Proceedings and Final Action

Treatment Requirements for Sewage Discharged into the Ohio River between Pittsburgh and Huntington

Treatment Standard No. 3
Treatment Standard No. 4

Adopted April 29, 1953

OHIO RIVER VALLEY
WATER SANITATION COMMISSION

OHIO RIVER VALLEY WATER SANITATION COMMISSION

An interstate agency representing Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Virginia and West Virginia.

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HEADQUARTERS • 414 WALNUT ST. • CINCINNATI 2, OHIO

PROCEEDINGS AND FINAL ACTION

DETERMINING TREATMENT REQUIREMENTS FOR SEWAGE
DISCHARGED INTO THE OHIO RIVER BETWEEN PITTSBURGH AND HUNTINGTON

Public Hearing held on March 31, 1953, Courtroom No.6,
U. S. Post Office and Court House, Pittsburgh, Pa.

Members of the Hearing Board:

Hudson Biery, *Chairman*
Commissioner for Ohio

E. A. Holbrook
Commissioner for Pennsylvania

W. W. Jennings
Commissioner for West Virginia

Appearances for the Commission:

Edward J. Cleary, *Executive Director and Chief Engineer*
Leonard A. Weakley, *Counsel*
Robert K. Horton, *Sanitary Engineer*
Harold W. Streeter, *Consultant*
F. H. Waring, *Secretary of the Commission and Chief Sanitary Engineer, Ohio Department of Health*
H. E. Moses, *Commissioner for Pennsylvania and Director Bureau of Sanitary Engineering, Pennsylvania Department of Health*
Robert F. Rocheleau, *Commissioner for West Virginia and Executive Secretary-Engineer, State Water Commission*
W. W. Towne, *Officer-in-Charge, Ohio and Tennessee Drainage Basins, U. S. Public Health Service*

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EXHIBITS

REPORT ON PUBLIC HEARING

HELD AT PITTSBURGH, PA. MARCH 31, 1953.

Ohio River Valley Water
Sanitation Commission
414 Walnut Street
Cincinnati 2, Ohio

Gentlemen:

The undersigned, appointed pursuant to action taken by the Commission at its meeting of January 28, 1953, constitute the Hearing Board empowered and instructed to conduct a public hearing with regard to the degree of treatment which shall be given to sewage discharged or permitted to flow into the waters of the Ohio River between Pittsburgh, Pennsylvania and Huntington, West Virginia. In accordance with the direction of the Commission, the undersigned submit the following report of the conduct of such hearing together with their findings and recommendations based upon the testimony and other evidence presented at that hearing.

1. The hearing was held, with all members of the Hearing Board present, on the 31st day of March, 1953, at Courtroom No. 6, sixth floor, U. S. Post Office and Court House, Seventh Avenue and Grant Street, Pittsburgh, Pa., commencing at 10:00 o'clock, A. M. A complete stenographic transcript was made of the proceedings had at the hearing and a copy thereof is filed herewith.

2. Prior notice of the hearing had been published and had been served upon interested parties in the manner and to the extent set forth in the transcript of proceedings filed herewith.

3. Parties interested in the subject matter of the hearing were present or were represented to the extent indicated by the roster of appearances which is attached to the transcript of proceedings filed herewith.

4. A written report of the Commission staff setting forth information, data, testimony and other evidence, relevant and material to the subject matter of the hearing, was presented in evidence and was supported by oral testimony of members of the staff. A copy of that report is attached as an exhibit to the transcript of proceedings filed herewith.

5. Full opportunity was given to all parties present or represented at the hearing to introduce evidence or testimony relevant or material to the subject matter of the hearing and to express their views with regard to the report and recommendations of the staff. No evidence other than that presented by the staff was ordered. All views expressed by those present have been duly considered by the Board in reaching the conclusions and recommendations set forth below.

6. Opportunity for the submission of written evidence or views pertinent to the subject matter of the hearing was expressly provided to any interested party, subject to the condition that it be submitted to the Hearing Board on or before the 15th day of April, 1953. No such additional evidence or views were submitted to this Board prior to the expiration of the period specified.

7. From a consideration of the evidence presented at the hearing, this Board finds that the information and other data submitted as above stated by the staff are accurate and pertinent to the subject matter of the hearing, and the Board further finds that the conclusions of the staff which are expressed in the written report presented at the hearing, as above stated, are reasonable and are fully supported by the evidence and data therein contained.

8. The Board finds that standards of treatment for sewage to be discharged or permitted to flow into this section of the Ohio River, should be adopted by the Commission and put into effect, which (1) will maintain satisfactory oxygen levels in that stretch of the Ohio River between the Pennsylvania-Ohio- West Virginia state line and Huntington; (2) will provide adequate protection for public water supplies by reducing the presence of coliform organisms at all water supply intakes located in this section of the Ohio River to not more than 5,000 per 100 milliliters, as a probable monthly average; (3) will under normal summer flow conditions maintain in substantial areas of the Ohio River betweem Moundsville, West Virginia and Huntington a water quality, suitable for recreational purposes, of not more than 1,000 coliform organisms per 100 milliliters as a probable monthly average; and (4) will otherwise accomplish the objectives of the Ohio River Valley Water Sanitation Compact with respect to the discharge of sewage into this stretch of the Ohio River. On the basis of information and data submitted at the hearing the Board is of the opinion that the establishment of the standards of treatment for sewage which are hereinafter recommended is based upon these considerations, is reasonable and is in conformity with the provisions of the Ohio River Valley Water Sanitation Compact.

9. Therefore, this Board recommends that the Commission take appropriate action to establish, subject to revision as changing conditions may require, the following standards for the treatment of sewage:

TREATMENT STANDARD NO. 3

All sewage from municipalities or other political subdivisions, public or private institutions or corporations discharged or permitted to flow into that portion of the Ohio River extending from the Allegheny County-Beaver County Line in Pennsylvania, located approximately 15 miles downstream from the confluence of the Allegheny and Monongahela Rivers at Pittsburgh, to U. S. Corps of Engineers Dam No. 27, located about five miles upstream from Huntington, W. Va., and being 301.0 miles downstream from Pittsburgh, Pa., shall be so treated as to provide for:

(a) Substantially complete removal of settleable solids; and
(b) Removal of not less than forty-five percent of the total suspended solids; and, in addition
(c) Reduction in coliform organisms in accordance with the following schedule:

Not less than 80% reduction during the months May through October.
Not less than 85% reduction during the months November through April.

TREATMENT STANDARD NO. 4

All sewage from municipalities or other political subdivisions, public or private institutions or corporations discharged or permitted to flow into that portion of the Ohio River extending from the point of confluence of the Allegheny and Monongahela Rivers at Pittsburgh, designated as Ohio River mile point 0.0, to the Allegheny County-Beaver County line in Pennsylvania, located approximately 15 miles downstream from the confluence of the Allegheny and Monongahela Rivers, shall be so treated as to provide for:

(a) Substantially complete removal of settleable solids; and
(b) Removal of not less than forty-five percent of the total suspended solids; and
(c) Reduction in biochemical-oxygen-demand of approximately fifty percent; and, in addition
(d) Reduction in coliform organisms in accordance with the following schedule:

Not less than 80% reduction during the months May through October
Not less than 85% reduction during the months November through April.

Respectfully submitted,

/s/ Hudson Biery
Chairman

/s/ E. A. Holbrook

/s/ W. W. Jennings

Hearing Board

Cincinnati, Ohio
April 1, 1952

TREATMENT STANDARD NO. 3

ACTION DETERMINING DEGREE OF TREATMENT TO BE GIVEN TO SEWAGE DISCHARGED INTO THE OHIO RIVER BETWEEN THE ALLEGHENY COUNTY-BEAVER COUNTY LINE IN PENNSYLVANIA AND HUNTINGTON, W. VA.

WHEREAS, at a meeting duly held on January 28, 1953, this Commission determined that it was necessary, through the exercise of powers granted to it by the language of Article VI of the Ohio River Valley Water Sanitation Compact, to determine what, if any, degree of treatment higher than that specified in said Article should be given to sewage from municipalities or other political subdivisions, public or private institutions or corporations discharged or permitted to flow into that portion of the Ohio River between Pittsburgh, Pa. and Huntington, W. Va.; and

WHEREAS, pursuant to action taken by the Commission at said meeting, a Hearing Board was appointed, empowered and instructed to conduct a public hearing with regard to the foregoing matter; and

WHEREAS, after notice of the time and place of said hearing had been given in the manner and to the extent set forth in the transcript of proceedings which has been filed with the Commission, the Hearing Board appointed as above set forth did, on the 31st day of March, 1953, conduct a public hearing at which technical reports and opinions, as well as other evidence relating to the foregoing matter, were received and at which all interested parties were given opportunity to express their opinions and to present evidence with respect to the problem under investigation; and

WHEREAS, copies of a full and complete stenographic transcript of the proceedings had at the hearing thus held, together with copies of findings and recommendations of the Hearing Board, have been filed with the Commission and have been distributed among the members hereof;

NOW THEREFORE, following due consideration of the findings and recommendations contained in the report of the Hearing Board covering the proceedings had at the hearing held as above set forth; and following due consideration of the testimony and other evidence produced at that hearing, together with the various views and opinions there expressed, all as set forth in the above-mentioned transcript of proceedings,

THE COMMISSION DOES HEREBY FIND THAT:

1. The notice of the time and place at which the above-mentioned hearing was to be held was sufficient in form and extent of publication to advise all interested parties and all parties likely to be affected thereby;

2. The procedure followed by the Hearing Board in the conduct of the hearing held as above described adequately provided to all interested parties and all parties likely to be

affected thereby full opportunity to be heard and to present any pertinent testimony, evidence, opinions, or views which they might wish to submit for the consideration of the Commission;

3. The evidence obtained at the hearing held as above described conclusively shows that in order to protect the public health and to preserve the waters of the Ohio River in that stretch between Pittsburgh, Pa. and Huntington, W. Va. for other legitimate uses within the contemplation of the Ohio River Valley Water Sanitation Compact a degree of treatment must be given to sewage discharged or permitted to flow into those waters higher than the minimum prescribed in Article VI of the Compact; and

THE COMMISSION DOES HEREBY ESTABLISH, subject to revision as changing conditions may require, the following standard for the treatment of sewage from municipalities or other political subdivisions, public or private institutions or corporations discharged or permitted to flow into that portion of the Ohio River extending from the Allegheny County-Beaver County line in Pennsylvania, located approximately 15 miles downstream from the confluence of the Allegheny and Monongahela Rivers at Pittsburgh, to U. S. Corps of Engineers Dam No. 27, located about five miles upstream from Huntington, W. Va., and being 301.0 miles downstream from Pittsburgh, Pa.;

(a) Substantially complete removal of settleable solids; and

(b) Removal of not less than forty-five percent of the total suspended solids; and, in addition

(c) Reduction in coliform organisms in accordance with the following schedule:

Not less than 80 percent reduction during the months May through October

Not less than 85 percent reduction during the months November through April.

The foregoing action was taken by the Ohio River Valley Water Sanitation Commission at a regular meeting duly held on April 29, 1953 at Cincinnati, Ohio.

