of employment. The Kanawha River Basin has been referred to as the "Ruhr Valley of America."

EVALUATION CRITERIA

Each water supply system was investigated on three bases: 1) drinking water quality was determined by sampling the finished and distributed water and returning these samples to the laboratories of the Bureau of Water Hygiene for bacteriological, chemical, and trace metal analyses, 2) the status of the water supply system facilities was determined by a field survey of the system and the gathering of data on three standard forms (four items were chosen to represent major problems; a) source(s), b) treatment, if any, c) distribution system pressures, and d) operation); 3) the status of the surveillance program over the water supply system was evaluated by obtaining bacteriological water quality data for the previous 12 months of record from State and county health department files.

A. Water Quality Criteria

Water quality was judged either:

(1) Not to exceed the Constituent Limits of the DWS (hereafter called Does not exceed limits), or,

(2) To exceed at least one "recommended" Constituent Limit (some are aesthetic parameters), but does not exceed any "mandatory" Constituent Limit (hereafter called Exceed recommended, but not mandatory limits) or,

(3) To exceed at least one "mandatory" Constituent Limit (hereafter called Exceed mandatory limits).

The limits for the constituents measured in this study are summarized in Table 2.

TABLE 2

Partial List of Bacteriological, Chemical, and Physical Constituent Concentration Limits Taken from the 1962 U. S. Public Health Service Drinking Water Standards

RECOMMENDED LIMITS

Constituent	Limit
Alkyl Benzene Sulfonate (Measured as methylene-blue-active substances)	0.5 mg/l
Arsenic	0.01 mg/l*
Boron	1.0 mg/l**
Chloride	250 mg/l
Color	15 Units
Copper	1.0 mg/l
Carbon-Chloroform Extract (CCE)	0.200 mg/l
Cyanide	0.01 mg/l
Fluoride	
Temp. (Ann.Avg.Max.Day, 5 years or more	
50.0-53.7	1.7 mg/l
53.8-58.3	1.5 mg/l
58.4-63.8	1.3 mg/l
63.9-70.6	1.2 mg/l
70.7-79.2	1.0 mg/l
79.3-90.5	0.8 mg/l
Iron	0.3 mg/l
Manganese	0.05 mg/l
Nitrate	45 mg/l
Radium-226	3 uuc/l (pc/l)***
Strontium-90	10 uuc/l (pc/l)***
Sulfate	250 mg/l
Total Dissolved Solids (TDS)	500 mg/l
Turbidity	
Untreated	5 Units
Treated by more than disinfection	1 Unit
Zinc	5 mg/l

TABLE 2 (Cont'd)

MANDATORY LIMITS

(If the concentration of any of these constituents are exceeded, the further use of this water for drinking and culinary purposes should be evaluated by the appropriate health authority because water of this quality represents a potential hazard to the health of consumers.)

Constituent	Limit
Arsenic	0.05 mg/l
Barium	1.0 mg/l
Boron	5.0 mg/l**
Cadmium	0.01 mg/l
Chromium (hexavalent)	0.05 mg/l
Coliform organisms (Measured by membrane filter technique)	Fails std. if: a) Arithmetic average of samples collected greater than 1 per 100 ml b) Two or more samples (5% or more if more than 20 examined) contain densities more than 4/100 ml
	0.2 mg/l
Cyanide	0.2 mg/l
Fluoride	
Temp. (Ann.Avg.Max.Day - 5 years or more)	
50.0-53.7	2.4 mg/l
53.8-58.3	2.2 mg/l
58.4-63.8	2.0 mg/l
63.9-70.6	1.8 mg/l
70.7-79.2	1.6 mg/l
79.3-90.5	1.4 mg/l
Gross Beta activity (in the absence of alpha or Sr-90)	1,000 uuc/l (pc/l)***
Lead	0.05 mg/l
Selenium	0.01 mg/l
Silver	0.05 mg/l

*Although the recommended arsenic concentration is 0.01 mg/l, because of interferences in some waters, the concentration of arsenic was only determined to be less than 0.03 mg/l. For the purposes of this study, these waters were considered not to exceed the recommended standard.

**Proposed for inclusion in the Drinking Water Standards.

***If these limits are exceeded, refer to Section 6.2 of the DWS.

B. Facilities Criteria

Source, treatment, operation, and distribution facilities were judged either:

1) To be essentially free from major deficiencies, or

2) To have one or more of the following major deficiencies (where applicable)

a) Inadequate source protection (in absence of disinfection or buying chlorinated water)

b) Inadequate disinfection (if disinfection practiced)

c) Inadequate control of disinfection (if practiced or if purchasing chlorinated water)

d) Inadequate clarification capabilities (if clarification practiced)

e) Inadequate control of clarification (if clarification practiced)

f) Inadequate pressure (<20 psi) in some or all areas of the distribution system

C. Bacteriological Surveillance Program Criteria

The bacteriological surveillance program over the water supply system was judged either:

1) To meet the following criteria or,

2) Not to meet one or both of the following,

a) Collection of the required number* of bacteriological

*See pages 3-6 of the Drinking Water Standards.

samples for no less than 11 months during the previous 12 months of record.

b) Passing the bacteriological quality standard* for no less than 11 months during the previous 12 months of record.

*See pages 3-6 of the Drinking Water Standards.

METHODS

A. Field Survey

The regional office staff, in cooperation with the West Virginia State Department of Health and the Charleston-Kanawha County Health Department officials prepared a listing of all known water supplies meeting the definition adopted for this study. The list contained the supply name, address, name of the superintendent or person in charge, and the telephone number. The list was cross-checked with community and subdivision names to eliminate duplication and establish those areas for which the water supply facilities were apparently unknown. A Form PHS-682, Report of Water Supply Used on Interstate Carriers, was prepared for each supply from State records. The completed list became the basis for work schedules for the field engineers. Actual field surveys were made by a staff of 4 PHS engineers from headquarters and the regional office.

During the field survey, the engineer completed Forms ECA-18, Inventory of Municipal Water Facilities, and ECA-19 Municipal Water Supply Sanitary Survey, to provide information on source; treatment; operation; laboratory control; personnel; distribution; surveillance practices; planning for improvements; and water rates. Examples of the standard forms are in the Appendix B.

B. Sampling Program

The following samples were collected and dispatched to various Bureau of Water Hygiene laboratories:

1) Raw water - 1 sample for bacteriological analysis

2) Finished water ready for distribution - 4 or 5 samples for chemical analyses as follows:

   a) 2 1/2-gallon sample to the Northeast Water Hygiene Laboratory. This was a grab sample for most ground water and small surface water treatment plants, but where possible a 14-day composite was taken. The following analyses were made on this sample:

Arsenic	Cyanide	Sulfate
Boron	MBAS	TDS
Chloride	Nitrate	Turbidity
Color	Selenium	

   b) 8-oz. aliquot sample for trace metals analysis was taken out of sample 2)a) above and sent to the Cincinnati Laboratory. The following analyses were made on this sample:

Barium	Copper	Manganese
Cadmium	Fluoride	Nickel
Chromium	Iron	Silver
Cobalt	Lead	Specific Conductance
		Zinc

   c) 1-gallon sample for radioactivity analyses was sent to one of the three Bureau of Radiological Health laboratories. It was collected in the same manner as sample 2)a) above. The following analyses were made on this sample:

Specific gamma emitting radionuclides
(I^{131}, Cs^{137}, Ba^{140})

Gross Alpha

Gross Beta

Radium-226, if gross alpha exceeded 3 pc/l

Strontium-90, if gross beta exceeded 10 pc/l

Tritium - (run on 10% of samples)

d) 1-gallon sample for pesticide analysis to the Gulf Coast Water Hygiene Laboratory from surface water supplies. It was collected in the same manner as sample 2)a) above. The following analyses were made on this sample:

Aldrin	Dieldrin	Heptachlor Epoxide
Chlordane	Endrin	Lindane
DDT	Heptachlor	Methoxychlor
		Toxaphene

e) 1 activated carbon monitor sample to the Cincinnati Laboratory from twelve systems having surface sources. Two systems that had surface sources were not sampled because the sources were considered similar to ones being sampled. Carbon chloroform extract (CCE) and carbon alcohol extract (CAE) concentrations were determined from this monitor.

3) Distribution System

Samples for bacteriological and trace metal analyses at the rate of 10 percent of the number required by Figure 1, of the DWS, with a minimum of 2 each from any water supply.

C. Laboratory Procedures

Bacteriological

All samples were collected in 8-oz. sterile, plastic, wide-mouth, screw-capped bottles which contained 0.2 ml of a 10% solution of sodium thiosulfate as a dechlorinating agent. This concentration of thiosulfate was sufficient to neutralize a sample containing about 15 mg/l residual chlorine, an amount above any residual that was present. Refrigeration of all samples was required during transportation back to the laboratory. Maximum time between collection and analysis did not exceed 30 hours. The bacteriological procedures were those of Standard Methods.*

The membrane filter (MF) procedure was used for total coliform detection in this study for three reasons. One, larger volumes (100-ml portions) of distributed water could be examined than with the MPN technique; two, the MF procedure yields more precise results; and three, less processing time would be involved per sample, so reexamination of many of the samples could have been made within the 30-hour time limit if required. All potable and source water samples were examined for total coliforms using M-Endo MF broth, incubated at 35°C for 20-24 hours. Because raw water quality varied with its source, three decimal sample portions were filtered, the volume being determined by the estimated water quality.

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*Standard Methods for the Examination of Water and Wastewater, 12th Ed., APHA, AWWA, and WPCF. American Public Health Assoc. New York, N.Y., 1965. 796 pp.

Any coliform colonies detected in the examination of a sample were further verified by transfer to phenol red lactose for 24- and 48-hour periods at 35°C incubation. All positive phenol red lactose broth tubes then were confirmed in brilliant green lactose at 35°C for verification of total coliforms and in EC medium at 44.5°C for detection of fecal coliforms. This procedure further confirmed the standard total coliform MF test and supplied additional information on the potentially hazardous occurrence of fecal coliform in those potable water supplies.

Basic knowledge was also needed on the general bacterial population of potable water. Therefore, the general population of bacterial count (plate count) was also made on all distribution system samples. Sample portions of 1 ml and 0.1 ml in plate count agar (Tryptone-Glucose-Yeast Agar), incubated 48 hours at 35°C were sufficient to yield the desired data.

Chemical

The five samples, as noted above, taken to determine the chemical quality of the finished and/or distributed water were analyzed as follows:

Sample 2)a). General Chemistry.

These constituents were generally determined by Standard Methods, except as listed below.

Barium

No standard method existed at the time this study was undertaken. An atomic absorption procedure, which will appear in the next edition of Standard

Methods, was used and was found acceptable. The analysis was made only on those samples that had less than 2 mg/l because above that concentration the barium precipitates out of solution.

Chloride

A variation of the potentiometric titration procedure was used, which is a tentative method in Standard Methods, page 372. Rather than titrate with silver nitrate to a specified end-point in millivolts, using a glass electrode and a silver-silver chloride electrode, a standard curve was prepared that related millivolts to chloride concentration. The concentration of an unknown is then determined from the standard curve. The procedure was just as accurate as the titration method and was simpler to carry out.

Fluoride

A fluoride electrode method, which will appear in the next edition of Standard Methods, was used. Precision and accuracy was generally better than any other method and the method was simpler to carry out.

Sample 2)b), Trace Metals.

The atomic absorption spectrophotometer method was used for all heavy metals (cadmium, chromium, copper, iron, lead, manganese, silver, zinc, nickel, and cobalt) because its sensitivity, specificity, simplicity and speed of analysis far exceeded the usual wet chemical methods. An atomic absorption method for these metals will appear in the next edition of <u>Standard Methods</u>.

Sample 2)c), Radioactivity.

These radiological constituents were determined using standard radiological counting techniques.

Sample 2)d), Pesticides.

No standard procedure for pesticide determinations existed at the time the CWSS was undertaken. Gas chromatography is generally the accepted method of analysis and will appear in the next edition of <u>Standard Methods</u>. Therefore, this technique was used.

Sample 2)e), Organics (CCE and CAE).

These organic constituents were determined using standard extraction techniques.

SUMMARY OF RESULTS

This Summary of Results section contains data on the three major objectives of this study, a determination of: 1) the drinking water quality in the study areas, 2) the status of the water supply systems providing this drinking water, and 3) the status of the surveillance programs over these water supply systems. The evaluation of each system for various catagories is shown on the summary table in Appendix C.

A. Study Sample

In an attempt to study a variety of water supply problems, and a variety of types of water supply systems of various sizes, the decision was made, in the design of the national study, to investigate all of the public water supplies in nine geographically distributed study areas. While this technique was not expected to provide a "perfect" random sample of water supply systems throughout the country, the results were expected to be reasonably representative of the status of the water supply industry in the United States.

The Charleston, West Virginia SMSA included all of Kanawha County. It was selected to represent those supplies using surface waters that receive the wastes from a highly industralized area, and the small coal mine town supplies represent supplies in economically depressed areas of the northern Applachian area.

B. Water Treatment Practices

Table 3a and 3b indicate that there are four(4) systems that do not disinfect, clarify, or buy chlorinated water, ten(10) that disinfect or buy chlorinated water, fifteen(15) that clarify and disinfect, and one(1) that clarifies but does not disinfect the water. There are five(5) systems that do not chlorinate.