Attest: /s/ F. H. Waring
Secretary

/s/ E. Blackburn Moore
Chairman

TREATMENT STANDARD NO. 4

ACTION DETERMINING DEGREE OF TREATMENT TO BE GIVEN TO SEWAGE DISCHARGED INTO THE OHIO RIVER BETWEEN THE CONFLUENCE OF THE ALLEGHENY AND MONONGAHELA RIVERS AT PITTSBURGH AND THE ALLEGHENY COUNTY-BEAVER COUNTY LINE IN PENNSYLVANIA

WHEREAS, at a meeting duly held on January 28, 1953, this Commission determined that it was necessary, through the exercise of powers granted to it by the language of Article VI of the Ohio River Valley Water Sanitation Compact, to determine what, if any, degree of treatment higher than that specified in said Article should be given to sewage from municipalities or other political subdivisions, public or private institutions or corporations discharged or permitted to flow into that portion of the Ohio River between Pittsburgh, Pa. and Huntington, W. Va.; and

WHEREAS, pursuant to action taken by the Commission at said meeting, a Hearing Board was appointed, empowered and instructed to conduct a public hearing with regard to the foregoing matter; and

WHEREAS, after notice of the time and place of said hearing had been given in the manner and to the extent set forth in the transcript of proceedings which has been filed with the Commission, the Hearing Board appointed as above set forth did, on the 31st day of March, 1953, conduct a public hearing at which technical reports and opinions, as well as other evidence relating to the foregoing matter, were received and at which all interested parties were given opportunity to express their opinions and to present evidence with respect to the problem under investigation; and

WHEREAS, copies of a full and complete stenographic transcript of the proceedings had at the hearing thus held, together with copies of findings and recommendations of the Hearing Board, have been filed with the Commission and have been distributed among the members hereof;

NOW THEREFORE, following due consideration of the findings and recommendations contained in the report of the Hearing Board covering the proceedings had at the hearing held as above set forth and following due consideration of the testimony and other evidence produced at that hearing, together with the various views and opinions there expressed, all as set forth in the above-mentioned transcript of proceedings,

THE COMMISSION DOES HEREBY FIND THAT:

1. The notice of the time and place at which the above-mentioned hearing was to be held was sufficient in form and extent of publication to advise all interested parties and all parties likely to be affected thereby;

2. The procedure followed by the Hearing Board in the conduct of the hearing held as above described adequately provided to all interested parties and all parties likely to be affected thereby full opportunity to be heard and to present any pertinent testimony, evidence, opinions, or views which they might wish to submit for the consideration of the Commission;

3. The evidence obtained at the hearing held as above described conclusively shows that in order to protect the public health and to preserve the waters of the Ohio River in that stretch between Pittsburgh, Pa. and Huntington, W. Va. for other legitimate uses within the contemplation of the Ohio River Valley Water Sanitation Compact a degree of treatment must be given to sewage discharged or permitted to flow into those waters higher than the minimum prescribed in Article VI of the Compact; and

THE COMMISSION DOES HEREBY ESTABLISH, subject to revision as changing conditions may require, the following standard for the treatment of sewage from municipalities or other political subdivisions, public or private institutions or corporations discharged or permitted to flow into that portion of the Ohio River extending from the point of confluence of the Allegheny and Monongahela Rivers at Pittsburgh, designated as Ohio River mile point 0.0, to the Allegheny County-Beaver County line in Pennsylvania, located approximately 15 miles downstream from the confluence of the Allegheny and Monongahela Rivers:

(a) Substantially complete removal of settleable solids; and

(b) Removal of not less than forty-five percent of the total suspended solids; and

(c) Reduction in biochemical-oxygen-demand of approximately fifty percent; and, in addition

(d) Reduction in coliform organisms in accordance with the following schedule:

Not less than 80 percent reduction during the months May through October.

Not less than 85 percent reduction during the months November through April.

The foregoing action was taken by the Ohio River Valley Water Sanitation Commission at a regular meeting duly held on April 29, 1953 at Cincinnati, Ohio.

Attest: /s/ F. H. Waring
Secretary

/s/ E. Blackburn Moore
Chairman

PROCEEDINGS AT HEARING

The Public Hearing of the Ohio River Valley Water Sanitation Commission convened in Courtroom Number 6 of the U. S. Post Office and Court House, Pittsburgh, Pa., March 31, 1953. Mr. Hudson Biery presiding, called the meeting to order at 10:00 o'clock a.m.

CHAIRMAN BIERY: Gentlemen, the meeting will come to order. We are indebted to Judge William A. Stewart of the United States Western District of Pennsylvania, for the use of these excellent quarters. I am informed that it is not customary to smoke in this room, so we will ask you gentlemen to please observe that.

This is a hearing that has been ordered by the Ohio River Valley Water Sanitation Commission in a resolution adopted January 28, 1953, to determine the treatment requirements for sewage discharged into the 300-mile stretch of the Ohio River between Pittsburgh and Huntington.

The Commission represents the eight states which compose the principal area of the Ohio River Basin under the Ohio River Valley Water Sanitation Compact.

The hearing board includes three members representing the three states most vitally interested in these proceedings.

On my right we have Commissioner E. A. Holbrook representing Pennsylvania. On my left we have Commissioner W. W. Jennings, West Virginia. Your chairman is Hudson Biery, Commissioner from Ohio. Counsel for the Board is Leonard A. Weakley, on my left, of the Cincinnati law firm of Taft, Stettinius & Hollister. I appreciate the presence of two other commissioners, Robert Rocheleau of West Virginia and H. E. Moses of Pennsylvania.

The Compact is an agreement authorized by Congress and enacted into law by eight states of the Ohio Valley for the purpose of controlling future pollution, and abating present pollution of the Ohio River and its tributaries. Copies of the Compact are available for anyone interested.

During this hearing the Chairman invites Commissioners Holbrook and Jennings to comment, and to question witnesses at any time. It is our joint responsibility to develop all possible information that may be helpful, and cooperate in presenting recommendations to the Commission covering the matters presently under consideration. The scope of this hearing will be limited to sanitary sewage. Industrial wastes will be considered at future hearings.

For the benefit of the reporter, we will ask witnesses to state their names clearly when they first appear, and it might be well to repeat the names for perhaps a time or two until the reporter becomes familiar with these names.

We are making a complete transcript of all evidence presented and in due time that transcript will be available to anyone interested. We suggest that you contact Mr. Cleary, our Executive Director, for arrangements to obtain the transcript if you think you need it.

At this time we will ask for a reading of the formal notice and the pertinent articles of the Compact, which will be presented by counsel for the Commission, Leonard A. Weakley. Mr. Weakley.

MR. WEAKLEY: Mr. Chairman, the official notice for this hearing reads as follows:

(Reading) "Pursuant to authority contained in Article VI of the Ohio River Valley Water Sanitation Compact, and pursuant to direction of the Ohio River Valley Water Sanitation Commission as contained in a resolution duly adopted at a regular meeting held on the 28th day of January, 1953, a public hearing will be held by the Commission at Courtroon No. 6, sixth floor, U. S. Post Office and Court House (new), Seventh Avenue and Grant Street, Pittsburgh, Pennsylvania, commencing at 10:00 a.m. o'clock on the 31st day of March, 1953, and continuing thereafter until completed. The purpose of said hearing will be to obtain and record data, information and other evidence for use by the Commission in determining the degree of treatment which shall be given to sewage discharged or permitted to flow into the waters of the Ohio River in that stretch extending from the point of confluence of the Allegheny and Monongahela Rivers at Pittsburgh, Pennsylvania, designated as mile point 0.0 to U. S. Corps of Engineers Dam No. 27, located about five miles upstream from Huntington, West Virginia, and being 301.0 miles downstream from Pittsburgh, Pennsylvania.

"Any and all parties whose interests may be affected by such determination are invited to be present or to be represented at the hearing to be held as above stated. All interested parties present or represented at said hearing will be given an adequate opportunity to express either orally or in writing, their views upon the issues there to be considered.

"Interested parties who desire additional information concerning the conduct of this hearing or who desire information with regard to evidence, views or recommendations which are to be submitted at such hearing are requested to call at the offices of the Ohio River Valley Water Sanitation Commission, 302 Mercantile Library Building, 414 Walnut Street, Cincinnati, Ohio. On and after the 9th day of March, 1953, there will be on file and available for examination at the offices of the Commission, located as above stated, copies of the report of the Commission covering its investigation of the treatment requirements for sewage discharged or permitted to flow into the stretch of the Ohio River as above defined and including recommendations with regard to the degree of treatment which should be established for such sewage."

Signed "Ohio River Valley Water Sanitation Commission, by E. Blackburn Moore, Chairman", dated February 27, 1953. (Copy of notice is attached hereto as Exhibit A.)

The pertinent portions of the Ohio River Valley Water Sanitation Compact, under authority of which this hearing is being held, and the section which is referred to in the notice reads as follows:

(Reading) "Article VI. It is recognized by the signatory states that no single standard for the treatment of sewage or industrial wastes is applicable in all parts of the district due to such variable factors as size, flow, location, character, self-purification, and usage of waters within the district. The guiding principle of this Compact shall be that pollution by sewage or industrial wastes originating within a signatory state shall not injuriously affect the various uses of the interstate waters as hereinbefore defined.

"All sewage from municipalities or other political subdivisions, public or private institutions, or corporations, discharged or permitted to flow into these portions of the Ohio River and its tributary waters which form boundaries between, or are contiguous to, two or more signatory states, or which flow from one signatory state into another signatory state, shall be so treated, within a time reasonable for the construction of the necessary works, as to provide for substantially complete removal of settleable solids, and the removal of not less than forty-five per cent of the total suspended solids; provided that, in order to protect the public health or to preserve the waters for other legitimate purposes, including those specified in Article I, in specific instances such higher degree of treatment shall be used as may be determined to be necessary by the Commission after investigation, due notice and hearing.

"All industrial wastes discharged or permitted to flow into the aforesaid waters shall be modified or treated, within a time reasonable for the construction of the necessary works, in order to protect the public health or to preserve the waters for other legitimate purposes, including those specified in Article I, to such degree as may be determined to be necessary by the Commission after investigation, due notice and hearing.

"All sewage or industrial wastes discharged or permitted to flow into tributaries of the aforesaid waters situated wholly within one state shall be treated to that extent, if any, which may be necessary to maintain such waters in a sanitary and satisfactory condition at least equal to the condition of the waters of the interstate stream immediately above the confluence.

"The Commission is hereby authorized to adopt, prescribe and promulgate rules, regulations and standards for administering and enforcing the provisions of this article."

That is the authority under which this hearing is being held.

CHAIRMAN BIERY: In a proceeding of this type, it is of the utmost importance that proper notice be given to all parties interested. At this time it is appropriate that the record should show the manner in which this hearing has been publicized, and to that end I will ask for testimony by the Secretary of the Commission, Mr. F. H. Waring.

MR. WARING: Notice was published as a paid advertisement in twelve newspapers and on the dates indicated in the attached list (Exhibit B). Affidavits of publication are on file in the Commission offices.

Notices were mailed March 6, 1953, to one or more city officials (officials being Clerk of Council, City Manager, and/or City Engineer as indicated) of the cities and towns indicated on attached List No. 2; these cities and towns being those located along that section of the Ohio River with which the hearing is concerned.

You will note the concentration of municipalities is greater at the head of the river. The Pennsylvania-Ohio-West Virginia state line crosses the river about 40 miles below the Point.

We have a detailed map that provides a vivid picture of the concentration of municipalities in the upper area of the river.

(Slide shown). (This slide is shown as Figure 1-A in the report attached hereto as Exhibit D.)

I will point out the cities of Wheeling, Weirton, Steubenville, East Liverpool. The Beaver River enters here.

We have a second detailed map.

(Slide shown). (This slide is shown as Figure 1-B in the report attached hereto as Exhibit D.)

This slide shows the lower section of the river. I will point out the location of Parkersburg and Huntington.

Mr. Chairman, with that introduction, I'd like to call on Mr. Horton to present a summary of the technical findings.

MR. HORTON: Mr. Chairman, regarding first the amount of sewage treatment required for the maintenance of desired oxygen conditions in the river, basic information on pollution loads in this stretch of the river has been obtained from the three states involved, Pennsylvania, West Virginia and Ohio.

All loads known or reported to be discharged into this stretch of the river have been taken into consideration.

Basic information on stream flows have been obtained from the reports of the U. S. Geological Survey. In our investigations due allowance has been made for increases in stream flow that might result from the operation of multiple-purpose reservoirs.

We have taken into consideration a number of factors, such as natural-purification processes of the river, acid conditions that sometimes prevail in the river, and of course many others.

The first point that I want to make is this: So far as oxygen is concerned, the worst condition in the river--that is, the condition of lowest oxygen content--occurs between Pittsburgh and the state line. That is, it occurs within the State of Pennsylvania, and as a result of wastes discharged in Pennsylvania. Therefore our investigations have not been concerned with the amount of treatment needed to protect a minimum desired oxygen level in the river. That is a matter for the State of Pennsylvania.

Our investigations, rather, have been along these lines: To determine if the amount of treatment that has been proposed and planned for wastes discharged within Pennsylvania will, first, satisfy minimum requirements of the Ohio River Valley Water Sanitation Compact; and second, will insure satisfactory oxygen conditions at and below the state line. We have found that these two conditions will be satisfied by the amount of treatment that has been proposed and planned within Pennsylvania, which is: Treatment of all sewage from Allegheny County discharged directly to the Ohio River so as to remove approximately 50 per cent of the BOD (biochemical-oxygen-demand); and primary treatment or its equivalent for all other wastes discharged from Pennsylvania directly to the river, meaning those wastes discharged between the Allegheny County-Beaver County line and the state line.

With regard to treatment needed for sewage discharges between the state line and Huntington, we have found that treatment of these discharges in accordance with minimum requirements of the Compact (namely, substantially complete removal of settleable solids and removal of not less than 45 percent of total suspended solids) should insure satisfactory oxygen conditions in the river. This amount of treatment should be sufficient to maintain oxygen conditions at a level at least equal to or higher than levels that have been established for other parts of the river.

That sums up our findings on oxygen conditions, Mr. Chairman, which are: That all sewage in the Pittsburgh-Huntington stretch of the Ohio River be treated so as to provide substantially complete removal of settleable solids and not less than 45 percent of the total suspended solids, and that in addition, sewage discharged within Allegheny County in Pennsylvania be treated so as to provide for approximately 50 percent reduction in BOD (biochemical-oxygen-demand).