Table 3b indicates, as would be expected, that most of the smaller systems do not treat the water before distribution, and most of those that do apply chlorination only.

C. Water Quality

Tables 4 and 5 show that fourteen(14) or 47 per cent of the water supply systems do not exceed the constituent limits of the Drinking Water Standards. Included in the remaining 53 per cent or sixteen(16) water systems, there were 10 per cent or three(3) that exceeded one or more of the mandatory limits while the remaining 43 per cent or thirteen(13) water systems exceeded one or more of the recommended constituent limits.

Two constituents, iron and manganese were the principal causes for a system to exceed the recommended limits. Coliform organism densities, and barium were the causes for the three supplies to exceed the mandatory limits.

TABLE 3a

WATER TREATMENT PRACTICES IN THE SYSTEMS STUDIED

Treatment Practice	Type of System (Number of Systems of each)						Overall System Totals	
	Surface Water & Mixed Source	Ground Water Source			Wholesale Finished Water Source	Special Systems		
		Springs	Wells	Mixture of Both			Number	Percent
Do not disinfect, clarify, or buy, chlorinated water	0	0	4	0	0	0	4	13
Disinfection only or buy chlorinated water	0	1	6	0	3	0	10	33
Clarification* and disinfection	13	0	2	0	0	0	15	50
Clarification* without disinfection	1	0	0	0	0	0	1	4
System Totals - Number	14	1	12	0	3	0	30	100

*Clarification is the removal of suspended material by coagulation, sedimentation and/or filtration.

TABLE 3b

WATER TREATMENT PRACTICES IN THE SYSTEMS STUDIED

Treatment Practice	Population Served in Thousands (Number of Systems of Each)							Overall System Totals	
	<.5	.5-5	5-10	10-25	25-50	50-100	> 100	Number	Percent
Do not disinfect, clarify, or buy chlorinated water	4	0	0	0	0	0	0	4	13
Disinfection only or buy chlorinated water	8	2	0	0	0	0	0	10	33
Clarification* and disinfection	1	9	2	1	0	1	1	15	50
Clarification* without disinfection	0	1	0	0	0	0	0	1	4
System totals Number	13	12	2	1	0	1	1	30	100

*Clarification is the removal of suspended material by coagulation, sedimentation and/or filtration.

TABLE 4

WATER QUALITY EVALUATION BY SOURCE

	Type of System (All data are percent of System Totals)						Overall System Totals	
	Surface Water & Mixed Source	Ground Water			Wholesale Finished Water Source	Special Systems		
		Springs	Wells	Mixture of Both			Number	Percent
Did not exceed Constituent Limits*	57	100	17	0	100	0	14	47
Exceed Constituent Limits*	43	0	83	0	0	0	16	53
Exceed recommended but not mandatory limits	36	0	67	0	0	0	13	43
Exceed mandatory limits	7	0	16	0	0	0	3	10
System Totals - Number	14	1	12	0	3	0	30	0

Note: 63 percent of the study population was served drinking water that essentially met the Constituent Limits.

***See pages 11-13 for definition of Constituent Limits.**

TABLE 5

WATER QUALITY EVALUATION BY COMMUNITY SIZE

	Population Served in Thousands (All data are percent of Size Totals)							Overall System Totals	
	<.5	.5-5	5-10	10-25	25-50	50-100	>100	Number	Percent
Did not exceed Constituent Limits*	38	50	100	0	0	0	100	14	47
Exceed Constituent Limits*	62	50	0	100	0	100	0	16	53
Exceed recommended but not mandatory limits	54	42	0	0	0	100	0	13	43
Exceed mandatory limits	8	8	0	100	0	0	0	3	10
System Totals - Number	13	12	2	1	0	1	1	30	0

Note: 63 percent of the study population was served drinking waterwith quality that did not exceed the Constituent Limits*

*See pages 11-13 for definition of Constituent Limits.

Table 4 indicates that the well sources produced the poorest quality of water. This was because of inadequate protection and high inorganics in the water that were not removed by treatment. Systems utilizing surface water; although often drawn from polluted sources, usually improve the quality of their distributed water by treatment. Because of this treatment the overall quality of finished water from surface and mixed sources was usually better than well source systems.

The footnote on Table 4 indicates that 63 percent of the study population was served water that essentially met the constituent limits. Most of the remaining 37 percent of the population were furnished water that exceeded the recommended limits. However, bacteriological samples from Leewood and St. Albans showed the presence of coliform organisms in excess of the limits. A sample from Miami exceeded the mandatory limits for barium. The population of these three communities was 21,250 or about 9 percent of the study population.

Table 5 shows that, in general the larger communities produce better quality water than the smaller ones. The percentage not meeting one or more recommended or mandatory limits also varies inversely with size.

D. Facilities Evaluation

Table 6 and 7 show that two (2) or 7 percent of the water systems investigated were essentially free from major deficiencies.

TABLE 6

FACILITIES EVALUATION BY SOURCE

	Type of System (All data are percent of System Totals)						Overall System Totals	
	Surface Water & Mixed Source	Ground Water			Wholesale Finished Water Source	Special Systems		
		Springs	Wells	Mixture of Both			Number	Percent
Essentially free of major deficiencies	7	100	0	0	0	0	2	7
Major Deficiencies	93	0	100	0	100	0	28	93
Inadequate source protection, in the absence of disinfection or buying chlorinated water	7	0	17	0	100	0	6	20
Inadequate disinfection, if practiced	29	0	67	0	0	0	12	40
Inadequate control of disinfection, if practiced or if buying chlorinated water	0	0	0	0	0	0	0	0
Inadequate clarification, if practiced	79	0	8	0	0	0	12	40
Inadequate control of clarification, if practiced	50	0	0	0	0	0	7	23
Low (<20 psi) pressure in some or all areas of the dist. system	43	0	33	0	67	0	12	40
State Totals - Number	14	1	12	0	3	0	30	0

TABLE 7

FACILITIES EVALUATION BY COMMUNITY SIZE

	Population Served in Thousands (All data are % of Size Totals)							System Overall/Totals	
	<.5	.5-5	5-10	10-25	25-50	50-100	>100	Number	Percent
Essentially free of major deficiencies	8	8	0	0	0	0	0	2	7
Major Deficiencies	92	92	100	100	0	100	100	28	93
Inadequate source protection, in the absence of disinfection or buying chlorinated water	23	25	0	0	0	0	0	6	20
Inadequate disinfection, if practiced	46	50	0	0	0	0	0	12	40
Inadequate control of disinfection, if practiced or if buying chlorinated water	0	0	0	0	0	0	0	0	0
Inadequate clarification, if practiced	8	50	100	100	0	100	100	12	40
Inadequate control of clarification, if practiced	8	50	0	0	0	0	0	7	23
Low (<20 psi) pressure in some or all areas of the dist. system	38	42	50	0	0	100	0	12	40
System Totals - Number	13	12	2	1	0	1	1	30	100

The remaining twenty-eight (28) or ninety-three (93) percent had deficiencies in various aspects of the systems as follows:

1. Source Protection

Table 6 shows that six (6) or twenty (20) percent of the systems have inadequate source protection in the absence of disinfection. As expected, it was the smaller communities that had this deficiency most often.

Three systems, Crown Hill, Eastbank, and Glasgow purchase water from other systems. Since these systems were judged to have deficiencies such as clarification, they were considered as an inadequate source.

2. Disinfection

Table 6 shows that twelve (12) or forty (40) percent of the systems had inadequate disinfection if it were practiced. This was generally true with well supplies and was probably caused by the presence of hydrogen sulfide or other interferring substances.

In addition to lack of residual chlorine in the distribution system, chlorination was judged inadequate if there had been any interruption of chlorination during the past year, and if no emergency equipment was available.

3. Clarification

Again Table 6 shows that twelve (12) or forty (40) percent of the systems had inadequate clarification if it were practiced. This deficience was not limited to the small systems.

Clarification was judged inadequate if any of the following was unsatisfactory: (a) chemical feed capacity, (b) chemical mixing, (c) flocculation, (d) settling, or (e) filtration.

4. Control of Clarification

Seven (7) systems or twenty-three (44) percent were deemed to have inadequate control of clarification if it were practiced. Control was deemed inadequate if a turbidity test was not run daily or jar tests were not run at frequent intervals.

5. Distribution System Pressure

Thirteen (13) or forty-three (43) percent of the systems had low (<20psi) pressure in some areas of the distribution system. This deficiency was evident in about all size systems. In the larger systems it may be caused by rapid economic growth without increasing size of mains, and in the smaller ones it probably was caused by corrosion due to poor chemical quality of the water.

Based on the above analysis, it was judged that there were only two (2) systems or seven (7) percent of the total, that were essentially free of major deficiencies. These were Kayford and Pinch.

E. Surveillance Program Evaluation

Tables 8 and 9 indicate that only three systems or 10 percent took a sufficient number of bacteriological samples and had satisfactory results in accordance with the criteria established for this survey. (See discussion on Bacteriological Surveillance Program Criteria). One other system took a sufficient number of samples but they were not satisfactory. The remaining 26 systems or 87 percent did not take sufficient number of samples.

F. Laboratory Analyses

Appendix D lists the chemical, physical, bacteriological, and radio chemical results of samples taken from the distribution systems of each utility.

No values were recorded for the pesticide samples collected from the surface water supplies because the results were only insignificant traces.

TABLE 8

SURVEILLANCE EVALUATION BY SOURCE

	Type of System (All date are percent of System Totals						Overall System Totals	
	Surface Water & Mixed Source	Ground Water			Wholesale Finished Water Source	Special Systems		
		Springs	Wells	Mixture of Both			Number	Percent
Meets Bacteriological surveillance criteria	21	0	0	0	0	0	3	10
Does not meet bacteriological surveillance criteria	79	100	100	0	100	0	27	90
Does not meet collection portion of the bacteriological surveillance criteria	79	0	100	0	100	0	26	87
System Totals	14	1	12	0	3	0	30	100

TABLE 9

SURVEILLANCE EVALUATION BY COMMUNITY SIZE

	Population Served in Thousands (All data are % of Size Totals)							System Overall/Totals	
	<.5	.5-5	5-10	10-25	25-50	50-100	100	Number	Percent
Meets bacteriological surveillance criteria	0	8	100	0	0	0	0	3	10
Does not meet bacteriological surveillance criteria	100	92	0	100	0	100	100	27	90
Does not meet collection portion of the bacteriological surveillance criteria	92	92	0	100	0	100	100	26	87
System Totals - Number	13	12	2	1	0	1	1	30	100

DISCUSSION OF RESULTS

Thirty water supply systems were surveyed in the Charleston, West Virginia, Standard Metropolitan Statistical Area. The systems serve about 229,000 people which is 92 percent of the population of the statistical area. Therefore, 8 percent of the population rely on individual systems or are served by a system with less than 15 services and/or 25 people. A brief discussion of each system is included in Appendix A.

In the Charleston Service Area there are three treatment plants, owned and operated by the West Virginia Water Company, serving 181,700 people, or about 78.3 percent of the population of the SMSA. This service area is outlined on the map on page 9. The three treatment plants are located in Nitro, Belle, and Charleston. The first two utilize water from the Kanawha River, and the latter from the Elk River.

The Kanawha River, in the Charleston area, is grossly polluted. Effects of pollution from this area result in a 30 to 40 mile reach downstream from Charleston being devoid of oxygen during low stream flows. Municipal wastes contribute to oxygen depletion, but they comprise only a small fraction of the industrial contribution. Industrial wastes also cause a severe taste and odor problem in the Kanawha River. The plant at Nitro is located downstream from

the major industrial wastes discharges. Extensive treatment must be provided to produce potable water and reduce taste and odors for the 5[illegible],000 people served.

Considerable research and pilot studies were undertaken at the Nitro plant in the past to determine the type of treatment that would be required to remove taste and odor producing organics. Filtration through beds of granular activated carbon was chosen. This process definitely improved the quality of water delivered to the consumer. Carbon Chloroform Extract (CCE) is a measure of organic residues in water. The CCE concentrations in finished water at the Nitro plant have met the Standard which is 200 ppb. However, in spite of special treatment and CCE levels complying with the Standard, there are frequent customer complaints regarding taste and odors.

Evidently the taste and odor problems are related to the types, as well as to the amounts of organics, since there is not a consistent relationship between tastes and odors and CCE. More research is required in this area to provide a more meaningful Standard, or a more efficient sampling-analytical procedure is required.

The West Virginia Water Company is currently planning a new treatment plant and expansion of intake facilities on the Elk River which will serve the entire area now served by the three plants, (Charleston, Nitro, and Belle). The existing three plants are operating at or near designed capacity and are in need of repair.

The quality of the Elk River is generally good, and is not influenced by the pollution which affects the Kanawha River. Plans and specifications have been prepared and approved by the State Department of Health. Approval is also required by the Public Service Commission. Improvements in the system are needed and the plan to use the Elk River to serve Charleston, Nitro and Belle, will provide a better quality of raw water.

With adequate planning, the Charleston Service Area system could be extended to serve the smaller communities upstream on the Kanawha River. This would be especially desirable because several of these supplies are old and poorly operated, as indicated by the number of deficiencies listed.

The smaller communities having populations less than 1,000 rely on ground water as a source of supply with two exceptions. Ground water quality is influenced greatly by iron and manganese. Thirteen communities are using water with concentrations of these elements in excess of the Public Health Service Drinking Water Standards. Sampling results indicate that one community is using water with an iron concentration 17 times the Standard of 0.3 mg/l.