These recommendations and the study on which they are based are set forth in the report that has already been submitted by Mr. Cleary as a part of the testimony of this hearing (report attached hereto as Exhibit D).

MR. CLEARY: Mr. Chairman, at this point Mr. Horton will proceed to discuss the bacterial conditions, which perhaps, are of greater significance in today's hearing.

MR. HORTON: The testimony regarding bacterial conditions in the river will address itself to three questions. The first question is this: What is a desirable bacterial-quality level in the river? Bacterial-quality levels are measured in terms of the number of coliform organisms, since the coliform organism is used as an index of sewage pollution.

The second question is: What are coliform levels in the river at the present time?

And the third question is: What is needed in the way of bacterial-reduction treatment to obtain the desired levels?

I would like to consider the first question in two parts, the first of which is the coliform level that is desirable with regard to protection of water supplies used for domestic purposes.

Our investigation of this question has consisted of a study and analysis of data and information from four different sources:

(1) Results of a five-year study by the U. S. Public Health Service on the operation of a large-scale experimental water-purification plant. The

purpose of these studies was to determine the limiting number of coliform organisms in the raw water that could be handled by this plant when producing a finished water meeting U. S. Public Health Service drinking water standards.

(2) Results of a two-year observational study, also by the Public Health Service, on actual operating efficiencies of some 31 water-treatment plants in the Ohio River basin, ten of which are on the Ohio River.

(3) Review of present-day efficiencies at water plants on the Ohio River, and a comparison of these efficiencies with what they were some 25 years ago.

(4) Review of the objectives and standards being used by other regulatory agencies.

MR. CLEARY: Isn't it true that Mr. Streeter, our staff consultant, did the original work on which conclusions of the U. S. Public Health Service studies were reached?

MR. HORTON: Yes, that is true. Our findings, after review and study of the information and data I have mentioned, may be summed up in three points, Mr. Chairman. The first is this: The limiting number of coliform organisms that can be handled by a so-called normal water-treatment plant, meaning one of the rapid-sand filter type providing post-chlorination to low residuals, is 5,000 coliform organisms for 100 milliters.

The second finding is that there are many water-treatment plants that can handle--and there are many plants now handling--much higher concentrations of coliforms in the raw water. However, these plants are doing this only by the use of what might be termed auxiliary treatment processes, which consist principally of the use of greater chlorine dosages and the maintenance of higher chlorine residuals in the finished water. Auxiliary treatment processes might also include such things as multistage coagulation and sedimentation, pre-settling, pre-chlorination, and others.

The third finding is that use of these auxiliary treatment processes at water plants, and particularly the use of greater amounts of chlorine, has intensified taste and odor problems and decreased the palatability of drinking water.

On the basis of these data then, we find that the maximum concentration of coliform organisms in raw water should be limited to 5,000 organisms per one hundred milliliters. This level should provide maximum safety and insure improved quality.

CHAIRMAN BIERY: May I interrupt you just a minute? There are quite a few laymen here like myself, who may not be entirely informed as to what a coliform organism is. Can you translate that briefly in terms we might understand? I have a vague notion the coliform organism has something to do with the discharge of the human animal.

MR. HORTON: That is correct. Coliform is the term used now. The original term was colon bacillus. The name comes from the colon, or large intestine. The waste from a human being contains literally billions of these organisms. And the presence of these organisms in a river is an index of sewage solution. A hundred milliliters is about half a glassful of water, or about three and a half ounces.

CHAIRMAN BIERY: There shouldn't be more than 5,000.

MR. HORTON: That is the level we recommend.

CHAIRMAN BIERY: I just wanted to develop that point so we would not lose sight of what it is all about.

MR. CLEARY: Five thousand is the limit suitable for treatment in a water-treatment plant?

MR. HORTON: That is right; in the raw water.

CHAIRMAN BIERY: After it has been well treated, what is the allowable limit on what may be remaining in that same amount of water?

MR. HORTON: One organism in that same amount of water.

CHAIRMAN BIERY: In other words, you get a reduction of 4,999?

MR. HORTON: That is right. Five thousand organisms per 100 milliliters in the raw water is the recommended level, Mr. Chairman.

With regard to recreational water, we have reviewed the results of research work by a number of investigators. So far as the risks can be calculated to a swimmer who might use the river, we find that an adequate safeguard should be provided if the level of coliform organisms is kept to 1,000 per 100 milliliters

To sum up, the recommended objectives are 5,000 organisms per 100 milliliters for the protection of water supplies, and 1,000 organisms per 100 milliliters where water is to be used for recreational purposes.

These recommendations and the studies on which they are based, are detailed in another document titled. "Bacterial-Quality Objectives for the Ohio River". We wish to submit this report as part of the testimony of the hearing. (Report is attached hereto as Exhibit E.)

That concludes discussion on the question of what are desirable bacterial-quality objectives for the river.

The second question for consideration is: What are coliform concentrations in the Ohio River at the present time?

We have obtained information on this question from four different sources. The first source of information has been the results of analyses made during the past five years at the water purification plants on the river.

The second source of information has been the results of the Ohio River survey made in 1939-41 by the U. S. Public Health Service (which results are published in House Document 266, 78th Congress.)

The third source of data has been the results of special analytical work that is being done at some of the water-treatment plants on the river in connection with a project sponsored by the Commission for constantly monitoring water quality.

The fourth source of data has been the results of a special survey conducted by the Commission in 1950.

Data from all these sources have been summarized on a chart, which I now show you.

(Slide shown). (This chart is attached hereto as Exhibit F.)

This chart summarizes the data. Coliform concentrations have been plotted on the vertical axis. Maximum concentration shown on the chart is 140,000 (this means 140,000 coliform organisms per 100 milliliters). The line here (pointing) represents a concentration of 1,000, not zero. The heavy line here (pointing) has been drawn at the recommended level of 5,000 coliform organisms per 100 milliliters.

The bars on the chart represent the results of coliform analyses from the different sources. We have attempted to differentiate among the sources of data. The completely blacked-in bars represent the results of the 1939-41 survey of the Public Health Service. The bars with horizontal stripes represent the results of the monitoring survey during the period 1950-52. The bars with cross-hatching represent results from the water-treatment plants during the five-year period 1947-51 (these results are those regularly reported to the state agencies).

Each bar has two significant points: The top of the bar, and the bottom of the blacked-out or cross-hatched area. The top of the bar represents the maximum coliform concentration observed during the period in which the analyses were made. The bottom of the blacked-out or cross-hatched area represents the average concentration during the same period.

The bars are spaced geographically; mile 0.0 (Pittsburgh) is on the left and Huntington is on the right.

The significant point I wish to make is that from immediately below Pittsburgh down to about mile 250 maximum coliform concentrations greatly exceed the 5,000 level. Furthermore, the average at many places is in excess of the 5,000 level. At the extreme lower end of the river, near Huntington, some of the maximum concentrations are less than 5,000 but both maximum and average concentrations are in excess of the 1,000 level.

I particularly call your attention to the two bars showing the highest concentrations observed. This bar (pointing) shows concentrations at Wheeling. The maximum there is about 140,000. The average concentration is about 50,000.

This bar (pointing) represents concentrations at Weirton. The maximum there is about 50,000 and the average about 18,000.

That concludes discussion on the question of coliform concentrations now existing in the Ohio River.

CHAIRMAN BIERY: What do they drink at Wheeling?

MR. HORTON: They must have a very good water-purification plant.

CHAIRMAN BIERY: Are we to understand that this exhibit, Bacterial-Quality Objectives for the Ohio River, is available for those who are interested.

MR. HORTON: Yes sir. It will be made a part of the record of this hearing.

MR. HOLBROOK: May I ask, is your general conclusion here that from the bacterial standpoint the condition of the upper Ohio is bad and it is getting worse?

MR. HORTON: The point I wish to make here is that coliform concentrations are higher in the upper part of the river than in the lower part of the river.

CHAIRMAN BIERY: I don't think you quite answered Commissioner Holbrook's question. He said they were getting worse; do you mean with respect to time?

MR. HOLBROOK: The condition of the river is not satisfactory now.

MR. HORTON: That is correct. These recommended objectives are exceeded throughout the entire stretch of the river, but the point where they are exceeded the most, is in the Weirton-Wheeling area.

I would like to take up now the third major point, which is the amount of bacterial-reduction treatment needed to reach the recommended quality objectives. In investigating this matter we have obtained basic information from the three states concerned on pollution loads. And, of course, we have taken into account other basic factors such as dilution available, natural purification, and so on.

We have approached this problem in two ways. The first approach has been to project known coliform concentrations in the river--occurring at some known river flow--to concentrations that might be expected at other river flows and under other conditions. The results of this work take the form of coliform profiles, and I can best discuss our findings by the use of slides.

(Slide shown). (This slide is shown as Figure 4 in report attached hereto as Exhibit D.)

This slide represents computed and observed coliform profiles in the river. The vertical axis represents coliform concentrations, and the range is from one hundred (bottom line) to 500,000 (near top line) coliform organisms per 100 milliliters. The horizontal axis represents mile points along the river, starting at Pittsburgh on the left and going to Huntington on the right.

The two heavy lines across the chart represent computed coliform concentrations. These concentrations have been computed taking into effect all of the known factors such as size of load, river flow, and so forth. The top heavy line (that is, the solid line) represents computed coliform concentrations at winter flows and at winter temperatures. The heavy dash line at the bottom represents coliform concentrations during summer flow and summer temperatures. It looks as if the two profiles are drawn on the same graph, but they aren't. Actually, different vertical axis have been used. The vertical axis for the top or winter profile is shown on the right; and the vertical axis for the bottom or summer profile is shown on the left.

Placed on the chart are the results of actual observations made during the 1939-41 survey by the Public Health Service. These results are shown by the circles. The black circles represent observed coliform concentrations during the winter. The computed winter profile has been drawn at the same flow at which these observations were made. The open circles represent observed concentrations during summer conditions.

The point that I wish to made is that, in general, there is very good agreement between the observed values and the computed values. If you will look at the computed values as shown by the lines, you will see they follow very closely the observations as shown by the circles.

Once we had checked computed values against observed data and obtained good agreement, we felt justified in proceeding to construct other profiles at other runoff conditions.

MR. CLEARY: What you are proving here, Mr. Horton, is the validity of your method of computation. You and Mr. Streeter developed a method of computation, and you have checked computed results against what has been actually found in the river. Those dots indicate actual conditions and the lines indicate your computed conditions. Because of the good agreement, you feel that the method is a valid one for projecting coliform concentrations under other conditions?

MR. HORTON: That is correct.

CHAIRMAN BIERY: Are these charts available for examination?

MR. HORTON: Yes sir. They have been reproduced in the report already submitted (Exhibit D).

Let's have the next slide.

(Slide shown). (This slide is shown as Figure 8 in the report attached hereto as Exhibit D).

These are computed profiles. Coliform concentrations are shown on the Y the vertical axis, and river mile points on the horizontal axis. The top profile line--the solid line--represents computed coliform concentrations without any bacterial-reduction treatment in effect. It has been drawn at a flow of 3,870 cfs (cubic feet per second) at the Sewickley gage. That flow was chosen because it represents the minimum monthly-average flow that might be expected once in ten years.

You can see how the coliform concentrations run. The 5,000 concentration which is the recommended objective for water supplies, is shown here (pointing). The coliform concentrations in the upper part of the river are in excess of the 5,000 level. In the lower part of the river concentrations go below 5,000, but are in excess of 1,000 organisms per 100 milliliters. Once the profile without treatment had been constructed, the next step was to determine the adjustment necessary--that is, the reduction in coliform concentrations needed--to bring the concentrations to within recommended levels. An adjusted profile is shown by the heavy dash line. This adjusted profile has been drawn on a basis of an 80 per cent reduction in all coliform loads.

You will see that from immediately below Pittsburgh throughout the stretch, concentrations are below the 5,000 level, with the exception of a small area between Steubenville and Wheeling. Actually, there are two water intakes in this area; however, concentrations at these intakes are only slightly in excess of 5,000.

I also wish to point out that in the lower part of the river there are two sections -- one from mile 155 to mile 175, and the other from mile 215 to mile 301--where concentrations would be expected to be less than 1,000 coliform organisms per 100 milliliters, which is the recommended objective for recreational water.

As I have said, these profiles have been drawn at the minimum ten-year flow that might be expected regardless of season. Minimum flows usually occur in the months of October or November.

May we have the next slide.

(Slide shown). (This slide is shown as Figure 9 in the report attached hereto as Exhibit D.)

The profiles on this slide have been drawn at a flow of 5,500 cfs (cubic feet per second) at the Sewickley gage. The purpose in drawing these profiles has been to show the minimum quality--conditions that might be expected during the recreational season of June through August. A flow of 5,500 cfs is approximately the minimun monthly-average flow that might be expected once in ten years during these three months. Coliform conditions shown on this slide are somewhat better than those shown on the preceding slide, since a higher river flow has been used (5,500 cfs versus 3,870 cfs).