Another observation that can be made from the Survey is that eight systems are providing fluoridated water to the consumer. These systems are the larger ones and serve 215,000 people of the total 229,000 served by public water systems in the Standard Metropolitan

Statistical Area. None of the small supplies fluoridate. From these statistics, it can be deduced that approximately 37,000 people in Kanawha County are not receiving the benefits of water containing fluoride in optimum concentration.

Appendix A gives a brief discussion of each system including comments on the major deficiencies. Appendix C indicates for each system what processes are practiced and what items are considered inadequate. From Appendix C and Table 1, it can be concluded that the majority of people are furnished water that meet the constituent limits, but that the majority of systems produce water that does not meet the constituent limits. Also most systems have major deficiencies in the facilities or operations, and that there is a lack of bacteriological surveillance.

Sixty-three (63) percent of the 229,000 people or 144,000 are furnished water that meets the constituent limits. Twenty-seven (27) percent of the people are supplied water that does not meet the recommended limits, and ten (10) percent are furnished water that did not meet the mandatory standards.

The majority of the systems or sixteen (16) produced water that exceed the constituent limits. Since these 16 systems served only 37 percent of the population, it is apparent that the poor quality water was produced by the smaller systems. As discussed previously the solution to part of this problem would be the merging of the smaller supplies into the larger ones where practical and feasible. Another approach is more adequate surveillance by the State and local health departments and the publicizing of the deficiencies in order to gain public support for the improvements.

The analyses of the survey results show that only two (2) systems are essentially free of major deficiencies while twenty-eight (28) had such deficiencies. Generally the smaller systems are located in economically depressed areas and have more difficulties in raising funds to make the necessary improvements. In some of the larger systems, it was observed that there were problems with clarification. In some cases these could be solved without expensive structural changes.

One of the most glaring deficiencies is the lack of bacteriological surveillance. This responsibility rests with the water utility as well as with the health departments. A sufficient number of bacteriological samples were collected and analyzed from only four (4) or thirteen (13) percent of the systems. This deficiency was generally attributed to the smaller communities. However, the two largest utilities did not collect quite enough samples so they were also judged deficient. Only 8 percent of the population were served by utilities that satisfied this criteria. If the two largest utilities had taken a few more samples, then eighty three (83) percent of the population would be served by utilities that met this requirement. However, that would leave seventeen (17) percent of the population served by utilities deficient on this account. In several cases no samples at all were collected during the entire year.

The State Department of Health did not call this deficiency to the attention of the utilities and require that it be corrected. The budget of the Sanitary Engineering Division had been cut to such a degree that it did not have the personnel to discharge its responsibility in the water-hygiene program. (Since the field survey was made the State Legislature has increased the budget of the Division of Sanitary Engineering, so that it is doing a better job.) However, considerably more funds are needed before the Division can satisfactorily discharge its responsibility.

To insure that potable water is distributed to the consumer it is not only necessary to have satisfactory quality of water leaving the water plant, but the distribution system must be free from defects which may contaminate water in the systems. Therefore, there is a need for utilities to have a program to search out and eliminate cross-connections with unapproved sources and hazardous plumbing conditions which may permit back siphonage of contaminated liquids. Although some communities have a plumbing code for new construction, no utility has a continuous program to insure that cross-connections and hazardous plumbing conditions are eliminated. There is a need for the State Department of Health to initiate a program of cross-connection control and back siphonage surveillance.

APPENDIX A

BRIEF DISCUSSION OF EACH SYSTEM INCLUDING DEFICIENCIES

APPENDIX A

BRIEF DISCUSSION OF EACH SYSTEM INCLUDING DEFICIENCIES

1. Acme

This system consists of a well and a distribution system which serves about 120 people. Little information was available about the system or quality of the water, except it contained noticeable amounts of hydrogen sulfide. There were no records of chemical or bacteriological analyses. Two samples collected during the survey had satisfactory bacteriological results. The water is not chlorinated. The pressure in the distribution system was deficient.

2. Alum Creek

Water from Coal River is softened, filtered, chlorinated, and distributed to about 2,000 people. The plant was neat and clean, but the records were somewhat incomplete. The chemical quality of the water was satisfactory, however, better follow-up should be made when samples are bacteriologically unsatisfactory. There is inadequate control of the clarification process and bacteriological surveillance. Residual chlorine is not maintained through the system.

3. Belle

Water from the Kanawha River is coagulated, settled, filtered, chlorinated, fluoridated and distributed to approximately 8,700 consumers. The plant is well operated, but it is quite old and is being operated at, or near, designed capacity. The clarification process was judged inadequate. Plans are underway to obtain water from the proposed new plant in Charleston, if and when it is built. Sufficient number of bacteriological samples are collected and are satisfactory. Those taken during the survey were also satisfactory.

4. Burnwell

Water from a spring is distributed to about 120 people. Small pipes and inadequate elevation of storage caused low pressures in the system. There were no data on the reliable yield of the spring. There was insufficient residual chlorine, probably because of the presence of hydrogen sulfide. Sufficient bacteriological samples have been collected, but the results were unsatisfactory. Samples taken during the survey indicated satisfactory bacteriological results, but the chemical results were high in iron and manganese.

5. Carbon

Carbon obtains its water from a well and distributes it to about 130 people. The facilities of the system seem satisfactory except for inadequate chlorination. Only one bacteriological sample had been collected in the last year and that was unsatisfactory. During the survey there was no residual chlorine in the system. The bacteriological samples collected during the survey were satisfactory, while the chemical sample was high in iron and manganese.

6. Cedar Grove

Water from the Kanawha River is coagulated, settled, filtered, chlorinated, and pumped to about 1,900 people in Cedar Grove.

In addition, water is wholesaled to Glasgow and Eastbank which have a combined population of 2,000 people. The treatment facilities seem to have sufficient capacity but some of the equipment is in poor condition and in need of repair. Of the samples taken, the chemical and bacteriological results were satisfactory. However, of the twenty-four samples required for the year, only four were collected. The clarification of the water and the control of clarification were considered inadequate.

7. Charleston

This is the largest system in the survey serving some 121,000 people. It is owned by the West Virginia Water Company. However, the plant which treats water from the Elk River is old and needs renovating. The real solution is to build a new one. Plans are being developed to construct a large plant to serve Charleston, Nitro, Belle, and other nearby communities, but there are some difficulties to be resolved before construction is started. Bacteriological samples were satisfactory, but not quite enough were collected. Residual chlorine is maintained through the system. Records are sufficient and available. There were indications that clarification was inadequate.

8. Chelyan

This system treats water from the Kanawha River and pumps it to approximately 2,100 consumers. Complaints have been received of low pressure at ends of the distribution system. There are insufficient safety precautions in the chlorination process. There was inadequate control of the clarification process, and the turbidity was not satisfactory.

9. Clendenin

Water from the Elk River is treated and pumped to approximately 3,500 consumers. The plant is old and chlorination procedure was judged inadequate. The chemical and bacteriological quality of the filtered water is satisfactory for the samples collected. However, insufficient numbers of bacteriological samples are being collected. There was inadequate control of clarification and the turbidity was not satisfactory. Plans are being made to construct an additional filter and more mains.

10. Corton

This small community obtains its water from the Elk River, and after treatment, distributes it to 36 people. Somewhat insufficient number of bacteriological samples have been taken, but all those taken were satisfactory as were thosetaken during the survey. The chemical analyses were also satisfactory. There was inadequate control of clarification but the turbidity was within acceptable limits.

11. Crown Hill

This community of 250 people obtains its water from Pratt. The distribution system is old, poorly maintained, and has sections with insufficient pressure. No samples are collected by Crown

Hill, and insufficient samples are collected by Pratt. Because of deficiencies in the Pratt system, it was considered that Crown Hill source was inadequate.

12. Decota

Water from a well is pumped through a system which serves about 320 people. The pressures are adequate, but storage is not. The high hydrogen sulfide content makes chlorination process ineffective. Only three bacteriological samples were taken last year although 24 are required, but these were satisfactory as were the two taken during the survey. The chemical samples indicate the presence of unsatisfactory amounts of iron and manganese.

13. Eastbank

Water is purchased from Cedar Grove and retailed to about 1,200 consumers. This system is in poor condition. There is a need for elevated storage and improvement of the water mains as water pressure is inadequate. No samples were collected from the system. Two samples collected during the survey were satisfactory and the residual chlorine was sufficient. Since Cedar Grove was judged inadequate in clarification, clarification control, and bacteriological surveillance, the source of Eastbank was judged inadequate.

14. Glasgow

Glasgow also purchases water from Cedar Grove and distributes it to about 1,000 consumers. The distribution system is in reasonably good condition, and there are no dead ends. Samples are not collected from this system. The two collected during the survey were satisfactory. Since Cedar Grove was judged inadequate in clarification, clarification control, and bacteriological surveillance, the source of Glasgow was judged inadequate.

15. Handley

This community is furnished water by the Chesapeake and Ohio Railroad which treats Kanawha River water primarily for boilers. Chlorination is not practiced. The operation is inadequate and pressures are low in the system. Insufficient bacteriological samples are taken. The two collected during the survey were satisfactory. There is talk of obtaining water from Montgomery instead of the railroad. This would be an excellent solution to the water supply problem.

16. Kayford

This supply is primarily for industry but furnishes water to 100 people. The source is a well and infiltration gallery. The maintenance of the system is poor but chlorination seems adequate. There are no major physical deficiencies reported. Only three bacteriological samples were collected last year, but these were satisfactory as were the two collected during the survey. The chemical analysis was also satisfactory.

17. Leewood

Water from a well is supplied to 150 people by a distribution system which is poorly maintained and has areas of low pressure. The concentration of hydrogen sulfide is so high that no residual chlorine can be maintained in the system. At time of survey, the chlorinator was not being used. Bacteriological samples were collected only two months last year and the results for one month were unsatisfactory. One of the two bacteriological samples taken during the survey was unsatisfactory.

18. Miami

Groundwater is pumped from a well, aerated, coagulated, settled, filtered, chlorinated and distributed to about 1,100 consumers. The purpose of the treatment is to reduce the hydrogen sulfide, iron, and manganese. The clogging of the filter with manganese and consumer complaints indicate that the treatment is not very effective. Chlorination was inadequate. The well is subject to flooding. Insufficient bacteriological samples are being taken and those collected do not meet the Standards. The two collected during the survey were satisfactory. Barium exceeded the mandatory limits.

19. Montgomery

This system is also owned by the West Virginia Water Company and provides the same treatment to Kanawha River water as does the Belle system. Sixty-five hundred people living in Montgomery, London, Hugheston, are served by this system. At times there are taste and odor problems and low pressures in some areas. Sufficient bacteriological samples are collected and they are satisfactory, as were those collected during the survey. Problems have been experienced in clarifying the water.

20. Nitro

There is an old plant that treats Kanawha River water taken from below the industrial complex at South Charleston. The raw water contains such large amounts of chemical wastes that it is very difficult to remove the tastes and odors by the normal treatment process. Granulated, activated carbon is used in lieu of sand in the filter to help solve the problems. The ultimate solution is a new source of water and this is being planned (see Charleston discussion). Insufficient bacteriological samples are collected and they were satisfactory. The chemical analyses indicated that the limit for manganese was exceeded. In some parts of the distribution system there is low pressure. At the time of inspection there were some problems with clarification. The system is being operated as well as possible under the circumstances. About 52,000 people are served by this system.

21. Pinch

Water from the Elk River is softened, filtered, chlorinated, fluoridated, and distributed to about 1,025 consumers. The treatment plant has sufficient capacity. The plant appears well designed and maintained. Only one bacteriological sample was collected last year and it was unsatisfactory. The two collected during the survey were satisfactory.

22. Pratt

Kanawha River water is coagulated, filtered, chlorinated, and distributed to 1,250 consumers in Pratt and 250 in Crown Hill and Hansford. The plant is operated at design capacity. There is a present need to increase the sedimentation capacity and the amount of storage in the system. At times the filter runs are five hours or less. The plant is allowed to operate when no operator is on duty. Insufficient bacteriological samples are collected. Those collected during the survey were satisfactory. Turbidity and iron were in excess of the recommended limits.

23. Rensford

Groundwater is pumped from three wells to supply 100 people. The wells are inadequately protected as coal dust finds its way into the water. As with most of the smaller systems, little information was available about the system. Only four bacteriological samples were taken last year and one was unsatisfactory. The two collected during the survey were satisfactory. Chlorination is not practiced. Chemical analyses indicated that the water was high in iron and manganese.

24. Republic

The system consists of a well, pump, and distribution system which seems quite adequate for the 90 people it serves. The chemical quality of the water is poor, having excessive iron, manganese, and hydrogen sulfide. It is difficult to maintain any residual chlorine in the system. No bacteriological samples were taken the last year, and one of the two taken during the survey was unsatisfactory.

25. Ronda

Water is pumped from a well through a distribution system to approximately 256 people. The well is located too close to a septic tank and a privy. The water is high in iron, manganese and sulfides which destroys the residual chlorine before it reaches the end of the system. No bacteriological samples were taken last year and one of the two collected during the field survey was unsatisfactory.

26. St. Albans

Water from Coal River receives conventional treatment and is distributed to about 20,000 consumers. The quality of the raw water is affected by mine drainage and occasional discharges of municipal sewage. The present plant is producing at, or over, designed capacity. Plans are being developed to construct another 1.5 mgd. plant to be operated in parallel with the present plant. Only eleven of the 240 samples required were collected during the last year. Those collected were satisfactory as were those collected during the survey. Short filter runs indicated that coagulation and settling was inadequate.

27. Shrewsbury

Water from two drilled wells is treated to reduce iron, manganese, and hydrogen sulfide and then is pumped into the distribution system which serves 640 people. This system also serves Monarch, West Virginia. The facilities are old and evidently do not work well and consumers complain that the water stains. Chemical analyses of samples collected during the survey confirm this complaint. Insufficient bacteriological samples were collected last year. Those collected were satisfactory as were the two taken during the survey.

28. <u>Sissonville</u>

Water from Pocatalico River is coagulated, settled, filtered, chlorinated, fluoridated, and distributed to about 2,500 consumers. Oil well pollution has increased the chlorides in the water source so much that a new temporary intake was constructed 2½ miles from the plant on the left branch of the Pocatalico River. This line has frozen in the winter, adding to the utility's problems. There are a number of design problems in the plant which need changing. Both the raw and finished water transmission lines need to be improved to prevent freezing and low pressure. The pollution of the source needs to be eliminated. Insufficient bacteriological samples have been collected and those that were do not meet the Standards. However, the two collected during the survey were satisfactory. Clarification was inadequate and resulted in turbidities above the constituent limits. Chlorination was also inadequate.

29. <u>Ward</u>

This industrial supply is serving only 45 people who will soon be moving. The system is to be abandoned. Bacteriological samples have not been collected recently. The two collected during the survey were satisfactory. Chlorination is not practiced routinely. There is low pressure in the distribution system.

30. Winifrede

This industrial supply serves about 60 people. It consists of a well, pump, and distribution system. It is poorly maintained and the chemical quality of the water is also poor. The well is subject to flooding. No bacteriological samples were taken the past year. One sample collected during the survey was satisfactory. There is no chlorination.

APPENDIX B

FORMS USED TO GATHER DATA

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Consumer Protection and Environmental Health Service
Environmental Control Administration
Bureau of Water Hygiene

INVENTORY OF MUNICIPAL WATER FACILITIES

CURRENT DATA

COMMUNITY OR FACILITY (1) a	Correct legal name
	Postal address of utility
COUNTY (1) b	
STATE	
CENSUS POPULATION (2) a	
CURRENT ESTIMATED POPULATION SERVED (2) b	
LAB. CONTROL (3)	
OWNERSHIP (4)	

(5) CLASSIFICATION	NUMBER OF SERVICES	NUMBER OF METERS	MGD AVG. WATER
RESIDENTIAL a			
COMMERCIAL b			
INDUSTRIAL c			
PUBLIC d			
TOTAL e			

SOURCE OF SUPPLY (6)

SAFE YIELD IMPOUNDED MG (7) a

MAXIMUM DEPENDABLE RATE (GR. WATER) MGD (7) b

RATED CAPACITY MGD (8)

TREATMENT (9) a

DIST. STORAGE

MGD TO MAINS (10) a

GRAVITY TO MAINS MG (10) b

IMPROVEMENTS NEEDED (11)

REMARKS

BOB #85-S6955
Exp. March 1970

MUNICIPAL WATER SUPPLY SANITARY SURVEY

SURVEY DATE

1. Leave this blank (for office use only) 12 (DUP ON EVERY CARD) Date of visit mo. day yr.

2. Name of supply Same as on inventory

3. Location Same as on inventory
post office common name, if different

4. Demands, MGD

	PRESENT	10-YR. ESTIMATE	UNKNOWN
A. Avg. day	From (23)	(24 ^ 28)	(30)
B. Max. day	Plant (31, 35)	(36 ^ 40)	(42)
C. Max. month	Records (43, 47)	(48 ^ 52)	(54)

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

6. LABORATORY CONTROL

A. Bacteriological (Distribution system only) From Fig 1-D.W.S.

(1) Min. number samples recommended per month by PHS DWS → [ ] (60, 62) UNKNOWN

(2) Avg. number/month for last 12 months May be [ ] (63, 65) [ ] (67)

(3) Range of least and most monthly samples from [zero] (68, 70) to [ ] (71, 73) [ ] (75)

(4) Number of months the Drinking Water Standards were not met during the last 12 months for: No. of months END CARD ONE [1] (80) UNKNOWN

(a) Quality — Sec 5.2 - D.W.S. [ ] (13, 14) [ ] (15)

(b) Number of samples {Months when sample numbers < no. in 6.A.(1) [ ] (16, 17) [ ] (18)

(c) NONE collected No samples for ___ months. [ ] (19, 20) [ ] (21)

(5) Are samples representative of distribution system? Judge from map of distribution system. [ ] (22) yes [ ] (23) no

(6) Are check samples collected as provided for in the Drinking Water Standards? Sec 3.15 - D.W.S. [ ] (24) yes [ ] (25) no

(7) Are samples requiring check samples reported by telephone? [ ] (26) yes [ ] (27) no

(8) Is the laboratory certified? [ ] (28) yes [ ] (29) no

(a) Within the past 3 years? [ ] (30) yes [ ] (31) no

(b) If yes to one or both, by whom was it certified. [ ] (32) State [ ] (33) PHS

(9) Are samples received by lab within 30 hours? [ ] (34) yes [ ] (35) no

(Handwritten margin annotations: "From plant records" alongside items (2)–(6); "Information from operator" across items (7)–(9).)

ECA-19

B. Chemical (finished water only)

(1) Samples of finished water are analyzed each [ ] month, [ ] year, [ ] 2 years, [ ] 3 years, [ ] infrequently [ ] never.

(2) Type of analysis: [ ] complete (PHS) [ ] partial

(3) Date of last chemical analysis [ ][ ] mo. [ ][ ] day [ ][ ] yr.

(4) Analyzed by [ ] utility, [ ] state, [ ] PHS, [ ] university, [ ] other.

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

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

Note other frequencies

C. Radioactivity

(1) Samples are analyzed each [ ] month, [ ] year, [ ] 2 years, [ ] 3 years, [ ] infrequently [ ] never. (END CARD 3) 3 80

(2) Date of last radiological analysis [ ][ ] mo. [ ][ ] day [ ][ ] yr.

(3) Analyzed by [ ] utility, [ ] state, [ ] PHS, [ ] university, [ ] other. (specify)

7. SANITARY SURVEY

A. Date of most recent survey [illegible] (mo. 26–27, day, yr. 30)

B. Survey made by: ☐ (31) state, ☐ (32) PHS, ☐ (33) local health department, ☐ (34) utility, ☐ (35) consultant. "Survey" requires written report of findings [handwritten, partly illegible]

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

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

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

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

8. FACILITIES & OPERATION, continued

J. Chlorination process was interrupted ☐☐ times in the last 12 months.
72 73

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

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

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

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

A. Are the following adequate:

	YES	NO
(1) Source, with respect to the following:		
(a) quantity	☐ 18	☐ 19
(b) bacteriological quality } Refer to PHS No. 1020	☐ 20	☐ 21
(c) chemical quality	☐ 22	☐ 23
(d) physical quality	☐ 24	☐ 25
(e) adequate protection	☐ 26	☐ 27
(2) Transmission of raw water	☐ 28	☐ 29
(3) Is the raw water sampled for:		
(a) Bacteriological contamination	☐ 30	☐ 31
(b) Chemical contamination	☐ 32	☐ 33
(4) Treatment, with respect to the folowing:		
(a) aeration	☐ 34	☐ 35
(b) chemical feed, capacity	☐ 36	☐ 37
(c) chemical feed, stand-by equipment	☐ 38	☐ 39
(d) chemical mixing	☐ 40	☐ 41
(e) flocculation	☐ 42	☐ 43

9. SOURCE, TREATMENT & DISTRIBUTION, continued

A. Are the following adequate (continued):

	YES	NO
(4) Treatment, continued:		
(f) settling	44	45
(g) recarbonation	46	47
(h) filtration At normal operating rates	[illegible]	[illegible]
(i) disinfection, capacity	50	51
(j) disinfection, stand-by equipment	52	53
(k) taste & odor control	54	55
(l) fluoridation	56	57
(5) Distribution, with respect to the following:		
(a) storage	58	59
(b) booster chlorination	60	61
(c) high service pumping	62	63
(d) booster pumping	64	65
(e) pressure	66	67
(6) Maintenance	68	69
(7) Records for:		
(a) disinfection	70	71
(b) filter runs	72	73
(c) chemical consumption	74	75
(d) operational control tests	76	77
(e) bacteriological examinations	78	79
(8) Cross-connection control	END CARD 5 [5] 80	
(a) ordinance	13	14
(b) program implementation	15	16
(c) progress	17	18

9. SOURCE, TREATMENT & DISTRIBUTION, continued

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

10. PERSONNEL

A. Water Purification Operator — This is the responsible plant operator - Not supt.

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

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

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

(4) Number of previous positions as water treatment operator [ ][ ] (36, 37)

(5) Total years of water purification experience [ ][ ] (38, 39)

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

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

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

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

10. PERSONNEL, continued

A. continued

(10) Is your present staff adequate in: Operator's opinion

(a) number ☐ yes ☐ no
60 61

(b) quality ☐ yes ☐ no
62 63

B. Operator's major complaint ______

C. Most frequent customer's complaint: Received by utility.

D. Management's most frequent complaint: ______

III. FINANCIAL INFORMATION

A. Bonded indebtedness: (water supply)

(1) General obligation bonds $ [ ] END CARD 8 [ ]

(a) statutory limit $ [ ]

(2) Revenue bonds $ [ ]

(a) statutory limit $ [ ]

B. Capital stock, par value $ [ ]

bonds, par value $ [ ]

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

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

E. Operation is controlled by: [ ] mayor-council, [ ] mayor-commission, [ ] independent water board, [ ] other, specify.

For city, district, etc. owned on.

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

(1) Value of planned improvement $ [ ]

(2) Planning by utility [ ] yes [ ] no utility only

(3) Planning by consultants [ ] yes [ ] no utility & consultants

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

	1 YR.	2-5 YRS.	6-10 YRS.
(1) Source	[ ]	[ ]	[ ]
(2) Treatment	[ ]	[ ]	[ ]
(3) Distribution	[ ]	[ ]	[ ]
(4) Other ________________	[ ]	[ ]	[ ]

H. Costs of production:

	CENTS/1,000 GALLONS
(1) Chemicals	[ ] [ ] . [ ]
(2) Labor, power, etc.	[ ] [ ] . [ ]
(3) Depreciation	[ ] [ ] . [ ]
(4) Other, including office, administration, meter reading, collection, etc.	[ ] [ ] . [ ]
(5) Total	[ ] [ ] . [ ]

II. FINANCIAL INFORMATION, continued

I. Tariff (Residential)

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

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

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

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

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

(d) etc. as needed to cover steps.

Adjust all rates to these units.

END CARD 8 [8] (80)

Note flat rate here as $/time unit

APPENDIX C

SUMMARY TABLE

APPENDIX C

Summary Table

COMMUNITY	Does not disinfect, clarify or buy chlorinated water	Disinfect only or buys chlorinated water	Clarifies and disinfects	Clarifies without disinfection	Does not exceed constituent limits	Exceeds one or more of the recommended limits	Exceeds one or more of the mandatory limits	Inadequate source protection in absence of disinfection
Acme	*				S			
Alum Creek			*		S			
Belle			*		S			
Burnwell		*				U		
Carbon		*				U		
Cedar Grove			*		S			
Charleston			*		S			
Cheylan			*			U		
Clendenin			*			U		
Corton			*		S			
Crown Hill		*			S			U
Decota		*				U		
Eastbank		*			S			U
Glasgow		*			S			U
Handley				*	S			U
Kayford		*			S			
Leewood		*					U	
Miami			*					
Montgomery			*		S			
Nitro			*			U		
Pinch			*		S			
Pratt			*			U		
Rensford	*					U		U
Republic		*				U		
Ronda		*				U		
St. Albans			*				U	
Shrewsbury			*			U		
Sissonville			*			U		
Ward	*				S			
Winifrede	*					U		U
TOTAL	4	10	15	1	14	13	3	6

* For Information only - not used in evaluation of systems
S Satisfactory - met criteria used in evaluation of systems
U Unsatisfactory - did not meet criteria

APPENDIX C

Summary Table

(continued)

COMMUNITY	Inadequate disinfection if practiced	Inadequate clarification if practiced	Inadequate control of clarification if practiced	Low Pressure	Essentially free of major deficiencies	Meets bacteriological surveillance criteria	Does not meet bacteriological surveillance criteria	Insufficient bacteriological samples collected
Acme				U			U	U
Alum Creek	U		U				U	U
Belle		U				S		
Burnwell	U			U			U	
Carbon	U						U	U
Cedar Grove		U	U				U	U
Charleston		U					U	U
Cheylan	U	U	U	U		S		
Clendenin	U	U	U				U	U
Corton		U	U				U	U
Crown Hill				U			U	U
Decota	U						U	U
Eastbank				U			U	U
Glasgow							U	U
Handley			U	U			U	U
Kayford					S		U	U
Leewood	U			U			U	U
Miami	U	U					U	U
Montgomery		U		U		S		
Nitro		U		U			U	U
Pinch					S		U	U
Pratt		U	U	U			U	U
Rensford							U	U
Republic	U						U	U
Ronda	U						U	U
St. Albans		U					U	U
Shrewsbury	U						U	U
Sissonville	U	U		U			U	U
Ward				U			U	U
Winifred							U	U
TOTAL	12	12	7	12	2	3	27	26

APPENDIX D

LABORATORY RESULTS

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                                 355003050200 ++++++++++++
THL.. MAR. 5, 1970        DRINKING WATER QUALITY DATA FROM "CWSS" COMPARED TO USPHS STANDARDS      PAGE 011
UNITS ARE MG/L EXCEPT: RADIATION IN PC/L. COLIFORMS PER 100/ML. COLOR & TURB.IN STD.UNITS

0002   355003050200      ACME WATER SUPPLY                                        LEEWOOD, WEST VIRGINIA      25122
  ID NO             POP   O IMP    COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL       SOURCE  OF  SUPPLY              AV DAY
355003050200        120   1 531    000  00 00 000  00  00  00  00  0  0  0 000  0  1 WELL                              000.00
AVERAGE                                            AVERAGE                                                          AVERAGE
 ABS      BA        CD        CR        CCE       F         PB        NO3       SE        SO4       ZN        TURB      BETA
0001      0000      0002      0002      0000      0002      0002      0001      0001      000       0002      0001      0001      NO.
                                                  □
 .17                .001      .000                0.22      .008      0.0       .004      10.       .015      0.70      2.