The top profile (solid line) represents coliform densities without any treatment in effect. The bottom profile (dash line) represents densities with 80 percent bacterial-reduction treatment in effect.

The "treatment" profile shows that throughout the entire river stretch coliform densities are below the 5,000 water-supply objective with the exception of one small area, which is immediately below Wheeling and in which there are no water intakes.

It should be noted that the number of river miles where concentrations of less than 1,000 may be expected is considerably greater at a flow of 5,500 cfs than at 3,870 cfs. At 5,500 cfs there would be a total of about 150 miles meeting the recreational objective.

The point I wish to make is that with 80 percent bacterial-reduction treatment during the summer season (May through October), in nine years out of ten there would be at least 150 miles of the river meeting the bathing-water objective, and further that coliform densities would meet the water-supply objective at all water intake points. Therefore, our recommendation is that during the summer period, treatment should provide for 80 percent reduction in coliform levels.

May we have the next slide.

(Slide shown). (This slide is shown as Figure 11 in the report attached hereto as Exhibit D.)

The profiles on this slide have been prepared to show expected coliform conditions in the river during the winter months of November through April. The top profile shows conditions without any treatment, and the two profiles below show conditions with treatment.

These profiles have been constructed at a flow of 50,000 cfs. We constructed several profiles at winter temperatures and with varying flows, and found that the worst conditions occur at a flow of about 50,000 cfs at the Sewickley gage.

Once we had determined what expected concentrations might be without treatment, the next question was to determine how much adjustment or reduction would be needed to bring coliform concentrations to within recommended levels.

Two treatment profiles are shown on the slide. The uppermost "treatment" profile (solid line) has been drawn on the basis of 80 percent bacterial-reduction treatment, and the lower "treatment" profile (dash line) has been drawn on the basis of 85 percent bacterial-reduction treatment.

I wish to call your attention to the section of river from the state line (mile point 40) to about mile 120. Throughout this section coliform densities are very close to the 5,000 objective level.

During the winter, river flow is subject to greater disturbance than in the summer, and therefore coliform densities in excess of average values are likely to occur more often. For this reason we believe that for adequate protection of water supplies during the winter season, an 85 percent reduction in bacterial concentrations is needed.

I have one other chart to show, which gives further evidence of the need for 80 and 85 percent bacterial-reduction treatment.

(Slide shown). (This slide is shown as Figure 5 in the report attached hereto as Exhibit D).

On this chart we have shown observed coliform densities at the Weirton intake during a two-year period. Coliform concentrations are shown on the vertical axis; and they have been plotted against the river flow (shown on the horizontal axis) at which the observations were made. The actual observations during the 1950-52 period are shown by the open circles and open triangles.

We have attempted to distinguish between the two seasons. The circles represent observations during the summer season of may through October, and the triangles represent observations during the winter season of November through April.

Superimposed on this chart are coliform values indicating what the observed concentrations might have been expected to be with the recommended treatment program in effect. In other words, we have taken the summer observed values and reduced them by 80 percent; the reduced values are shown by the filled-in circles. The winter observed values have been reduced by 85 percent, and these reduced values are shown by the filled-in triangles.

You will note that practically all of the reduced values fall below the 5,000 objective. There are one or two points that are above the objective, but we believe that a high degree of treatment would not be justified.

That concludes our presentation, Mr. Chairman. I would like now to summarize our recommendations, which are that so far as bacterial-reduction treatment is concerned, 80 percent be provided during the months of May through October, and 85 percent dur ing the months of November through April.

MR. HOLBROOK: I note the high pollution at Weirton and at Wheeling. What causes the high pollution at these places?

MR. HORTON: At Weirton, or Wheeling, the concentration of coliform organisms is directly due to the upstream sources of pollution.

MR. HOLBROOK: That is the point I wanted to make. The heavier populations upstream, their pollution coming down on those cities?

MR. HORTON: That is right.

MR. CLEARY: Are there any questions you wish to address either to Mr. Horton or Mr. Streeter in connection with the technical question?

CHAIRMAN BIERY: There are a number of engineers present. I think it would be most appropriate if any of the engineers would like to address a question to Mr. Horton.

MR. J.F. LABOON: J. F. Laboon, Allegheny County Sanitary Authority.

What observations I have made, and I think I discussed it with you by phone, Ed, is that you are obtaining a much higher bacterial count at higher flows which occur in wintertime. That chart demonstrated that very clearly by the triangles, which are the winter results.

Well, I question whether that will agree with future conditions after sewage treatment takes place in the upper reaches of the Ohio. For instance, it is my theory, which I think we have supported by justification at Pittsburgh, that the sewage at the present time settles out in these tremendous settling basins which are formed by the navigation dams, and this sewage rests on the bottom of the river in the form of sludge. It is not moved out until higher flows come along. In fact, at the present time it is masked somewhat by the acid condition of our rivers, so you get a delayed bacterial-pollution result, I will say, on that account.

Now when the floods come along, they wash the bottoms of these rivers out, wash out these settling basins behind the dams, and thus cause the sludge to go downstream at the higher flows; and this is why your bacterial count rises.

When we complete treatment here in the Pittsburgh area and upstream in the Ohio, we will not have these tremendous sludge deposits we have now. Consequently the bacterial load at that time will be reduced. We know that bacterial conditions in wintertime are more inhibited than they are in the summertime, so it is unnatural that bacterial counts should exhibit a tremendous increase in growth at higher flows and at lower temperatures. So the sludge theory to me presents a logical answer to that particular question. Following that up, I wonder whether 85 percent chlorination in wintertime will be justified in the future. Of course, river results will prove whether that will be necessary or not. But my thinking at the present time is, after these plants are built it (bacterial pollution) will not be on the increase in the wintertime, and therefore our chlorination in wintertime may be reduced to lesser requirements than they are at the present time in summer conditions.

CHAIRMAN BIERY: The question is very pertinent. Will you discuss that more fully?

MR. HORTON: Mr. Chairman, these studies have been made on the basis of known factors applying to bacterial pollution in this part of the river. These factors include, among others: the known population discharging to the river, acid conditions that sometimes prevail in the river, natural die-away of bacteria the rate of which -- as you point out -- is different in the wintertime from what it is in the summertime, and the matter of sludge deposits behind the navigation dams. Actually, the recommended treatment requirements are based on the assumption of no sludge deposits, since this is the condition that will be obtained when sewage treatment has been put into effect for the upstream population. So to answer your question, the matter of sludge deposits has been taken into account in these studies. I think you will find that the concentrations of coliform organisms we have shown at the water intakes will be expected from the upstream pollution loads known to be discharged to the river, without the effect of any washout of sludge deposits.

CHAIRMAN BIERY: Does that answer your question?

MR. LABOON: No, it doesn't.

CHAIRMAN BIERY: Would you like to have the chart projected again?

MR. LABOON: Yes, it might be well to show the chart to illustrate my point.

I still don't understand why the treatment, even though you assume that the acid waste will be removed -- I am not sure that your question is correct.

MR. HORTON: We will show this profile, the one with the circles and triangles.

(Slide shown). (This slide is shown as Figure 5 in the report attached hereto as Exhibit D.)

MR. LABOON: I notice here your flow on the horizontal axis increases; so does your bacterial count, which is unusual. You have much more dilution at that time with the same pollution load than you have in the summertime. There is no difference between the loads, and yet you find a much higher bacterial count with a much greater dilution in wintertime when your conditions of bacterial growth are less favorable than they are in the summertime.

You are going to remove this bacterial load by treatment. You are not going to have these sludge deposits, because discharges in the Pittsburgh area will have little solids, since apparently all the settleable solids will be removed.

Our survey shows -- we did make, by the way, a sludge-deposit test of the streams in the Pittsburgh area, and strangely enough, we found very little deposit -- that at times there is a scouring action that takes place and washes these sludge banks away. Yet we have in our report a picture of the condition at the Sixth-Street outfall, City of Pittsburgh, where a diesel boat happened to come alongside and stirred up the river bottom. It just turned it black. So we know there are local deposits of that kind of sludge which are quite extensive at times. The point here is that I can't accept the theory, but it may be perfectly all right. I respect your theory, but to me this doesn't agree with what this chart demonstrates.

MR. CLEARY: I was going to say that Mr. Streeter, with 40 years study on this particular matter may wish to go into the intimate details.

CHAIRMAN BIERY: Mr. Streeter, we will be happy to have your ideas about this.

MR. STREETER: The chart you have up here is based on recent observations at the Weirton intake. No doubt it shows the effects of washouts of sludge deposits at higher winter flows, and also those of lowered bacterial death rates and shortened times of flow.

The computed profile which Mr. Horton has shown is based, however, on the assumption of no accumulation of sludge deposits, but on coliform contributions at various points diluted by assumed flows. There are four points along the Ohio, Pittsburgh, Wheeling, Cincinnati and Louisville, where we have had rather extensive measurements of coliform-bacteria contributions to the river. The measured contributions by Pittsburgh and Wheeling have been lower in the summer than in the wintertime, contrary to what we have observed at Cincinnati and Louisville. This is probably due to the conditions not only in the river, but in the sewer systems of those two cities. It may be that in time these conditions will be changed, but all we have to go on now have been the results of measuring increases in coliform densities over fairly long periods of time between points above and below those four cities I mentioned.

It is very difficult to predict what may happen after 50 percent treatment has been established at Pittsburgh. But I think that the trend will continue to be toward higher coliform densities in the river under winter conditions than under those of summer, necessitating higher bacterial reductions in the winter months. The same general trend prevails throughout the entire river, probably due to lowered times of flow and rate of self-purification, which tend to offset, or more than offset, any increased coliform discharges in sewage during the warmer season.

MR. LABOON: I don't want to go on record as being critical of the conclusions formed here by the technical staff of the Ohio River Valley Water Sanitation Commission, but I was questioning this matter of taking present data.

I understand these curves show present data, present bacterial findings in the river, and not a theoretical curve based on say the improved conditions when treatment is in effect and when acid is entirely removed. We say removed as a bacterial factor in the streams.

Following on that too, when you were making your studies some years back, I believe you found that the center of the peak of pollution at that time was East Liverpool, or Steubenville, It has now moved downstream to Wheeling, with increased organic pollution.

MR. STREETER: I think that there may be some doubt in your mind as to the basis of those profiles, but the only observations that went into them were the results of past observations of coliform bacterial contributions at Pittsburgh and Wheeling when acid conditions were not acute. The profiles were not observational in any sense at all except in that respect.

MR. LABOON: You say not under acid conditions, still under present conditions where sludge is formed behind these dams --

MR. STREETER: We simply allowed for the contributing population multiplied by a per capita unit which we obtained from past observations under non-acid conditions. The profiles as drawn do not reflect any effect of sludge accumulations in the pools.

MR. LABOON: How do you account for the high bacterial counts in the wintertime, the organic load?

MR. STREETER: In general, seasonal variation curves have shown higher per capita contributions of coliform bacteria during the summer than in the winter. But in this upper section of the river, all the measurements we have had available have shown higher coliform contributions in the winter than in the summer, even at river flows higher than those normally associated with acid conditions in the river itself.

CHAIRMAN BIERY: The hearing board appreciates the observations of Mr. Laboon, and I assure you they will be given further consideration by the engineers of the Commission.

Mr. LeFeber I believe wants to ask a question.

MR. ALFRED LeFEBER: I was very much interested in the observations of the preceding speaker, Mr. Laboon of Pittsburgh, because it coincides very much with our own observations. In doing pipe-line work, for example, across the Ohio River, there are times during the summer months when we have to forgo that activity because of the terrific depositions of sludge, as much as three and a half to four feet close in to shore.

Now there is no question but what with the flushing out of the basins in high water, we get an increased load as the result of putting the sludge into suspension. Thus we get a modified or a changed picture.

Similarly, to merely catalog and list bacterial count at waterworks intakes, failing to take into account the nature and location and type of construction of those intakes, is quite fallacious. For example, the charts I observe here indicate that when we get down to Huntington, I suddenly gain the impression we are fresh out of bugs, that pollution is on the wane. And yet at Ashland, just below the mouth of the Big Sandy, we have had monthly averages as high as a hundred thousand. Down that far the charts here don't indicate that, or we get that impression for the terminal point on the chart; yet directly across the river from Ashland is Ironton. Their water is altogether different, just almost directly across the river, one from the other.

Now the point is, the location of the Ashland intake is such that not only are there certain items of sewage, the entire flow of the Big Sandy, but the fact too is that their intake is located at the mouth of a lock. Thus every steamer passing up and down the entire river gets in its work and contributes to deposit its sludge to the intake waters, so there are many factors.