  AS       B         CL        CU        CN        FE        MN                            AG        TDS       COLOR     ALPHA     COLI
NO. 0001   0001      0001      0002      0001      0002      0002                          0002      0001      0001      0001      0002

  .00      .00       16.       .004      .000      .100      .050                          .000      291.      0.        0.        0.0

MAXIMUM                                            MAXIMUM                                                                  MAXIMUM
 ABS      BA        CD        CR        CCE       F         PB        NO3       SE        SO4       ZN        TURB      BETA
                                                                                                                              EXCD
                                                  □
 .17                .002      .000                0.25      .016      0.0       .004      10.       .019      0.70      2.

  AS       B         CL        CU        CN        FE        MN                            AG        TDS       COLOR     ALPHA     COLI
EXCD

  .00    L .100      16.       .005      .000      .133      .051                          .000      291.      L 5.      0.        0.0

*    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
                                 355062450200 ++++++++++++
0004   355062450200      BELLE DIV.-WEST VIRGINIA WATER  COMPANY                  BELLE, WEST VIRGINIA        25015
  ID NO             POP   O IMP    COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL       SOURCE  OF  SUPPLY              AV DAY
355062450200       8700   2        001  20 01 002  00  01  04  01  0  0  2 001  0  KANAWHA RIVER                       000.95
AVERAGE                                            AVERAGE                                                          AVERAGE
 ABS      BA        CD        CR        CCE       F         PB        NO3       SE        SO4       ZN        TURB      BETA
0001      0000      0003      0003      0001      0003      0003      0001      0001      0001      0003      0001      0001      NO.

 .06                .000      .000      .033      0.82      .009      2.8       .004      27.       .021      0.40      1.

  AS       B         CL        CU        CN        FE        MN                            AG        TDS       COLOR     ALPHA     COLI
NO. 0001   0001      0001      0003      0001      0003      0003                          0003      0001      0001      0001      0002

  .00      .00       11.       .014      .000      .027      .000                          .002      68.       0.        0.        0.0

MAXIMUM                                            MAXIMUM                                                                  MAXIMUM
 ABS      BA        CD        CR        CCF       F         PB        NO3       SE        SO4       ZN        TURB      BETA
                                                                                                                              EXCD

 .06                .000      .000      .033      0.90      .017      2.8       .004      27.       .044      0.40      1.

  AS       B         CL        CU        CN        FE        MN                            AG        TDS       COLOR     ALPHA     COLI
EXCD

  .00      .00       11.       .019      .000      .042      .001                          .004      68.       L 5.      0.        0.0

 * EXCEEDS RECOMMENDED STANDARDS, ** EXCEEDS MANDATORY STANDARDS, □ LESS THAN OPTIMUM CONCENTRATION OF F.
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THU., MAR. 5, 1970      DRINKING WATER QUALITY DATA FROM "CWSS" COMPARED TO USPHS STANDARDS     PAGE 012
                                 355118250200 ++++++++++
UNITS ARE MG/L EXCEPT: RADIATION IN PC/L, COLIFORMS PER 100/ML, COLOR & TURB.IN STD.UNITS

0003   355118250200      BURNWELL WATER SUPPLY             IMPERIAL CALLIERY CO              BURNWELL, WEST VIRGINIA    25034
  ID NO              POP      C IMP    COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL        SOURCE  OF  SUPPLY                AV DAY
355118250200         100   2 620     000  00 00 000  00  00  00  00  0  0  0 004  0  1 WELL
AVERAGE                                                 AVERAGE                                                               AVERAGE
 ABS      BA        CD        CR        CCE       F         PB        NO3       SE        SO4       ZN        TURB      BETA
0001      0000      0003      0003      0000      0003      0003      0001      0001      0001      0003      0001      0001     NO.
                                                  ¤
 .07                .001      .000                0.00      .018      0.0       .002      91.       .086      2.40      2.

      AS        B         CL        CU        CN        FE        MN                  AG        TDS       COLOR     ALPHA     COLI
NO.  0001      0001      0001      0003      0001      0003      0003                0003      0001      0001      0001      0003
                                                       *         *
     .00       .00       47.       .035      .003      .721      .137                .005      342.       0.        0.       0.0

MAXIMUM                                                 MAXIMUM                                                               MAXIMUM
 ABS      BA        CD        CR        CCE       F         PB        NO3       SE        SO4       ZN        TURB      BETA
                                                                                                                                 EXCD
                                                  ¤
 .07                .003      .000               L0.20      .027      0.0       .002      91.       .179      2.40      2.

      AS        B         CL        CU        CN        FE        MN                  AG        TDS       COLOR     ALPHA     COLI
EXCD                                                      3         3
                                                       *         *
     .00     L .100      47.       .066      .003     1.085      .153                .006      342.      L 5.       0.       0.0

*    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
                                 355131400200 ++++++++++++
0004   355131400200      CARBON WATER SUPPLY               CARBON FUEL COMPANY               CARBON, WEST VIRGINIA      25037
  ID NO              POP      O IMP    COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL        SOURCE  OF  SUPPLY                AV DAY
355131400200         130   2 021     000  00 00 000  01  00  00  00  0  0  0 004  0  1 WELL                                    000.01
AVERAGE                                                 AVERAGE                                                               AVERAGE
 ABS      BA        CD        CR        CCE       F         PB        NO3       SE        SO4       ZN        TURB      BETA
0001      0000      0003      0003      0000      0003      0003      0001      0001      0001      0003      0001      0001     NO.
                                                  ¤
 .11                .000      .000                0.00      .005      0.5       .002      53.       .191      3.50      2.

      AS        B         CL        CU        CN        FE        MN                  AG        TDS       COLOR     ALPHA     COLI
NO.  0001      0001      0001      0003      0001      0003      0003                0003      0001      0001      0001      0002
                                                       *         *
     .00       .00       13.       .003      .000      .701      .085                .001      229.       0.        0.       0.0

MAXIMUM                                                 MAXIMUM                                                               MAXIMUM
 ABS      BA        CD        CR        CCE       F         PB        NO3       SE        SO4       ZN        TURB      BETA
                                                                                                                                 EXCD
                                                  ¤
 .11                .000      .000               L0.20      .015      0.5       .002      53.       .453      3.50      2.

      AS        B         CL        CU        CN        FE        MN                  AG        TDS       COLOR     ALPHA     COLI
EXCD                                                      3         3
                                                       *         *
     .00       .00       13.       .009      .000      .823      .103                .002      229.      L 5.       0.       0.0

* EXCEEDS RECOMMENDED STANDARDS, ** EXCEEDS MANDATORY STANDARDS, ¤ LESS THAN OPTIMUM CONCENTRATION OF F.
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THL.. MAR. 5, 1970 DRINKING WATER QUALITY DATA FROM "CWSS" COMPARED TO USPHS STANDARDS PAGE 013

355140400200 ++++++++++++

UNITS ARE MG/L EXCEPT: RADIATION IN PC/L, COLIFORMS PER 100/ML, COLOR & TURB, IN STD.UNITS

0004 355140400200 CEDAR GROVE MUNICIPAL WATER CO. CITY HALL BLDG. CEDAR GROVE, WEST VIRGINIA 25039

ID NO	POP	O IMP	COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL	SOURCE OF SUPPLY	AV DAY
355140400200	1750	1	010 01 01 012 00 01 04 01 0 0 0 001 0	KANAWHA RIVER	000.36

AVERAGE

	ABS	BA	CD	CR	CCE	F	PB	NO3	SE	SO4	ZN	TURB	BETA	
	0001	0000	0003	0003	0001	0003	0003	0001	0001	0001	0003	0001	0001	NO.
	.06		.000	.000	.043	¤ 0.06	.017	3.4	.003	39.	.027	0.67	2.	

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
NO.	0001	0001	0001	0003	0001	0003	0003	0003	0001	0001	0001	0002
	.00	.00	2.9	.003	.000	.027	.009	.001	94.	0.	0.	0.0

MAXIMUM

	ABS	BA	CD	CR	CCE	F	PB	NO3	SE	SO4	ZN	TURB	BETA
	.06		.000	.000	.043	¤ 0.19	.035	3.4	.003	39.	.041	0.67	2.

MAXIMUM EXCD

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
EXCD	.00	.00	2.9	.006	.000	.033	.012	.002	94.	L 5.	0.	0.0

* *

355145800200 ++++++++++++

0016 355145800200 CHARLESTON DIV.-WEST VIRGINIA WATER COMPANY CHARLESTON, WEST VIRGINIA 25301

ID NO	POP	O IMP	COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL	SOURCE OF SUPPLY	AV DAY
355145800200	121000	2	005 20 01 200 00 10 04 01 0 0 2 021 0	ELK RIVER	018.00

AVERAGE

	ABS	BA	CD	CR	CCE	F	PB	NO3	SE	SO4	ZN	TURB	BETA	
	0001	0000	0015	0015	0001	0015	0015	0001	0001	0001	0015	0001	0001	NO.
	.06		.000	.001	.024	1.00	.002	1.6	.005	21.	.036	0.13	2.	

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
NO.	0001	0001	0001	0015	0001	0015	0015	0015	0001	0001	0001	0014
	.00	.00	5.6	.011	.000	.098	.000	.001	93.	0.	0.	0.0

MAXIMUM

	ABS	BA	CD	CR	CCF	F	PB	NO3	SE	SO4	ZN	TURB	BETA
	.06		.002	.009	.024	1.10	.017	1.6	.005	21.	.175	0.13	2.

MAXIMUM EXCD

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
EXCD						1						
	.00	L .100	5.6	.033	.000	* .719	.005	.005	93.	L 5.	0.	0.0

* EXCEEDS RECOMMENDED STANDARDS. ** EXCEEDS MANDATORY STANDARDS. ¤ LESS THAN OPTIMUM CONCENTRATION OF F.

THU., MAR. 5, 1970 DRINKING WATER QUALITY DATA FROM "CWSS" COMPARED TO USPHS STANDARDS PAGE 014
355149450200 ++++++++++++

UNITS ARE MG/L EXCEPT: RADIATION IN PC/L, COLIFORMS PER 100/ML, COLOR & TURB.IN STD.UNITS

0004 355149450200 CHELYAN WATER SUPPLY COMMUNITY WATER CO CHELYAN, WEST VIRGINIA 25041

ID NO	POP	O IMP	COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL	SOURCE OF SUPPLY	AV DAY
355149450200	2100	2	011 00 00 002 00 01 04 01 0 0 0 001 0	KANAWHA RIVER	000.11

AVERAGE

	ABS	BA	CD	CR	CCE	F	PB	NO3	SE	SO4	ZN	TURB	BETA
NO.	0001	0000	0003	0003	0001	0003	0003	0001	0001	0001	0003	0001	0001
AVERAGE	.04		.001	.000	.029	□ 0.06	.000	3.5	.003	35.	.023	* 3.20	2.

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
NO.	0001	0001	0001	0003	0001	0003	0003	0003	0001	0001	0001	0002
AVERAGE	.00	.00	9.1	.009	.000	.140	.044	.000	101.	0.	0.	0.0

MAXIMUM

	ABS	BA	CD	CR	CCE	F	PB	NO3	SE	SO4	ZN	TURB	BETA
EXCD												1	
MAXIMUM	.04		.002	.000	.029	□ 0.19	.000	3.5	.003	35.	.038	* 3.20	2.

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
EXCD												
MAXIMUM	.00	.00	9.1	.015	.000	.187	.053	.002	101.	L 5.	0.	0.0

* *

355160800200 ++++++++++++

0004 355160800200 CLENDENIN MUNICIPAL WATER SUPPLYCITY HALL BLDG. CLENDENIN, WEST VIRGINIA 25045

ID NO	POP	O IMP	COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL	SOURCE OF SUPPLY	AV DAY
355160800200	3500	2 220	011 01 00 002 00 40 04 01 0 0 3 001 0	ELK RIVER	000.19

AVERAGE

	ABS	BA	CD	CR	CCE	F	PB	NO3	SE	SO4	ZN	TURB	BETA
NO.	0001	0000	0003	0003	0001	0003	0003	0001	0001	0001	0003	0001	0001
AVERAGE	.05		.001	.003	.022	□ 0.55	.011	2.1	.003	46.	.033	* 1.80	2.

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
NO.	0001	0001	0001	0003	0001	0003	0003	0003	0001	0001	0001	0002
AVERAGE	.00	.00	3.6	.024	.000	.168	.006	.001	129.	0.	0.	0.0

MAXIMUM

	ABS	BA	CD	CR	CCF	F	PB	NO3	SE	SO4	ZN	TURB	BETA
EXCD												1	
MAXIMUM	.05		.002	.010	.022	□ 0.56	.017	2.1	.003	46.	.082	* 1.80	2.

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
EXCD						1						
MAXIMUM	.00	.00	3.6	.050	.000	* .466	.015	.002	129.	L 5.	0.	0.0

* EXCEEDS RECOMMENDED STANDARDS, ** EXCEEDS MANDATORY STANDARDS, □ LESS THAN OPTIMUM CONCENTRATION OF F.

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                                 355184250200 ************
THU., MAR.  5, 1970       DRINKING WATER QUALITY DATA FROM "CWSS" COMPARED TO USPHS STANDARDS     PAGE 015
UNITS ARE MG/L EXCEPT RADIATION IN PC/L, COLIFORMS PER 100/ML, COLOR 6 TURB,IN STD.UNITS

0004   355184250200      CORTON WATER SUPPLY              CONSOLIDATED GAS SUPPLY CORP.    CORTON, WEST VIRGINIA     25050
  ID NO               POP      0 IMP     COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL       SOURCE  OF  SUPPLY             AV DAY
355184250200         036   2 000     100  00 00 000  10  40  00  01  0   0   0 004  0  ELK RIVER                         000.01
AVERAGE                                                     AVERAGE                                                         AVERAGE
 ABS       BA        CD        CR        CCE       F         PB        NO3       SE        SO4       ZN        TURB      BETA
0001      0000      0003      0003      0000      0003      0003      0001      0001      0001      0003      0001      0001      NO.
                                                  ¤
 .02                .001      .000                0.12      .005      0.8       .004      24.       .020      0.85      2.

   AS        B         CL        CU        CN        FE        MN                  AG        TDS       COLOR     ALPHA     COLI
NO. 0001    0001      0001      0003      0001      0003      0003                0003      0001      0001      0001      0002

   .00       .00       3.2       .007      .003      .046      .005                .000      82.       0.        0.        0.0

MAXIMUM                                                     MAXIMUM                                                         MAXIMUM
 ABS       BA        CD        CR        CCE       F         PB        NO3       SE        SO4       ZN        TURB      BETA
                                                                                                                              EXCD
                                                  ¤
 .02                .002      .000                0.13      .017      0.8       .004      24.       .026      0.85      2.

   AS        B         CL        CU        CN        FE        MN                  AG        TDS       COLOR     ALPHA     COLI
EXCD

   .00       .00       3.2       .009      .003      .055      .007                .000      82.       L 5.      0.        0.0

*    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
                                 355197450200 ************
0003   355197450200      CROWN HILL WATER SUPPLY          RIVERTON COAL COMPANY            CROWN HILL,WEST VIRGINIA  25052
  ID NO               POP      0 IMP     COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL       SOURCE  OF  SUPPLY             AV DAY
355197450200         250   2 300     000  00 00 000  00  00  00  00  0   0   0 000  4  /PRATT/            355655800200   000.02
AVERAGE                                                     AVERAGE                                                         AVERAGE
 ABS       BA        CD        CR        CCE       F         PB        NO3       SE        SO4       ZN        TURB      BETA
0001      0000      0003      0003      0001      0003      0003      0001      0001      0001      0003      0001      0001      NO.
                                                  ¤
 .03                .001      .000      .034      0.06      .005      3.5       .002      31.       .415      3.30      2.

   AS        B         CL        CU        CN        FE        MN                  AG        TDS       COLOR     ALPHA     COLI
NO. 0001    0001      0001      0003      0001      0003      0003                0003      0001      0001      0001      0002

   .00       .00       8.6       .010      .000      .154      .022                .000      94.       0.        0.        0.0

MAXIMUM                                                     MAXIMUM                                                         MAXIMUM
 ABS       BA        CD        CR        CCE       F         PB        NO3       SE        SO4       ZN        TURB      BETA
                                                                                                                              EXCD
                                                  ¤
 .03                .004      .000      .034      0.20      .015      3.5       .002      31.       .930      3.30      2.

   AS        B         CL        CU        CN        FE        MN                  AG        TDS       COLOR     ALPHA     COLI
EXCD

   .00       .00       8.6       .015      .000      .187      .034                .002      94.       L 5.      0.        0.0

 * EXCEEDS RECOMMENDED STANDARDS, ** EXCEEDS MANDATORY STANDARDS, ¤ LESS THAN OPTIMUM CONCENTRATION OF F,
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355213600200 ++++++++++++

UNITS ARE MG/L EXCEPT: RADIATION IN PC/L, COLIFORMS PER 100/ML, COLOR & TURB.IN STD.UNITS

0004 355213600200 DECOTA MUNICIPAL WATER SUPPLY DECOTA, WEST VIRGINIA 25055

ID NO	POP	C IMP	COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL	SOURCE OF SUPPLY	AV DAY
355213600200	320	2 120	000 00 00 000 01 00 00 00 0 0 0 004 0	ONE WELL	000.02

AVERAGE

ABS	BA	CD	CR	CCE	F	PB	NO3	SE	SO4	ZN	TURB	BETA	NO.
0001	0000	0003	0003	0000	0003	0003	0001	0001	0001	0003	0001	0001	
.03		.002	.000		□ 0.07	.018	0.6	.002	193.	.362	1.30	3.	

NO.	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
	0001	0001	0001	0003	0001	0003	0003	0003	0001	0001	0001	0002
	.00	.00	41.	.011	.000	* 1.058	* .315	.001	* 546.	0.	0.	0.0

MAXIMUM

ABS	BA	CD	CR	CCE	F	PB	NO3	SE	SO4	ZN	TURB	BETA	EXCD
.03		.004	.000		□ 0.23	.021	0.6	.002	193.	1.010	1.30	3.	

EXCD	AS	B	CL	CU	CN	FE 2	MN 3	AG	TDS 1	COLOR	ALPHA	COLI
	.00	L .100	41.	.021	.000	* 2.550	* .514	.002	* 546.	L 5.	0.	0.0

* *

355235800200 ++++++++++++

0003 355235800200 EASTBANK WATER SERVICE EASTBANK, WEST VIRGINIA 25067

ID NO	POP	C IMP	COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL	SOURCE OF SUPPLY	AV DAY
355235800200	1200	1 300	000 00 00 000 00 00 00 00 0 0 0 000 4	/CEDAR GROVE/ 355140400200	000.08

AVERAGE

ABS	BA	CD	CR	CCF	F	PB	NO3	SE	SO4	ZN	TURB	BETA	NO.
0001	0000	0003	0003	0001	0003	0003	0001	000.	0001	0003	0001	0001	
.06		.000	.000	.043	□ 0.06	.000	3.4	.003	39.	.025	0.67	2.	

NO.	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
	0001	0001	0001	0003	0001	0003	0003	0003	0001	0001	0001	0002
	.00	.00	2.9	.002	.000	.104	.023	.002	94.	0.	0.	0.0

MAXIMUM

ABS	BA	CD	CR	CCF	F	PB	NO3	SE	SO4	ZN	TURB	BETA	EXCD
.06		.000	.000	.043	□ 0.19	.000	3.4	.003	39.	.037	0.67	2.	

EXCD	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
	.00	.00	2.9	.004	.000	.176	.040	.002	94.	L 5.	0.	0.0

* EXCEEDS RECOMMENDED STANDARDS, ** EXCEEDS MANDATORY STANDARDS, □ LESS THAN OPTIMUM CONCENTRATION OF F.

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                                      355315600200 ************
THU., MAR.  5, 1970       DRINKING WATER QUALITY DATA FROM "CWSS" COMPARED TO USPHS STANDARDS      PAGE 017
UNITS ARE MG/L EXCEPT: RADIATION IN PC/L, COLIFORMS PER 100/ML, COLOR & TURB.IN STD.UNITS

0003   355315600200       GLASGOW WATER SERVICE                                                 GLASGOW, WEST VIRGINIA      25086
  ID NC             POP    O IMP    COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL       SOURCE  OF  SUPPLY                AV DAY
355315600200       1000  1 000    000  00 00 000  00  00  00  00  0  0  0 000  4  /CEDAR GROVE/        355140400200   000.10
AVERAGE                                                    AVERAGE                                                       AVERAGE
 ABS      BA        CD        CR        CCE       F         PB        NO3       SE        SO4       ZN        TURB      BETA
0001     0000      0003      0003      0001      0003      0003      0001      0001      0001      0003      0001      0001       NO.
                                                 ¤
 .06               .000      .000      .043      0.06      .000       3.4      .003      39.       .113      0.67       2.

  AS        B         CL        CU        CN        FE        MN                  AG        TDS       COLOR     ALPHA     COLI
NC. 0001  0001      0001      0003      0001      0003      0003                0003      0001      0001      0001      0002

  .00       .00       2.9      .010      .000      .095      .010                .000      94.        0.        0.       0.0

MAXIMUM                                                    MAXIMUM                                                       MAXIMUM
 ABS      BA        CD        CR        CCE       F         PB        NO3       SE        SO4       ZN        TURB      BETA
                                                                                                                          EXCD
                                                 ¤
 .06               .002      .000      .043      0.19      .000       3.4      .003      39.       .244      0.67       2.

  AS        B         CL        CU        CN        FE        MN                  AG        TDS       COLOR     ALPHA     COLI
EXCD

  .00       .00       2.9      .020      .000      .149      .013                .002      94.       L 5.       0.       0.0

*    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
                                      355348010200 ************
0004   355348010200       HANDLEY- C.& O. RR WATER SYSTEM                                       HANDLEY, WEST VIRGINIA      25102
  ID NO             POP    C IMP    COA CCR TO MIX AER SED FIT FIM AM RC FL DIS CL       SOURCE  OF  SUPPLY                AV DAY
355348010200       1000  2 020    037  01 00 000  00  40  00  00  0  0  0 000  0  KANAWHA RIVER                              000.17
AVERAGE                                                    AVERAGE                                                       AVERAGE
 ABS      BA        CD        CR        CCE       F         PB        NO3       SE        SO4       ZN        TURB      BETA
0001     0000      0003      0003      0000      0003      0003      0001      0001      0001      0003      0001      0000       NO.
                                                 ¤
 .05               .001      .000                0.06      .007       3.1      .003      31.       .018      0.53

  AS        B         CL        CU        CN        FE        MN                  AG        TDS       COLOR     ALPHA     COLI
NC. 0001  0001      0001      0003      0001      0003      0003                0003      0001      0001      0001      0002

  .00       .00       7.2      .008      .000      .158      .006                .000      152.       0.        0.       0.0

MAXIMUM                                                    MAXIMUM                                                       MAXIMUM
 ABS      BA        CD        CR        CCE       F         PB        NO3       SE        SO4       ZN        TURB      BETA
                                                                                                                          EXCD
                                                 ¤
 .05               .003      .000                0.20      .023       3.1      .003      31.       .038      0.53

  AS        B         CL        CU        CN        FE        MN                  AG        TDS       COLOR     ALPHA     COLI
EXCD

  .00       .00       7.2      .017      .000      .261      .009                .000      152.      L 5.       0.       0.0

 * EXCEEDS RECOMMENDED STANDARDS, ** EXCEEDS MANDATORY STANDARDS, ¤ LESS THAN OPTIMUM CONCENTRATION OF F,
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THU., MAR. 5, 1970          355423010200 ++++++++++
                     DRINKING WATER QUALITY DATA FROM "CWSS" COMPARED TO USPHS STANDARDS     PAGE 018
UNITS ARE MG/L EXCEPT: RADIATION IN PC/L, COLIFORMS PER 100/ML, COLOR & TURB.IN STD.UNITS

0C03   355423010200      KAYFORD DIVISION WATER SUPPLY   BETHLEHEM MINES CORP.          KAYFORD, WEST VIRGINIA      25116
  ID NC             POP    O IMP    COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL      SOURCE  OF  SUPPLY            AV DAY
355423010200        100   2 702     000  00 00 000  00  00  00  00  0  0  0 004  0  CATCHMENT IN OLD COAL MINE
AVERAGE                                                  AVERAGE                                                      AVERAGE
 ABS      BA        CD        CR        CCE       F         PB        NO3       SE        SO4       ZN        TURB      BETA
0001      0000      0002      0002      0000      0002      0002      0001      0001      0001      0002      0001      0001      NO.
                                                  □
 .07                .000      .000                0.00      .008      2.3       .014      158.      .389      0.63      5.