I question, with the complex nature of the river its continual changing factors, whether we are going to be able to resolve this thing to a matter of standards and curves and get it down to mathematics.

If we will study last year's condition of the Ohio River, we had a most extraordinary thing. Down our way, we had pool stage nearly the entire year; the condition of the river was marvelous from the standpoint of the type of high water. We had a little acid. Yet the quality of water which was produced was abominable; so while I appreciate the complex nature of the problem before the technicians -- they are attempting to do a very splendid job -- yet at the same time, there are these practical considerations such as how much will we benefit by the elimination, by failing to make the contribution of the sludge to the pools. I think it is a very practical matter and one which we have encountered, actually encountered, which gets us back again to one thing, that perhaps just merely reducing the quality of the type of contribution at any given point may not be enough. Perhaps we should all contribute the same quality of sewage, regardless of quantity, come to think about it.

MR. HOLBROOK: You say the steamboats get in their work. What kind of work?

MR. LeFEBER: The paddle wheels, and of course the more recent types of diesels, stir up the deposits on the bottom.

There is one other point which I think the layman is not particularly aware of. Streams that are tributary to the Ohio River, when they enter the Ohio River, they hug the nearest bank, and so it is with the sewage contribution. It doesn't flow and comingle gently and definitely with the entire stream; it makes a sharp right-angle turn. If it is loaded with dye or any colored substance, you can trace it right down the bank.

CHAIRMAN BIERY: Is the board to get the inference from your statement, that possibly the 85 percent reduction should be applicable in summer?

MR. LeFEBER: In order to operate treatment facilities it seems to me if you have got such wide latitudes that you are going to be sitting there watching that river 24 hours a day and 365 days a year and figure what are we going to do next, the quality of waste should be produced and put in the stream. I believe that the gross polluter will always remain the gross polluter. The big city with a thousand BOD or suspended solids, with a little village adjacent with 200, if you reduce them 50 percent, the one is still five times the other.

CHAIRMAN BIERY: Thank you. Mr. LeBeber.

MR. LABOON: I'd like to add to that. That is the real reason why I got on my feet. I question the theory that 85 percent reduction of bacteria is necessary in wintertime as opposed to 80 percent in summertime. I believe the reverse would be more nearly true, although I do respect the findings of your experts, yet my own experience leads me to ask the question whether you need as much bacterial reduction in wintertime as you do in summertime.

However, you have set up a standard of 5,000 coliforms per hundred milliliters, which is a respectable standard, and I would like to project the question at this time to that point: Will that require residual chlorine or will it require something less to protect that bacterial quality that is to be measured at the plant, or measured by the condition of the river itself?

MR. STREETER: You are speaking about the 85 percent reduction.

So far as we have been able to determine, that is within the range of sub-residual chlorination. If you go to measurable residuals, you get a higher percentage reduction than that. We did not think it necessary or desirable to analyze that question, but I think you perhaps are familiar with work at the Hyperion sewage plant in Los Angeles. Here they can get percentages of reduction in coliform bacteria ranging all the way from 40 percent to 95 percent, according to the percentage of the chlorine demand of the sewage which has been satisfied by chlorination. That is a technical question of operation that I don't think I would like to get into unless the Chairman wants to, but I think that you are operating at a rather low level of chlorination when you are down to 80-85 percent reduction.

MR. LABOON: My point is again, that with ordinary operations, residual chlorine, you will meet all bacterial requirements, whether 80 or 85 or 89 percent.

MR. STREETER: I think you are right. I think if you get to operating on a chlorine residual, you will far exceed these requirements that we have suggested.

MR. LABOON: I just wanted to make that point. Now, Mr. Chairman, may I address a question to the Wheeling situation?

CHAIRMAN BIERY: You may go right ahead with any observations you care to make with respect to the Allegheny County Sanitary Authority and your situation in Pittsburgh.

MR. LABOON: The reason I raise that question is, as I mentioned to Mr. Streeter, some years back the center of pollution, let's say the peak of pollution was centered at East Liverpool, or Steubenville. It is now moved downstream according to data and is peaked at Wheeling.

We were glad to hear the previous speaker say that he thought the design at Wheeling was good, because I was the man in charge of the design, and in charge also of construction. I know we have had some troubles there since, as far as operations are concerned. I'd like to ask Mr. Todd whether he has noticed an increase in bacterial load during the time it has been in operation. Have you noticed an increase in bacterial load? Do you think we located the intake at the right place?

MR. A. R. TODD: A. R. Todd, Wheeling, West Virginia. Answering the last question first, you located your intake, and you had five sewer outlets in Warwood, just above it.

Now the statement that I wanted to file with the Commission was this, and it will answer Mr. Laboon's question: I have been there since 1932, and it has been my experience that the river has been getting worse each succeeding year except one. That was the year immediately after the war stopped. Before that, industries were on a 24-hour basis; they stopped, and we had a little slackening off. At that time the river got a little better but now it is getting worse each year. Does that answer it?

MR. LABOON: Yes.

CHAIRMAN BIERY: Mr. Laboon, do you have any further observations pertinent to the Allegheny County Sanitary Authority?

MR. LABOON: No, sir.

CHAIRMAN BIERY: Are you through, Mr. Cleary?

MR. CLEARY: Mr. Chairman, we have supporting testimony to be presented by representatives of three of the states most intimately concerned with this stretch of the river.

I would like to call on Mr. H. E. Moses, Commonwealth of Pennsylvania, consulting chief engineer of the State Health Department, also vice-chairman of the Ohio River Valley Water Sanitation Commission.

MR. MOSES: Mr. Chairman, and gentlemen: I just want to bring Pennsylvania's position into the matter of the degree of treatment involved here. This is part and parcel of a state-wide program which we inaugurated in 1944. The Sanitary Water Board, which administers our stream pollution action, toured the state and held ten hearings, inviting everybody that was interested, and giving everybody a chance to express their opinion about the policy of the Board, or the plan of the Board for a state-wide cleanup campaign.

After that, the Board adopted a policy that was state-wide in extent, and they are still following that, and we are having quite good success with it. Many plants are being built. In the meantime plans are being made for treatment. They set up different degrees of treatment. One was primary degree of treatment, 35 percent reduction, the maximum at 85 percent reduction of BOD, as measured by the BOD tests, and intermediate degrees of treatment which might be necessary due to load conditions.

The Board then began to issue notices to offenders throughout the entire Commonwealth. Thus far more than 1,300 such notices have been issued by the Board to industries and to municipalities and state institutions who were polluters, the first part of the order saying to abate or prepare plans. This policy has been followed ever since. We have been getting a lot of plans.

At first, that was state-wide in effect. Then later we moved to watershed handling, and we attacked all the watersheds in the state, of which there are three major ones, the Delaware and the Susquehanna in the east, and the Ohio on the west.

Today we are concerned with the Ohio watershed. What happens here is that you have a great concentration of pollution at the head of the Ohio River in Allegheny County. It has been spoken of, and I think we are all familiar with what we have here. The population in the Ohio watershed is about three and a half million people, and about one-half million of those people reside in Allegheny County. That makes the problem acute at this point. I must say then that along the line somewhere, the Allegheny County Sanitary Authority was formed to handle this problem here. In their preliminary study, they planned to concentrate all the sewage in the county at one spot. At the site selected there is already a sewage works, below the State Penitentiary on the Ohio River, on the righthand side of the river going down. It was found too expensive to bring all that sewage into one point. They broke it up into several different units or sections. In the center of the county, we have the great Allegheny County Samitary Authority, including the city of Pittsburgh and 64 other municipalities that are banded together to deliver their sewage into one system, and to take it to the site for a sewage treatment works.

In the rest of the county, the municipalities are broken up into six or seven subdistricts where their sewage will be treated in their own sewage treatment works in one or two municipalities, or a section of municipalities as the situation may be. That is the situation as we find it today.

Now because of the fact that they were bringing a vast volume of sewage to this one point of treatment, it was determined by the Sanitary Water Board and by the Allegheny County Sanitary Authority, that primary treatment alone was not sufficient to protect the river at that point. Instead of going to complete treatment, they went part-way along there, and decided to provide an intermediate degree of treatment, which is in effect a reduction of BOD of about 50 percent. That is what Mr. Laboon and his people have been designing to, and what we have agreed to, and then we extended that degree of treatment down to the Allegheny County-Beaver County line. From there to the state line the requirement is primary treatment. In both instances requirements include chlorination to take care of the bacterial load.

That is the situation we have had there, and the plans are being designed in their final contract drawings. We have a great many of them at the present time. I was informed yesterday that the job would probably be finished by August or September of this year, at which time the Authority will have submitted to the Sanitary Water Board, complete plans, contract drawings, for this great project here in the Pittsburgh area.

The next steps will be the study of those plans, which we are undertaking at the present time, the issuance of permits, the matter of financing, and then, I persume and hope, actual construction of plants by the County Authority as well as the towns down river closer to the state line.

CHAIRMAN BIERY: Do you have anything further, Mr. Cleary, you want to present? One gentleman from Pennsylvania has indicated he wishes to be heard, Mr. J. E. Anderson.

MR. CLEARY. Would you prefer to keep the statements in order of supporting testimony?

CHAIRMAN BIERY: You have someone else you want to call?

MR. CLEARY: I do.

CHAIRMAN BIERY: Proceed.

MR. CLEARY: I now call on Mr. F. H. Waring, chief engineer of the Ohio State Department of Health, and secretary of the Ohio River Valley Water Sanitation Commission.

MR. WARING: Mr. Chairman, on the Ohio side of the river, we have concentrations of population of significance at Ease Liverpool, Wellsville, Toronto, Steubenville, Martins Ferry, Bellaire, carrying it down through what we call the Wheeling District. Below that we have a less concentrated population until we get to Marietta, then Gallipolis, and we reach the Huntington area. Now that is the zone of river we are talking about.

On this question of degree of treatment, we in Ohio have considered what is the minimum that should be applied at this time. Therefore we have directed ourselves to the quality of water reaching the intakes of the several cities which use the Ohio River as a source of supply; and again naming them: East Liverpool, Toronto, Steubenville, Bellaire, formerly Marietta -- it is not any longer -- and Pomeroy.

Watching the results over the period of years since the original surveys were conducted in 1939 to 1941 we have come to the conclusion that there is a step-up in the concentration. We have also observed, just as Mr. Streeter told you, and Mr. Horton, that the concentrations reach very high proportion in the winter months. Now that is not just once, with the flush of the first storm, but all throught the winter period. And my observation is -- and in my mind that is accounted for this way: the dilution is offset by time of flow and temperature, because temperature prevents nature from going to work and killing off -- or die-away, as we call it - - these bacteria. They are essentially traveling in cold storage, if you wish. So that is my explanation of why always in the winter months, steadily, we have observed at East Liverpool and downstream, concentrations as high as a hundred thousand coliforms, many days in the month, steadily. And it is necessary to resort to intensive water purification to get those bacteria removed.

Now to those of you who might inquire what the situation is today with respect to what it was during the 1939-41 survey, we have not carried the bacterial dilutions way down in testing the way we did in 1939 and 1941. Therefore figures at East Liverpool, and possible at Steubenville and Toronto, might not show the same high reaults that we observed years ago. However, isolated tests which our own department has made, bear out the statement already presented that the pollution is just as great and greater than it was ten years ago.

We have notified our cities on the Ohio side of the river of the minimum degree of treatment required.

We in Ohio have not had our Sanitary Water Board in operation as long as Pennsylvania has. We call it our Water Pollution Control Board, It went into full effect September 27, 1952, when we were required to give permits and set up the conditions of the permit to cities not only on the Ohio River but all over the state.

We have notified all of the Ohio River cities of the degree of treatment which they are to attain, and that is the removal of settleable solids and 45 per cent of the suspended matter, as indicated in the Compact. We call it primary treatment plus chlorination.

We have had to change some of the first recommendations after we saw the results of the Huntington-to-Cincinnati studies. In that area plans have been modified to include that second step of chlorination, or as we call it, reduction of bacteria. And so upstream the same standard now is being applied, and the cities have been told this in their permits.

A number of the cities have their detailed plans all drawn. Some modification would be needed -- not very much -- to incorporate this one item of reduction of bacteria. The capital cost of including this is very small in comparison with the total cost. Operating cost is of course different.

That I think summarizes the situation on our side of the river.

MR. CLEARY: Mr. Waring, you confirm then the finding s of the Commission staff, that during the winter period the coliform content is higher than during the summer period, such observations having been made by the laboratories , that report to you.

MR. WARING: Yes.

MR. CLEARY: I now call on Mr. Rocheleau, executive secretary of the West Virginia State Water Commission, and a commissioner from the State of West Virginia of the Ohio River Valley Water Sanitation Commission.