  AS        B         CL        CU        CN        FE        MN                            AG        TDS       COLOR     ALPHA     COLI
NC. 0001  0001      0001      0002      0001      0002      0002                          0002      0001      0001      0001      0002

  .00       .00       5.4       .222      .000      .030      .004                          .001      408.      0.        0.        0.0

MAXIMUM                                                  MAXIMUM                                                      MAXIMUM
 ABS      BA        CD        CR        CCE       F         PB        NO3       SE        SO4       ZN        TURB      BETA
                                                                                                                       EXCD
                                                  □
 .07                .000      .000               L0.20      .016      2.3       .014      158.      .700      0.63      5.
  AS        B         CL        CU        CN        FE        MN                            AG        TDS       COLOR     ALPHA     COLI
EXCD

  .00     L .100      5.4       .442      .000      .036      .005                          .002      408.      L 5.      0.        0.0

*    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
                                            355462050200 ++++++++++++
0C04   355462050200      LEEWOOD WATER SUPPLY CO.                                      LEEWOOD,WEST VIRGINIA        25122
  ID NO             POP    O IMP    COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL      SOURCE  OF  SUPPLY            AV DAY
355462050200        150   2 731     000  00 00 000  04  00  00  00  0  0  0 004  0  1 WELL                           000.01
AVERAGE                                                  AVERAGE                                                      AVERAGE
 ABS      BA        CD        CR        CCE       F         PB        NO3       SE        SO4       ZN        TURB      BETA
0001      0000      0003      0003      0000      0003      0003      0001      0001      0001      0003      0001      0001      NO.
                                                  □
 .03                .000      .000                0.22      .005      0.0       .001      35.       .100      0.23      3.

  AS        B         CL        CU        CN        FE        MN                            AG        TDS       COLOR     ALPHA     COLI
NC. 0001  0001      0001      0003      0001      0003      0003                          0003      0001      0001      0001      0002
                                                                                                                                **
  .00       .00       60.       .397      .003      .109      .027                          .001      362.      0.        0.        1.5

MAXIMUM                                                  MAXIMUM                                                      MAXIMUM
 ABS      BA        CD        CR        CCF       F         PB        NO3       SE        SO4       ZN        TURB      BETA
                                                                                                                       EXCD
                                                  □
 .03                .001      .000                0.23      .016     L .1       .001      35.       .179      0.23      3.
  AS        B         CL        CU        CN        FE        MN                            AG        TDS       COLOR     ALPHA     COLI
EXCD                            1                                                                                               1
                                *
  .00     L .100      60.       1.168     .003      .237      .031                          .002      362.      L 5.      0.        2.0

* EXCEEDS RECOMMENDED STANDARDS, ** EXCEEDS MANDATORY STANDARDS, □ LESS THAN OPTIMUM CONCENTRATION OF F.
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                              355475400200 ++++++++++++
THU., MAR.  5, 1970      DRINKING WATER QUALITY DATA FROM "CWSS" COMPARED TO USPHS STANDARDS      PAGE 019
UNITS ARE MG/L EXCEPT: RADIATION IN PC/L, COLIFORMS PER 100/ML, COLOR & TURB.IN STD.UNITS

0004   355475400200      LINCOLN PUBLIC SERVICE DISTRICT                               ALUM CREEK, WEST VIRGINIA  25003
  ID NO           POP    O IMP    COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL       SOURCE  OF  SUPPLY              AV DAY
355475400200      2000   1 000    021  01 00 022  00  00  04  01  0  0  0 001    COAL RIVER                          000.07
AVERAGE                                                   AVERAGE                                                    AVERAGE
 ABS      BA       CD        CR       CCE       F        PB       NO3      SE       SO4      ZN       TURB     BETA
0000     0000     0003      0003     0001      0003     0003     0000     0003     0000     0003     0000     0000      NO.
                                               □
                  .000      .021     .086      0.11     .000                                 .011

   AS       B        CL       CU       CN        FE       MN                AG       TDS      COLOR    ALPHA    COLI
NO. 0000   0000     0000     0003     0000      0003     0003              0003     0000     0000     0000     0002

                             .033               .024     .009              .002                                  0.0

MAXIMUM                                               MAXIMUM                                                    MAXIMUM
 ABS      BA       CD        CR       CCE       F        PB       NO3      SE       SO4      ZN       TURB     BETA
                                                                                                                    EXCD
                                               □
                  .001      .051     .086      0.18     .000        *                        .014

   AS       B        CL       CU       CN        FE       MN                AG       TDS      COLOR    ALPHA    COLI
EXCD

                             .076               .031     .011              .005                                  0.0

*   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
                              355537050200 ++++++++++++
0004   355537050200      MIAMI CIT-UNITED WATER SER. CORP. [illegible]                  CHARLESTON, WEST VIRGINIA  25301
  ID NO           POP    O IMP    COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL       SOURCE  OF  SUPPLY              DAY
355537050200      1100   2 120    010  00 00 002  10  01  2[illegible]  01  0  0  0 0[illegible]    DRILLED WELL          02.05
AVERAGE                                                   AVERAGE                                                    AVERAGE
 ABS      BA       CD        CR       CCE       F        PB       NO3      SE       SO4      ZN       TURB     BETA
0001     0001     0003      0003     0000      0001     0003     000[illegible]     000[illegible]     [illegible]1     0003     0001     0001      NO.
         **                                    □
 .04     1.55     .002      .000               0.31     .0[illegible]        0.2      .00[illegible]     1.5      .286     0.38     3.

   AS       B        CL       CU       CN        FE       MN                AG       TDS      COLOR    ALPHA    COLI
NO. 0001   0001     0001     0003     0001      0003     0003              0001     0001     0001     0001     0002

 .00      .0[illegible]      43.      .012     .000      .0[illegible]     .0[illegible]              .00[illegible]     3[illegible]4.      [illegible]      [illegible]      [illegible]

MAXIMUM                                               MAXIMUM                                                    MAXIMUM
 ABS      BA       CD        CR       CCE       F        PB       NO3      SE       SO4      ZN       TURB     BETA
           1                                                                                                        EXCD
         **                                    □
 .04     1.55     .005      .000               0.32     .0[illegible]        0.2      .002     1.5      .606     0.38     3.

   AS       B        CL       CU       CN        FE       MN                AG       TDS      COLOR    ALPHA    COLI
EXCD

 .00      .0[illegible]      43.      .014     .000      .0[illegible]     .045              .003     3[illegible]4.     [illegible]      [illegible]      [illegible]

* EXCEEDS RECOMMENDED STANDARDS. ** EXCEEDS MANDATORY STANDARDS. □ LESS THAN OPTIMUM CONCENTRATION OF F.
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THU., MAR. 5, 1970 DRINKING WATER QUALITY DATA FROM "CWSS" COMPARED TO USPHS STANDARDS PAGE 020

UNITS ARE MG/L EXCEPT: RADIATION IN PC/L, COLIFORMS PER 100/ML, COLOR & TURB.IN STD.UNITS

355554500100 ++++++++++++

0005 355554500100 MONTGOMERY CITY WATER SUPPLY WEST VIRGINIA WATER COMPANY MONTGOMERY, WEST VIRGINIA 25136

ID NO	POP	O IMP	COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL	SOURCE OF SUPPLY	AV DAY
355554500100	6500	2 100	011 20 01 002 00 01 04 01 0 1 2 001 0	KANAWHA RIVER	000.43

AVERAGE

	ABS	BA	CD	CR	CCE	F	PB	NO3	SE	SO4	ZN	TURB	BETA	
NO.	0001	0000	0003	0003	0001	0003	0003	0001	0001	0001	0003	0001	0001	
AVERAGE	.07		.000	.000	.082	1.20	.009	4.2	.002	30.	.024	0.52	1.	

	AS	B	CL	CU	CN	FE	MN		AG	TDS	COLOR	ALPHA	COLI
NO.	0001	0001	0001	0003	0001	0003	0003		0003	0001	0001	0001	0002
AVERAGE	.00	.00	7.2	.015	.000	.022	.001		.001	107.	0.	0.	0.0

MAXIMUM

	ABS	BA	CD	CR	CCF	F	PB	NO3	SE	SO4	ZN	TURB	BETA
EXCD						* 1							
MAXIMUM	.07		.001	.000	.082	1.40	.015	4.2	.002	30.	.035	0.52	1.

	AS	B	CL	CU	CN	FE	MN		AG	TDS	COLOR	ALPHA	COLI
EXCD													
MAXIMUM	.00	.00	7.2	.022	.000	.025	.002		.004	107.	L 5.	0.	0.0

* *

355589200200 ++++++++++++

0009 355589200200 WEST VIRGINIA WATER CO. NITRO, W. VA. 25143

ID NO	POP	C IMP	COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL	SOURCE OF SUPPLY	AV DAY
355589200200	52000	2 332	001 21 01 004 10 01 02 00 0 0 2 001 0	KANAWHA RIVER	009.00

AVERAGE

	ABS	BA	CD	CR	CCF	F	PB	NO3	SE	SO4	ZN	TURB	BETA
NO.	0001	0000	0008	0008	0001	0008	0008	0001	0001	0001	0008	0001	0001
AVERAGE	.07		.000	.000	.086	1.05	.000	0.0	.003	29.	.214	0.53	4.

	AS	B	CL	CU	CN	FE	MN		AG	TDS	COLOR	ALPHA	COLI
NO.	0001	0001	0001	0008	0001	0008	0008		0008	0001	0001	0001	0007
AVERAGE	.00	.00	23.	.008	.000	.042	* .063		.001	147.	0.	0.	0.0

MAXIMUM

	ABS	BA	CD	CR	CCF	F	PB	NO3	SE	SO4	ZN	TURB	BETA
EXCD													
MAXIMUM	.07		.002	.000	.086	1.12	.000	L .1	.003	29.	.288	0.53	4.

	AS	B	CL	CU	CN	FE	MN		AG	TDS	COLOR	ALPHA	COLI
EXCD							3						
MAXIMUM	.00	.00	23.	.013	.000	.190	* .197		.003	147.	L 5.	0.	0.0

* EXCEEDS RECOMMENDED STANDARDS, ** EXCEEDS MANDATORY STANDARDS, □ LESS THAN OPTIMUM CONCENTRATION OF F.

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                                       355640000200 ++++++++++++
THU., MAR.  5, 1970        DRINKING WATER QUALITY DATA FROM "CWSS" COMPARED TO USPHS STANDARDS     PAGE 021
UNITS ARE MG/L EXCEPT: RADIATION IN PC/L, COLIFORMS PER 100/ML, COLOR & TURB,IN STD.UNITS

0004   355640000200      PINCH PUBLIC SERVICE DISTRICT                                  PINCH, WEST VIRGINIA       25156
  ID NO              POP     O IMP     COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL       SOURCE  OF  SUPPLY           AV DAY
355640000200        1025  1 000     024  01 00 022  00  40  04  01  0  0  3 001  0  ELK RIVER                       000.06
AVERAGE                                                AVERAGE                                                     AVERAGE
 ABS       BA        CD        CR        CCE       F         PB        NO3       SE        SO4       ZN        TURB      BETA
0001      0000      0003      0003      0001      0003      0003      0001      0001      0001      0003      0001      0001      NO.

  .08               .000      .000      .042      1.11      .005       1.9      .003       25.      .021      1.20       0.

   AS        B         CL        CU        CN        FE        MN                  AG        TDS       COLOR     ALPHA     COLI
NO. 0001    0001      0001      0003      0001      0003      0003                0003      0001      0001      0001      0002

   .00       .00       4.6      .014      .000      .022      .000                .001      80.        0.        0.       0.0

MAXIMUM                                               MAXIMUM                                                           MAXIMUM
 ABS       BA        CD        CR        CCE       F         PB        NO3       SE        SO4       ZN        TURB      BETA
                                                                                                                           EXCD

  .08               .001      .000      .042      1.15      .017       1.9      .003       25.      .041      1.20       0.

   AS        B         CL        CU        CN        FE        MN                  AG        TDS       COLOR     ALPHA     COLI
EXCD

   .00       .00       4.6      .022      .000      .033      .000                .003      80.       L 5.       0.       0.0

*    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
                                       355655800200 ++++++++++++
0004   355655800200      PRATT MUNICIPAL WATER SUPPLY     CITY HALL BLDG.                PRATT, WEST VIRGINIA       25162
  ID NO              POP     C IMP     COA CCR TO MIX AER SED FIT FIM AM RC FL DIS CL       SOURCE  OF  SUPPLY           AV DAY
355655800200        1500  1 160     021  00 00 012  00  01  04  01  0  0  0 001  0  KANAWHA RIVER                   000.10
AVERAGE                                                AVERAGE                                                     AVERAGE
 ABS       BA        CD        CR        CCE       F         PB        NO3       SE        SO4       ZN        TURB      BETA
0001      0000      0003      0003      0001      0003      0003      0001      0001      0001      0003      0001      0001      NO.
                                                  ¤                                                            *
  .03               .002      .000      .034      0.06      .007       3.5      .002       31.      .788      3.30       2.

   AS        B         CL        CU        CN        FE        MN                  AG        TDS       COLOR     ALPHA     COLI
NC. 0001    0001      0001      0003      0001      0003      0003                0003      0001      0001      0001      0002

   .00       .00       8.6      .008      .000      .339      .035                .000      94.        0.        0.       0.0

MAXIMUM                                               MAXIMUM                                                           MAXIMUM
 ABS       BA        CD        CR        CCE       F         PB        NO3       SE        SO4       ZN        TURB      BETA
                                                                                                                 1         EXCD
                                                  ¤                                                            *
  .03               .004      .000      .034      0.20      .022       3.5      .002       31.      1.300     3.30       2.

   AS        B         CL        CU        CN        FE        MN                  AG        TDS       COLOR     ALPHA     COLI
EXCD                                                   1
                                                  *
   .00       .00       8.6      .015      .000      .638      .041                .000      94.       L 5.       0.       0.0

* EXCEEDS RECOMMENDED STANDARDS, ** EXCEEDS MANDATORY STANDARDS, ¤ LESS THAN OPTIMUM CONCENTRATION OF F.
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UNITS ARE MG/L EXCEPT: RADIATION IN PC/L, COLIFORMS PER 100/ML, COLOR & TURB.IN STD.UNITS

0003 355687650200 RENSFORD WATER SUPPLY AMHERST COAL COMPANY RENSFORD, WEST VIRGINIA 25300
ID NO POP C IMP COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL SOURCE OF SUPPLY AV DAY
355687650200 100 2 000 00 00 000 00 00 00 00 0 0 0 000 0 3 WELLS 000.01

AVERAGE AVERAGE AVERAGE

ABS	BA	CD	CR	CCE	F	PB	NO3	SE	SO4	ZN	TURB	BETA	
0001	0000	0003	0003	0000	0003	0003	0001	0001	0001	0003	0001	0001	NO.
.02		.002	.013		¤ 0.40	.000	0.0	.002	123.	.292	4.50	6.	

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
NO.	0001	0001	0001	0003	0001	0003	0003	0003	0001	0001	0001	0003
	.00	.11	88.	.016	.000	* .751	* .149	.000	* 606.	0.	0.	0.0

MAXIMUM MAXIMUM MAXIMUM

ABS	BA	CD	CR	CCF	F	PB	NO3	SE	SO4	ZN	TURB	BETA	
													EXCD
.02		.003	.040		¤ 0.40	.000	L .1	.002	123.	.469	4.50	6.	

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
EXCD						3	3		1			
	.00	.11	88.	.018	.000	* .832	* .151	.000	* 606.	L 5.	0.	0.0

* *

355688300200 ++++++++++++

0004 355688300200 REPUBLIC WATER SUPPLY CARBON FUEL CO REPUBLIC, WEST VIRGINIA 25037
ID NO POP C IMP COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL SOURCE OF SUPPLY AV DAY
355688300200 090 2 U04 000 00 00 000 00 00 00 00 0 0 0 004 0 1 WELL 000.00

AVERAGE AVERAGE AVERAGE

ABS	BA	CD	CR	CCE	F	PB	NO3	SE	SO4	ZN	TURB	BETA	
0001	0000	0003	0003	0000	0003	0003	0001	0001	0001	0003	0001	0001	NO.
.09		.000	.000		¤ 0.00	.000	0.0	.002	126.	.192	2.00	2.	

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
NO.	0001	0001	0001	0003	0001	0003	0003	0003	0001	0001	0001	0002
	.00	.00	2.9	.005	.000	* 4.430	* .331	.001	299.	0.	0.	0.0

MAXIMUM MAXIMUM MAXIMUM

ABS	BA	CD	CR	CCF	F	PB	NO3	SE	SO4	ZN	TURB	BETA	
													EXCD
.09		.000	.000		¤ L0.20	.000	0.0	.002	126.	.505	2.00	2.	

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
EXCD						3	3					
	.00	L .100	2.9	.009	.000	* 5.000	* .337	.002	299.	L 5.	0.	0.0

* EXCEEDS RECOMMENDED STANDARDS, ** EXCEEDS MANDATORY STANDARDS, ¤ LESS THAN OPTIMUM CONCENTRATION OF F.

THU., MAR. 5, 1970 DRINKING WATER QUALITY DATA FROM "CWSS" COMPARED TO USPHS STANDARDS PAGE 023

UNITS ARE MG/L EXCEPT: RADIATION IN PC/L, COLIFORMS PER 100/ML, COLOR & TURB, IN STD. UNITS

355711650200 ++++++++++

0004 355711650200 RONDA WATER SUPPLY RIVERVIEW DEVELOPMENT CO SHARON, WEST VIRGINIA 25182

ID NO	POP	O IMP	COA	COR	TO	MIX	AER	SED	FIT	FIM	AM	RC	FL	DIS	CL	SOURCE OF SUPPLY	AV DAY
355711650200	256	2 121	000	00	00	000	00	00	00	00	0	0	0	004	0	ONE WELL	000.01

AVERAGE

	ABS	BA	CD	CR	CCE	F	PB	NO3	SE	SO4	ZN	TURB	BETA
NO.	0001	0000	0003	0003	0000	0003	0003	0001	0001	0001	0003	0001	0001
AVERAGE	.12		.000	.000		□ 0.28	.000	1.3	.002	2.1	.381	4.10	7.

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
NO.	0001	0001	0001	0003	0001	0003	0003	0003	0001	0001	0001	0002
AVERAGE	.00	.14	82.	.012	.000	* 2.714	* .083	.002	* 1032.	0.	0.	0.5

MAXIMUM

	ABS	BA	CD	CR	CCE	F	PB	NO3	SE	SO4	ZN	TURB	BETA
MAXIMUM	.12		.002	.000		□ 0.29	.000	1.3	.002	2.1	.573	4.10	7.
EXCD													

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
EXCD						3	3		1			
MAXIMUM	.00	.14	82.	.013	.000	* 3.216	* .084	.004	* 1032.	L 5.	0.	1.0

* *

355720600200 ++++++++++++

0004 355720600200 MUNICIPAL WATER + SEWER DEPT. 1006 SOUTH B STREET ST. ALBANS, WEST VIRGINIA 25177

ID NO	POP	O IMP	COA	COR	TO	MIX	AER	SED	FIT	FIM	AM	RC	FL	DIS	CL	SOURCE OF SUPPLY	AV DAY
355720600200	20000	1 020	011	01	00	020	00	40	20	03	0	0	2	001	0	COAL RIVER	001.30

AVERAGE

	ABS	BA	CD	CR	CCE	F	PB	NO3	SE	SO4	ZN	TURB	BETA
NO.	0001	0000	0003	0003	0001	0003	0003	0001	0001	0001	0003	0001	0001
AVERAGE	.05		.001	.000	.070	□ 0.63	.014	1.6	.005	93.	.016	0.40	2.

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
NO.	0001	0001	0001	0003	0001	0003	0003	0003	0001	0001	0001	0002
AVERAGE	.00	.00	5.5	.010	.000	.020	.002	.000	175.	0.	0.	** 5.0

MAXIMUM

	ABS	BA	CD	CR	CCE	F	PB	NO3	SE	SO4	ZN	TURB	BETA
MAXIMUM	.05		.002	.000	.070	□ 0.68	.022	1.6	.005	93.	.023	0.40	2.
EXCD													

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
EXCD												1
MAXIMUM	.00	.00	5.5	.011	.000	.051	.004	.000	175.	L 5.	0.	*** 10.0

* EXCEEDS RECOMMENDED STANDARDS, ** EXCEEDS MANDATORY STANDARDS, □ LESS THAN OPTIMUM CONCENTRATION OF F.
*** COLIFORMS EXCEED 4/100 ML, RESAMPLING NECESSARY TO FIND CAUSE

355746500200 ++++++++++++

UNITS ARE MG/L EXCEPT: RADIATION IN PC/L, COLIFORMS PER 100/ML, COLOR & TURB. IN STD. UNITS

0004 355746500200 SHREWSBURY WATER SUPPLY RIVERVIEW DEVELOPMENT CO SHREWSBURY, WEST VIRGINIA 25184

ID NO	POP	C IMP	COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL	SOURCE OF SUPPLY	AV DAY
355746500200	640	2 121	010 00 00 002 10 01 20 01 0 0 0 001 0	2 DRILLED WELLS	000.05

AVERAGE

	ABS	BA	CD	CR	CCE	F	PB	NO3	SE	SO4	ZN	TURB	BETA	
	0001	0000	0003	0003	0000	0003	0003	0001	0001	0001	0003	0001	0001	NO.
	.06		.000	.000		□ 0.06	.006	1.9	.001	65.	.111	0.45	1.	

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
NO.	0001	0001	0001	0003	0001	0003	0003	0003	0001	0001	0001	0002
	.00	.00	57.	.009	.000	.34[illegible]	* .152	.002	358.	0.	0.	0.0

MAXIMUM

	ABS	BA	CD	CR	CCE	F	PB	NO3	SE	SO4	ZN	TURB	BETA
EXCD													
	.06		.007	.000		□ 0.20	.018	1.9	.001	65.	.305	0.45	1.

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
EXCD						1	2					
	.00	.00	57.	.010	.000	* .148	* .338	.003	358.	L 5.	0.	0.0

* *

355751400200 ++++++++++++

0004 355751400200 SISSONVILLE PUBLIC SERVICE DIST. SISSONVILLE, WEST VIRGINIA 25320

ID NO	POP	C IMP	COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL	SOURCE OF SUPPLY	AV DAY
355751400200	25000	1 326	031 01 01 002 30 40 04 01 0 0 3 001 0	POCATALICO RIVER	000.11

AVERAGE

	ABS	BA	CD	CR	CCE	F	PB	NO3	SE	SO4	ZN	TURB	BETA	
	0001	0003	0003	0003	0001	0003	0003	0001	0001	0001	0003	0001	0001	NO.
	[illegible]		.002	.000	.087	1.11	.009	0.6	.004	51.	.051	* 1.60	3.	

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
NO.	0001	[illegible]	0001	0003	0001	0003	0003	0003	0001	0001	0001	0002
	.00	.00	[illegible]	.005	.000	.12[illegible]	.018	.000	147.	0.	0.	0.0

MAXIMUM

	ABS	BA	CD	CR	CCE	F	PB	NO3	SE	SO4	ZN	TURB	BETA
EXCD												1	
	.0[illegible]		.003	.000	.087	1.20	.017	0.6	.004	51.	.080	* 1.60	3.

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
EXCD												
	[illegible]	[illegible]	7.1	.010	.000	.180	.030	.000	147.	L 5.	0.	0.0

* EXCEEDS RECOMMENDED STANDARDS, ** EXCEEDS MANDATORY STANDARDS, □ LESS THAN OPTIMUM CONCENTRATION OF F.

THU., MAR. 5, 1970 DRINKING WATER QUALITY DATA FROM "CWSS" COMPARED TO USPHS STANDARDS PAGE 025
UNITS ARE MG/L EXCEPT: RADIATION IN PC/L, COLIFORMS PER 100/ML, COLOR & TURB.IN STD.UNITS

355843040200 ++++++++++++

0003	355843040200	WARD WATER SUPPLY	VALLEY CAMP COAL CO. OF WARD	WARD, WEST VIRGINIA	25207
ID NO	POP	C IMP	COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL	SOURCE OF SUPPLY	AV DAY
355843040200	045	2 000	000 00 00 000 00 00 00 00 0 0 0 000 0	ONE WELL	000.03

AVERAGE

	ABS	BA	CD	CR	CCE	F	PB	NO3	SE	SO4	ZN	TURB	BETA	
NO.	0001	0000	0003	0003	0000	0003	0003	0001	0001	0001	0003	0001	0001	NO.
	.04		.000	.000		□ 0.00	.005	3.3	.005	93.	.161	0.43	3.	

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
NO.	0001	0001	0001	0003	0001	0002	0002	0003	0001	0001	0001	0002
	.00	.00	3.8	.032	.000	.137	.002	.001	184.	0.	0.	0.0

MAXIMUM

	ABS	BA	CD	CR	CCE	F	PB	NO3	SE	SO4	ZN	TURB	BETA
EXCD													
	.04		.001	.000		□ L0.20	.015	3.3	.005	93.	.424	0.43	3.

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
EXCD												
	.00	L .100	3.8	.069	.000	.253	.005	.002	184.	L 5.	0.	0.0

* *

355883300200 ++++++++++++

0001	355883300200	WINIFREDE WATER SUPPLY	WINIFREDE COAL CO	WINIFREDE, WEST VIRGINIA	25214
ID NO	POP	C IMP	COA COR TO MIX AER SED FIT FIM AM RC FL DIS CL	SOURCE OF SUPPLY	AV DAY
355883300200	060	1	000 00 00 000 00 00 00 00 0 0 0 000 0	ONE WELL	000.01

AVERAGE

	ABS	BA	CD	CR	CCE	F	PB	NO3	SE	SO4	ZN	TURB	BETA	
NO.	0001	0000	0001	0001	0000	0001	0001	0001	0001	0001	0001	0001	0001	NO.
	.06		.003	.000		□ 0.20	.000	0.8	.001	22.	.035	0.34	5.	

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
NO.	0001	0001	0001	0001	0001	0001	0001	0001	0001	0001	0001	0001
	.00	.00	26.	.014	.000	.064	* .055	.000	311.	0.	0.	0.0

MAXIMUM

	ABS	BA	CD	CR	CCE	F	PB	NO3	SE	SO4	ZN	TURB	BETA
EXCD													
	.06		.003	.000		□ 0.20	.000	0.8	.001	22.	.035	0.34	5.

	AS	B	CL	CU	CN	FE	MN	AG	TDS	COLOR	ALPHA	COLI
EXCD							1					
	.00	L .100	26.	.014	.000	.064	* .055	.000	311.	L 5.	0.	0.0

* EXCEEDS RECOMMENDED STANDARDS, ** EXCEEDS MANDATORY STANDARDS, □ LESS THAN OPTIMUM CONCENTRATION OF F.