MR. ROCHELEAU: Mr. Chairman, gentlemen: The proposed treatment standard which has been outlined this morning by Mr. Horton, and which has been detailed in the report that has been given to the hearing board, certainly meets with West Virginia's approval, and is consistent with the policy that we follow in this section of the Ohio River from the state line to Huntington.

I might also add that the procedure of the Ohio River Commission in directing its attention to public health matters at this hearing rather than to industrial wastes, or postponing industrial problems to a later date, is also in complete accord with the state of West Virginia's program.

I have examined data in our files which our Commission has acquired independently and which has not been made availabe to the Ohio River Commission. As far as the bacterial loading of the river is concerned in that stretch between the state line and Huntington, our data were acquired during the summer months of 1948 and 1949. One of the computed coliform profiles that has been shown you (Figure 4 in the report attached hereto as Exhibit D), has been taken and our results have been superimposed on it. We were interested in checking the validity of the method that Mr. Streeter and Mr. Horton used in approaching the problem. I would like to offer this an an exhibit. (This chart is attached hereto as Exhibit G).

I might say our results compare very favorably with those shown on the computed profile.

CHAIRMAN BIERY: We'd like very much to make it a part of the record.

MR. HOLBROOK: You say "favorably". Do you mean closely?

MR. ROCHELEAU: Very closely.

MR. JENNINGS: You find a higher point in the summer or winter months?

MR. ROCHELEAU: Our work was done in the summer months.

Comment was made about the lower reach of the river down in the Gallipolis area. It was stated in effect the lower oxygen content there was possibly due to pollution from the Kanawha River. Our Commission has been actively engaged in trying to do something about the Kanawha River. We have set a stream objective of four parts per million at the critical point, which is some 30 miles from the mouth of the river. We feel that if we achieve this objective at the critical point, we will obtain an oxygen content of between five and a half and six parts per million at the confluence of the Kanawha River with the Ohio. That is all I have, Mr. Chairman.

MR. CLEARY: Any questions of Mr. Rocheleau, Mr. Chairman?

CHAIRMAN BIERY: Any questions from the visiting engineers?

MR. CLEARY: We have some additional statements for presentation. At this time, I'd like to call on Mr. W. W. Towne, engineer of the U. S. Public Health Service, and officer-in-charge of the Ohio-Tennessee Drainage Basin Office.

MR. TOWNE: Mr. Chairman, gentlemen: The interest of the Federal government in pollution control on the Ohio River dates back many years, as Mr. Streeter mentioned in his early studies on the river, back in 1913 and 1914. Our immediate interest stems, however, from passage of Public Law 845 known as the Federal Water Pollution Control Act, which became a federal law in 1948. I'd like briefly to state two or three of what I feel are the primary prerequisites of this act.

To begin with, congress made it evident and fairly apparent, and so stated in the act, that it should be the policy of Congress to recognize, preserve and protect primary responsibilities and rights of states in controlling water pollution. The Public Health Service is fully in agreement with this policy. In fact, that has been the way the Public Health Service has operated ever since its existence.

Two or three of the requirements of the act require that the Surgeon General shall, after careful investigation and in cooperation with other federal agencies, state water control agencies and interstate agencies, and with the municipalities and industries involved, prepare or adopt comprehensive programs for eliminating or reducing the pollution of interstate waters.

With these thoughts in mind, our office has reviewed this report, with the thought that it might serve as a document which the Surgeon General

"We would appreciate it very much if you could incorporate this letter as a permanent record in the forthcoming hearing to be held at Pittsburgh, Pennsylvania." (Statement by Messrs. Allison and Bartlett is attached hereto as Exhibit J.)

One explanation I think they did not make, is that most of the wells they draw from are embedded in a sand bar which is submerged by the high level Gallipolis Dam. When they pull heavily on that, they do infiltrate the river water.

CHAIRMAN BIERY: The letter will be made part of the record. (Exhibit J.)

MR. CLEARY: Mr. Chairman, at this time I'd like to call on Mr. Daniel Heekin, president of the Heekin Can Company in Cincinnati, a man who has been intensely interested in pollution abatement, and who is also an industrialist affected by the Cincinnati sewage treatment program.

MR. HEEKIN: The usual thing to do, I believe, when called upon in such a meeting, is to introduce yourself. I am Daniel Heekin, a business-man from Cincinnati, and a graduate of Purdue University, a mechanical engineer in the class of 1910. I have lived in Cincinnati all my life and early in my mature days I began to be impressed by the horrible condition of the Ohio River, the Great Miami and the Little Miami, and smaller creeks in the immediate vicinity, both in Ohio and in Kentucky. My first technical information on the way to reduct this shameful pollution was while I was a junior at Purdue when it was my good fortune to be able to take an elective subject in biology. It is not my purpose to give a technical talk, but rather one emanating from a taxpayer interested in five or six enterprises in Cincinnati which are paying their respective shares for our preventive measures. I am happy to recommend making these payments to my associates and in this I have their entire support.

My first trip on the Ohio River was in a rowboat when I was aged 7, and since that time I have spent many pleasurabe hours and some profitable ones, on the Ohio River. My memory being reasonably good and my powers of ob-servation normal, I recall that as a boy we swam in and drank out of the streams in the vicinity of which I spoke before. It is my contention and, of course, which hasn't actually been put to proof by tests, that if one drank out of most of these streams today, he probably wouldn't live long enough to arrive at a hospital in time to be saved.

The solution to the safe disposal of ordinary city sewage was develop-ed a long time ago -- perhaps as long as 100 years -- and several methods have been perfected, namely, settling, chemical and activated sludge. In a city the size of Cincinnati, this of course requires a tremendous initial expendi-ture if you count the money spent over the years to bring about a concentration of the city sewage so that it is possible to handle it in one or more sewage disposal plants. Fortunately, the city fathers started as far back as 50 years building intercepter sewers. I recall one such construction effort which I observed as a child, and while it meant little to me at the time, I have learn-ed later that this was one of our first intercepters and is about to be put to its ultimate usage when our first sewage disposal plant is opened in Cincinnati next fall. Further, I recall a matter of perhaps 40 years ago, when a huge in-tercepter was put in Millcreek Valley, a watershed which practically bisects the downtown area of Cincinnati. At this point another sewage disposal plant will be built and I believe the plans call for an additional two smaller ones, at which time Cincinnati will be a city its inhabitants can be proud of.

Across the river from Cincinnati, the two northern Kentucky counties have combined in their efforts and are now constructing a large sewage disposal plant which will take care of the sewage originated by the great majority of the people in those two counties. I mention these matters to let you know that we, living practically in the middle of the length of the Ohio River, have done to help this great problem of stream pollution on to its final successful accomplishment. We hope in our actions that we have encouraged others to step in and do likewise. All of this costs money, to be sure. At the present time residents in Cincinnati are paying a 60 per cent tax on their household water bills and industries are paying 6 cents extra on the first 60,000 cubic feet used and 5.4 cents thereafter.

We in industry are now in the process of analyzing our sewage discharge, first, because it is necessary for everyone to find out what he is putting in the river that might be detrimental, and second, I believe that there is a provision for a lower rate for those who have less harmful ingredients in their sewage. Very briefly, this takes care of the subject of what might be called ordinary city discharge into the Ohio River, and of course this is only a part of the problem.

Next we come to industrial waste and this covers a multitude of ingredients, some of them which are exceedingly harmful and toxic. Colonel Strong of the U. S. Engineers, whose offices are in the City of Cincinnati, referred to the Ohio River Valley in a recent talk as the "Ruhr Valley of the United States of America" and indeed it is. I recall very distinctly years back when this statement could not be made, because in the last 50 years, particularly since World War I, the Ohio Valley has become a teeming giant and what with our ordinary expansion, growing as usual, and the building of plants in the valley due to the brand new movement in Atomic Energy Research, we are growing at the rate of ten times what we did 50 years ago. All of this brings terrific problems and very dangerous ones.

What I am coming to is just this, that while a natural waste from cities seems to be under reasonable control, the study of our industrial waste has only begun. I recall very well, during the war, when the government synthetic rubber plants were operating on the Great Kanawha at Charleston, West Virginia, we Cincinnatians were both very loyal and very polite, because if anyone had cause to raise the roof, we did. When these synthetic rubber plants began to make styrene and butadiene, actually our Cincinnati public water was so bad that when one would take a drink of hot water early in the morning, as is my custom, this habit would cause one to burp about 11:00 o'clock and the result was the creation of an atmosphere around one that would remind you of the odor emanating from an overheated, worn out truck tire.

I would like to say to you gentlemen, that this whole matter of pollution isn't one of whether we are going to get together and clean up our streams, or one of what it is going to cost, but when are we going to clean them up. Rest assured that the longer this polluting condition exists and grows, just so long will we be working in this Ohio Valley in a manner calculated to run all the people out of it. I therefore beg of you to get together with your neighbors up here at the beginning of the Ohio Valley, and begin to work on how to treat us Cincinnatians as we are about to begin treating our friends down in Louisville. This is our first job and we should drive hard to finish this portion of our good work, having in mind all the time that some industrial wastes present even a greater problem. (Mr. Heekin's statement is attached hereto as Exhibit K.)

CHAIRMAN BIERY: Thank you, Mr. Heekin. Mr. Holbrook, I believe, would like to address a question to you.

MR. HOLBROOK: As I get it, the people of Cincinnati are paying so much on their water bill, and the industries are paying --

MR. HEEKIN: Sixty per cent.

MR. HOLBROOK: You didn't say what they are paying it for.

MR. HEEKIN: For the building of our sewage disposal plants, and whatever additional sewers are required.

MR. HOLBROOK: They are paying the tax now, before they get the service?

MR. HEEKIN: That is right. One plant, however, will be in operation in October.

MR. JENNINGS: This hearing is designed to establish certain tretment standards. Do you think the proposed standards mentioned here this morning, approximately are correct?

MR. HEEKIN: If you are asking me as an engineer on the subject, I am not qualified. If you ask what I think yes.

CHAIRMAN BIERY: I think it should be observed at this time, that this is Mr. Heekin's birthday. I can't imagine a man having a more distinguished birthday party than is being enjoyed by Mr. Heekin today, with all these engineers present.

MR. HEEKIN: Thank you. We will assemble later for three cheers outside the door. (Applause and laughter.)

MR. CLEARY: Mr. Chairman, I have one more statement. That is from the Cincinnati Chamber of Commerce, presented by Douglas K. Fuller, who could not be here. The statement is in the hands of Mr. Waring.

MR. WARING: The communication is dated March 30, from Douglas K. Fuller, executive vice-president, Cincinnati Chamber of Commerce, directed to the Commission.

(Reading) "Your commission is holding a public hearing in Pittsburgh, Pennsylvania, commencing ten o'clock March 31, 1953, for the purpose of establishing the degree of treatment to be given sewage discharged into the Ohio River between Pittsburgh, Pa. and Huntington, W. Va. It will be appreciated if you will incorporate this communication in the record of the above hearing.

"For more than twenty years the Cincinnati Chamber of Commerce has continuously and assiduously promoted the cause of stream sanitation in the Ohio

Valley Watershed. This long continued effort culminated in the signing of the Ohio River Valley Water Sanitation Compact on June 30, 1948, when the Governors, Secretaries of State and Compact Commissioners from the signatory states met in Cincinnati for the ceremonial signing of this historic document.

"Subsequent to the signing of the Compact, the Cincinnati Chamber of Commerce has continued to support the cause of stream sanitation. We worked actively for the passage of Senate Bill 62 in the 99th General Assembly of Ohio. This Act established the Ohio Water Pollution Control Board which, since its inception, has done much to strengthen Ohio's control of pollution and has advanced the planning and construction of Treatment Works in this state. We have also continued to be active in our own community. Substantial progress in this community has been made toward providing facilities for the treatment of wastes, both residential and industrial, to meet the standards established by your Commission.

"On May 12, 1948, City Council of the City of Cincinnati passed an Ordinance, No. 195 - 1948, fixing rates to be charged for the use of its Sewerage System and Treatment Works and providing funds for the construction, management, operation and maintenance of the Sewerage System Treatment & Disposal Works.

"Twenty-two political subdivisions in Hamilton County have agreed to cooperate by discharging their wastes throught the facilities of the Cincinnati System, so that a substantial majority of the communities in Hamilton County are thus meeting their obligation to cease pollution of the streams. The charges imposed by Ordinance No. 195 - 1948, above referred to, first were imposed beginning July 1, 1948 and from that date to June 30, 1952, the collections under that Ordinance had amounted to more than seven and a half million dollars.

"On January 21, 1953, the City Council of the City of Cincinnati passed Ordinance No. 24 - 1953, modifying the previous Rate Ordinance by increasing the charges in an amount estimated to meet the increased cost of constructing the necessary facilities.

"On the same date the Council of the City of Cincinnati passed an Ordinance, No. 25 - 1953, authorizing and directing the City Manager to make and enforce rules and regulations governing the discharge of sewage, industrial wastes and other matter, establishing surcharges, etc. Under the Ordinance, rules and regulations for the handling of industrial wastes and the charges therefor have been established.

"The first of the disposal works in the Cincinnati area, The Little Miami Sewage Treatment Plant, with a capacity of 29,000,000 gallons daily, is practically complete - at a cost in excess of $5,000,000. It is expected that this plant will be placed in operation within the next few months. A second plant, known as the Mill Creek Sewage Treatment Plant, Is in the final stages of design. A site for this facility has been acquired and the contract for grading of the site is to be let within the next few weeks.

"The engineering estimate for the cost of this second Treatment Plant is approximately $22,000,000. The Division of Engineering in the Department of Public Works of the City of Cincinnati estimates that the cost of the complet sewage disposal program for this community will be approximately $47,000,000.

"It may be seen from this recital of facts that the Cincinnati area is making substantial, rapid and continuing progress toward abating its pollution of the Ohio River and its tributaries. While these local works in this community are of some direct benefit to this community, their major benefit is to the communities lying to the west, downstream from us. We, in turn, will receive maximun benefits from the Pollution Control Program only when our friends and neighbors to the east - upstream, do their part toward controlling the pollution generated in their local communites. It is our sincere hope that these friends and neighbors upstream will come to grips with their local problems promptly, will firmly resolve to do their share toward the common objective of providing and uncontaminated and useable water supply for all the inhabitants and for all the industry in the Ohio Valley." (Mr Fuller's statement is attached hereto as Exhibit L.)

CHAIRMAN BIERY: Thank you, Mr. Waring.

It is the opinion of the hearing board that we might conceivably finish if we go straight through until one o'clock. If we can do that, it would be better than to adjourn and come back and have another session this afternoon. To that end, we shall move forward.

There are several gentlemen here who wish to make statements, and maybe some who have not indicated whether or not they wish to make a statement, but I am going to ask Mr. Anderson of Coraopolis, Pa. to make a statement.

MR. ANDERSON: I just had a question; it was answered by Mr. Horton, that the requirements of the State of Pennsylvania conform to the requirements of the Commission. Thank you.

CHAIRMAN BIERY: You feel that the proposals are in harmony with your ideas about what should be done?

MR. ANDERSON: Yes.

CHAIRMAN BIERY: There are two gentlemen here from Ambridge, Pennsylvania. Mr. Rapp, of the Municipal Sewage Authority, I am wondering if you would like to make a statement? Is Mr. Rapp here? He was here.

There is another gentleman here from Ambridge, Mr. Culleton, Chief Engineer of the National Supply Company. Does Mr. Culleton have any observations?

Mr. Thomas is here, of the City of Wheeling Sewer Commission. Does Mr. Thomas care to make any observation?

MR. THOMAS: I want to call on the Mayor.

CHAIRMAN BIERY: We'd be very happy to hear the Mayor.

MAYOR CHARLES J. SCHUCK: This has been an exceedingly interesting meeting so far as we are concerned, particularly by reason of the fact that we find ourselves just at the present time in the very midst of endeavoring to put ourselves in position where we at least would not be violating any decree of the U. S. Supreme Court and would be complying with that in every way in carrying on the work that we have.

We comtemplate very shortly, to have an issue of bonds in the sum of $7,500,000, which is as you know somewhat large for a city the size of Wheeling, but yet we expect to put that proposition through. We expect to have it raised by the necessary sewerage charge that will parallel to a degree our present water charges. What that percentage may be, we have not yet figured in its entirety, but this contemplates an entire new sewerage system for Wheeling; it contemplates the erection of a reduction plant that would probably entail an expense of over two millions of dollars.

In that way, we are moving forward to a place where we now have complied with everything so far as the West Virginia law is concerned and we think the Federal regulations as well. We are now waiting on the report of our financial agents and the moment that is obtained we are ready to move in to council. Then with the necessary enabling ordinances with which this project will be put in operation, we hope by the fall we will begin to break ground, so to speak, for a new sewerage system in Wheeling.

We are hoping, then, when we do this thing, those to the north and south will likewise do their duty, or it won't do very much good for us to do ours.

Of course at the present time we are cleaning up ourselves. We have two swimming pools now; we have four under construction at the present time. No matter what you may have heard this morning about Wheeling, we are at least going to try to be as clean as we can.

CHAIRMAN BIERY: We are very happy to have that constructive statement in the record.

Mr. Ewing is here from Wheeling. Mr Ewing represents A. E. Masten & Company, investment bankers.

MR. EWING: I am with A. E. Masten and Company. We have been acting as financial consultants for the City of Wheeling with their proposed bond issue and financing.

I just thought if there were any other sanitary boards and commissions that like to talk to us, we'd be glad to answer any of their questions and help them without any obligation to a certain point. Thank you. (Laughter)

CHAIRMAN BIERY: Thank you. No doubt there will be much conversation with men like you. We really ought to charge you for a commercial. (Laughter) Under the circumstances, we are very happy to have your statement.

Mr. Scheehle, I believe, of Martins Ferry, is here.

MR. SCHEEHLE: The only question I have gentlemen, is, are there any outside funds available in this valley to build a sewage treatment plant?

CHAIRMAN BIERY: You mean Federal money?

MR. SCHEEHLE: Yes.

CHAIRMAN BIERY: Not over which we have any jurisdiction. I am afraid there isn't. To answer you question, Public Law 845, I think, had $22,500,000.

That much money was authorized but not appropriated. About the only effect of it was to hold forth vain hope to a good many municipalities that they might somehow get some of it. Since it was not appropriated and since the bill which did carry sizable Federal grants several years ago was vetoed, there probably is no fund from which help can be drawn at the present time. I believe it is a fact however, that the revenue bond type of investment is looked upon with much favor throughout the country, and we gather the impression from many situations that that method of financing will solve a great many community problems. We commend that for your investigation. I wish we could give you a little more encouragement.

There are three gentlemen here from the Weirton Steel Company. While we are not considering industrial wastes at this hearing, if any one of them have any observations, we should be happy to have them.

MR. MUNNS: Are you looking at me?

CHAIRMAN BIERY: You are in the middle.

MR. MUNNS: We are cooperating as you know with you gentlemen in every way. Mr. Sample here, our chief chemist, attends all your meetings and is here now. Do you have something to say?

MR. SAMPLE: Mr. Chairman, he is too large for me to argue with, but I think that the hearing is going along mighty fine. I am glad to hear the statements on policies and also on the amounts that will be permitted to be put in the river. Thank you.

CHAIRMAN BIERY: We could call the roll of the cities in West Virginia and Ohio and Pennsylvania. That would consume still more time. If there are any cities that would like to be heard now, this would be an appropriate time. I am just giving general invitation for anyone representing a city in any of the three states to make any statement that you might care to make.

MR. MUNNS: Mr. Chairman, we also represent the City of Weirton. Our president is mayor of the city. Mr. Strassburger may want to comment along those lines.

CHAIRMAN BIERY: That ought to give Weirton a pretty good representation.

MR. STRASSBURGER: We were asked to represent both the city and company at this hearing.

Mr. Sample said we are interested in the regulations proposed, and I believe that the control measures are sound and good from an engineering standpoint. We will certainly transmit the information from this meeting to the city authorities.

CHAIRMAN BIERY: Are there any other interested parties who might like to be heard at this time?

MR. MOSES: Probably Mr. Laboon could bring you up to date as to the exact situation.

MR. LABOON: He is talking about what is being carried on by the cities upstream from Pittsburgh.

MR. MOSES: I said in my former remarks this was a state-wide program, and the same considerations apply in all the rest of the watershed, the Ohio watershed, which is about 16,000 square miles, as apply in this valley. There may be a difference in the degree of treatment, depending on the conditions, but the work in the upper part of the basin is going ahead comparably and parallel with the work at this particular point.

Is that whay you had in mind sir?

MAYOR SCHUCK: I was wondering what if anything was being done. I heard your report before, but it just went to a certain degree. I was wondering whether or not this particular area here was doing everything that was to bring about prevention of further pollution, because if not, what good would it do further down the river so far as our attempt was concerned, to purify the stream?

MR. MOSES: We have two distinct things. There is a great volume of pollution in the Pittsburgh area. We explained how that is being taken care of. The plans are being finished by August or September. The watershed pact extends clear up to the New York state line. On the Ohio watershed, the towns have had orders to go ahead. Plants will be built, so there is a campanion program being carried on. The result of that would be improvement in this whole watershed.

I might add on the Beaver watershed we cleaned up everything there up to a certain point. Every municipality on that whole watershed is treating sewage, at least to a primary degree, and even beyond that. That applies to industry as well, so we point with pride to the Beaver watershed which has been known for a number of years as a place which has been cleaned, and we hope to do the same job on the remainder of the Ohio watershed.

CHAIRMAN BIERY: Are there any county commissioners here from counties of Pennsylvania, West Virginia or Ohio, who might like to have something in the record? This problem is very frequently county-wide in its scope. If there are any county commissioners who happen to have any observations for the record , we will be glad to have them.

Are there any further questions of any of the Pittsburgh witnesses before we close? Have you anything further, Mr. Cleary?

MR. CLEARY: No.

CHAIRMAN BIERY: Mr. LeFeber, anything from you?

MR. LeFEBER: No.

CHAIRMAN BIERY: Mr. Laboon?

MR. LABOON: No.

CHAIRMAN BIERY: The hearing board is grateful for the expeditious manner in which the witnesses have responded and in which the discussion has been conducted by the men who are so vitally concerned.

The Chairman would like to make one observation on the industrial situation. While we are not considering industrial waste at this hearing, and it may be some little time will elapse before we can hold formal hearings on industrial wastes, it seems to me that the record might well show that material progress is being made by the Commission in its study of many types of industrial wastes and to that end it is receiving the finest cooperation from many of the industrial concerns of the Ohio Valley.

The industrial problems are being attacked along an industry-wide basis, the Commission having authority to bring about reduction or treatment of industrial wastes. Obviously it would be impractical and rather difficult for the Commission to proceed against individual plants. That would be time-consuming and harassing both for the plant and for the Commission, so the other philosophy is being evolved to try to have industry help the Commission arrive at reasonable things that can be done within the shortest possible time, so that within a very few months we will probably embark upon some hearings that will involve industrial wastes.

I merely make that part of the record to show that there is no error here of ommission. The municipal problem moves a little more slowly on account of its exposure to the legislative process, whereas when the industrial waste problem is tackled, it will move more expeditiously under management as we know it in this country.

Mr. Cleary I think wants to supplement what I have just said.

MR. CLEARY: So that the impression doesn't get about that industry is doing nothing, the Commission could report otherwise. In one respect the Commission has enlisted the aid of almost a hundred members of industry in the Ohio Valley representing top management, who are serving on advisory boards or committees. They have been meeting for three years. A lot of progress has been made toward the time when hearings will be held to establish requirements for treatment. More importantly, industry is not standing by, at least not progressive industry. Where known methods and applications can be made, such work is moving forward.

There are two men in the audience, Mr. Chairman, who represent companies that already are spending considerable sums of money. I wonder if Mr. Shannon of the Koppers Company would like to say something about the work they are doing at Follansbee to reduce that tremendous load of phenol.

MR. SHANNON: I have no statement to make. I haven't come to make any statement. We do expect to have a plant in operation about the first of the year which will virtually remove all of our phenol contamination.

CHAIRMAN BIERY: Anything further, Mr. Cleary?

MR. CLEARY: I don't know wheter Mr. George Dreher is here of Jones & Laughlin. Is Mr. Dreher in the audience? Would you like to say something about J. & L.?

MR. DREHER: We have just recently completed the engineering, and the appropriation is going through our management committee for -- I don't know the exact figures, but it is over a million and a half now. There will be an added appropriation to that later which will bring it up to two million for acid disposal systems in Pittsburgh and Aliquippa, which shows we are really doing something about the problem. We know there is still acid in the stream, we don't believe any acid is good.

MR. CLEARY: The point I want to make is that by the time the towns get their treatment plants built, I think the industries will be in pace with them.

MR. JENNINGS: Since you have opened it, why not list the committees?

MR. CLEARY: The industry committees now working with the Commission -- there would be more if the staff were large enough to service them -- include the Steel Industry Action Committion, the Metal Finishing Action Committee, the Chemical Salts Committee, the Organic Chemicals Committee, the Distillery Committee, the Bituminous Coal Advisory Committee and the Oil Refining Committee. The total membership is close to one hundred on these committees, and as one of our magazines recently pointed out, top management has sent in its first team to aid the Commission in coming to grips with problems in probably one of the most complex river systems in the world, and certainly one of the most heavily polluted areas.

CHAIRMAN BIERY: Have you any further observations, Mr. Jennings?

MR. JENNINGS: None.

CHAIRMAN BIERY: Dean Holbrook, anything further?

MR. HOLBROOK: I was just thinking, Mr. Chairman, that this hearing has done one thing for me. It has established very definitely in my mind that this is an interstate and not an intrastate problem. For the first time I think I have gripped that solidly.

CHAIRMAN BIERY: Mr. Weakley, have you any Observation?

MR. WEAKLEY: No.

CHAIRMAN BIERY: As soon as practical, after the completion of the hearing, the Board will review the testimony and the evidence. A complete record will be made. The hearing board is required to make its recommendations to the Commission, the Commission will review the whole mass of data that has been supplied, and if there should be any further additions to the record that any of the engineers representing the municipalities or otherwise would like to make to the record, they may be included to to the 15 of April.

We are very anxious that there be no mistakes made in the administration of this program. The Commission is very anxious that there be no mistakes made. It is just as bad to be overenthusiastic as it is to be pessimistic in dealing with the money that has to be spent for treatment plants. Our responsibility to the taxpayer is just as great if the plant is inadequate and has to be shortly rebuilt or enlarged, as it if if the municipality is required to build much more expensive plants than are needed under the circumstances.

I want to assure you the Commission is extremely anxious that we proceed along sound lines, and we value highly the observations of you men in the field who are struggling with this problem from day to day.

We want to thank you again for your participation in the hearing, and unless there is somthing further, we will stand adjourned.

(Whereupon at 12:30 o'clock p.m., the hearing was adjourned.)

EXHIBIT A

OHIO RIVER VALLEY WATER SANITATION COMMISSION

NOTICE OF PUBLIC HEARING

Pursuant to authority contained in Article VI of the Ohio River Valley Water Sanitation Compact, and pursuant to direction of the Ohio River Valley Water Sanitation Commission as contained in a resolution duly adopted at a regular meeting held on the 28th day of January, 1953, a public hearing will be held by the Commission at Courtroom No. 6, sixth floor, U. S. Post Office and Court House (New), Seventh Avenue and Grant Street, Pittsburgh, Pennsylvania, commencing at 10:00 A. M. o'clock on the 31st day of March, 1953, and continuing thereafter until completed. The purpose of said hearing will be to obtain and record data, information and other evidence for use by the Commission in determining the degree of treatment which shall be given to sewage discharged or permitted to flow into the waters of the Ohio River in that stretch extending from the point of confluence of the Allegheny and Monongahela Rivers at Pittsburgh, Pennsylvania, designated as mile point 0.0, to U. S. Corps of Engineers Dam No. 27, located about five miles upstream from Huntington, West Virginia, and being 301.0 miles downstream from Pittsburgh, Pennsylvania.

Any and all parties whose interests may be affected by such determination are invited to be present or to be represented at the hearing to be held as above stated. All interested parties present or represented at said hearing will be given an adequate opportunity to express either orally or in writing, their views upon the issues there to be considered.

Interested parties who desire additional information concerning the conduct of this hearing or who desire information with regard to evidence, views or recommendations which are to be submitted at such hearing are requested to call at the offices of the Ohio River Valley Water Sanitation Commission, 302 Mercantile Library Building, 414 Walnut Street, Cincinnati, Ohio. On and after the 9th day of March, 1953, there will be on file and available for examination at the offices of the Commission, located as above stated, copies of the report of the Commission covering its investigation of the treatment requirements for sewage discharged or permitted to flow into the stretch of the Ohio River as above defined and including recommendations with regard to the degree of treatment which should be established for such sewage.

OHIO RIVER VALLEY WATER SANITATION COMMISSION

By E. Blackburn Moore, Chairman

February 27, 1953

EXHIBIT B

CERTIFICATION OF PUBLICATION AND DISTRIBUTION OF NOTICE OF PUBLIC HEARING TO BE HELD IN PITTSBURGH, PA. MARCH 31, 1953.

I, Robert K. Horton, hereby certify that the notice of public hearing attached hereto (said hearing to be held in Pittsburgh, Pennsylvania, March 31, 1953) was published and distributed in accordance with the following schedule:

(a) Notice was published as a paid advertisement in the newspapers and on the dates indicated in attached List No. 1. Affidavits of publication are on file in the Commission offices.

(b) Notices were mailed March 6, 1953, to one or more city officials (officials being Clerk of Council, City Manager, and/or City Engineer as indicated) of the cities and towns indicated on attached List No. 2; these cities and towns being those located along that section of the Ohio River with which the Hearing is concerned as indicated by the U.S. Corps of Engineers Ohio River Navigation Charts (latest available), the Rand McNally Commercial Atlas and Marketing Guide (83rd edition, 1952), and the Rand McNally Road Atlas (1951 edition) -- (post-office locations determined from U.S. Official Postal Guide, Part I Domestic, July 1951).

(c) Notices were mailed March 6, 1953, to the Boards of County Commissioners of the counties shown on attached List No. 3; these counties being those bordering that section of the Ohio River with which the Hearing is concerned.

(d) Notices were mailed March 6,1953, to municipal organizations shown on attached List No. 4; these organizations being Chambers of Commerce, Boards of Trade and Business Associations at places located along that section of the Ohio River with which the Hearing is concerned (these organizations are listed in a directory published July 1952 by the Chamber of Commerce of the State of New York).

(e) Notices were mailed March 6, 1953, to the Leagues of Municipalities of the three states concerned (Pennsylvania, Ohio and West Virginia); names of these Leagues are indicated on attached List No. 5.

(f) Notices were mailed March 6, 1953, to those industrial concerns shown on attached List No. 6. This list shows those industries known or reported by the State Sanitary Engineers as discharging or which might possibly discharge liquid wastes directly into the section of the Ohio River involved, and includes some, but not all, of the industrial concerns located within the City of Pittsburgh, Pennsylvania.

(g) Notices were mailed March 6, 1953, to certain trade associations as shown on attached List No. 7; these associations being selected from state directories as those whose members most likely would be interested in or affected by the hearing.

(h) Notices were mailed March 6, 1953, to the Attorneys General of Pennsylvania, Ohio and West Virginia. Names of Attorneys General are indicated on attached List No. 8.

(i) Notices were mailed March 6, 1953, to state agencies of Pennsylvania, Ohio and West Virginia as shown on attached List No. 9. These agencies include state water pollution control agencies, state departments of health and others.

/s/ Robert K. Horton

STATE OF OHIO, COUNTY OF HAMILTON: SS:

ROBERT K. HORTON, being first duly sworn, says that the allegations contained in the foregoing certificate are true.

/s/ Robert K. Horton

Sworn to before me and subscribed in my presence this 24th day of March, 1953.

/s/ Verna B. Ballman
Notary Public
Hamilton County, Ohio

List No. 1

NEWSPAPERS

Name of Newspaper	Place of Publication	Dates of Publication
Post-Gazette	Post-Gazette Publishing Co. 110 Grant Street Pittsburgh, Pennsylvania	3-9-53, 3-16-53
Beaver Valley Times	Beaver newspapers, Inc. Beaver, Pennsylvania	3-9-53, 3-16-53
Review	Brush-Moore Newspapers, Inc. 210 East 4th Street East Liverpool, Ohio	3-9-53, 3-16-53
Times	Weirton Printing & Publishing Co. Weirton, West Virginia	3-9-53, 3-16-53
Herald-Star	Brush-Moore Newspapers, Inc. Steubenville, Ohio	3-9-53, 3-16-53
News-Register	H. C. Ogden 15th & Main Streets Wheeling, West Virginia	3-9-53, 3-16-53
Echo	Craig Shaw Moundsville, West Virginia	3-9-53, 3-16-53
Wetzel Republican	Wetzel Republican New Martinsville, West Virginia	3-6-53, 3-13-53
Times	Times Co. Marietta, Ohio	3-9-53, 3-16-53
Sentinel	C. F.Wiemer Pomeroy, Ohio	3-9-53, 3-16-53
Tribune	The Gallipolis Publishing Co. Gallipolis, Ohio	3-9-53, 3-16-53
Advertiser	Huntington Publishing Co. Huntington, West Virginia	3-9-53, 3-16-53

LIST NO. 2 -- TOWNS AND CITIES

Code
cc = Clerk of Council
cm = City Manager
ce = City Engineer

PENNSYLVANIA

Allegheny County

McKees Rocks, cc, cm, ce
Allegheny County Sanitary Authority
- Aspinwall (Pittsburgh), cc, cm
- Avalon (Pittsburgh), cc, cm, ce
- Bellevue (Pittsburgh), cc, cm, ce
- Ben Avon (Pittsburgh), cc, cm
- Ben Avon Heights (Pittsburgh), cc
- Braddock, cc, cm, ce
- Brentwood (Pittsburgh), cc, cm, ce
- Bridgeville, cc, cm, ce
- Castle Shannon (Pittsburgh), cc,cm,ce
- Carnegie, cc, cm, ce
- Chalfant (East Pittsburgh), cc
- Crafton (Pittsburgh), cc, cm, ce
- Churchill (Wilkinsburg), cc, cm
- Dormont (Pittsburgh), cc, cm, ce
- East McKeesport, cc, cm
- East Pittsburgh, cc, cm, ce
- Edgewood (Pittsburgh), cc, cm, ce
- Emsworth (Pittsburgh), cc, cm
- Etna (Pittsburgh), cc, cm, ce
- Forest Hills (Pittsburgh), cc, cm, ce
- Fox Chapel (Sharpsburg), cc, cm
- Greentree (Wabash), cc, cm
- Heidelburg (Post Office name is Loupurex), cc, cm
- Homestead, cc, cm, ce
- Ingram (Pittsburgh), cc, cm
- Millvale (Pittsburgh), cc, cm, ce
- Mt. Lebanon (Pittsburgh), cc, cm, ce
- Mt. Oliver (Pittsburgh), cc, cm, ce
- Munhall (Homestead), cc, cm, ce
- North Braddock (Braddock), cc, cm, ce
- Pitcairn, cc, cm, ce
- Pittsburgh, cc, cm, ce
- Rankin (Braddock), cc, cm, ce
- Rosslyn Farms (Carnegie), cc
- Sharpsburg (Pittsburgh), cc, cm, ce
- Stowe (McKees Rocks), cc, cm, ce
- Thornburg (Pittsburgh), cc
- Trafford (Note: West Moreland County), cc, cm
- Turtle Creek, cc, cm, ce
- Verona, cc, cm
- Wall, cc, cm
- West Homestead (Homestead), cc, cm

Allegheny County Sanitary Authority (continued)
- West Mifflin (Homestead),cc,cm,ce
- West View (Pittsburgh), cc, cm, ce
- Whitaker (Homestead), cc, cm
- Wilkinsburg (Pittsburgh),cc,cm,ce
- Wilmerding, cc, cm, ce
- Woodville State Hospital (Supt.)

Clifton (Bridgeville), cc
Oakland (Pittsburgh)
Neville Island (Pittsburgh), cc
Dixmont, cc
Dixmont State Hosp. (Dixmont) (Supt.)
Glenfield, cc
Haysville (Pittsburgh), cc
Coraopolis, cc, cm, ce
Osborne (Sewickley), cc
Sewickley, cc, cm, ce
Stoops Ferry (Coraopolis), cc
Edgeworth (Sewickley), cc, cm
Shields (Sewickley), cc
Leetsdale, cc, cm

Beaver County

South Heights, cc
Ambridge, cc, cm, ce
West Economy (Aliquippa), cc
Economy (Ambridge), cc
Aliquippa, cc, cm, ce
Baden, cc, cm
Conway, cc, cm
Freedom, cc, cm
Monaca, cc, cm, ce
Colona (Monaca), cc
Rochester, cc, cm, ce
West Bridgewater (Corporation name is Bridgewater), cc, cm
Beaver, cc, cm, ce
Federal Housing Project (Beaver)(Supt.)
Vanport, cc
Merrill (Beaver), cc
Kobuta (Monaca) cc
Industry, cc
Shippingport, cc
Midland, cc, cm, ce
Georgetown, cc
Smiths Ferry (Corporation name is Glascow), cc

WEST VIRGINIA

Hancock County
Chester, cc, cm
Newell, cc, cm
Congo (Newell), cc
Arroyo (new Cumberland), cc
Moscow (New Cumberland), cc
New Cumberland, cc, cm
East Toronto or Yalia(New Cumberland), cc
Weirton, cc, cm, ce

Brooke County
Follansbee, cc, cm
Wellsburg, cc, cm, ce
Cross Creek (Wellsburg), cc, cm
Beechbottom, cc
Power, cc
Short Creek, cc

Ohio County
Wheeling, cc, cm, ce

Marshall County
Benwood, cc, cm
McMechen, cc, cm
Glendale, cc, cm
Moundsville, cc, cm, ce
West Virginia State Penitentiary (Moundsville) (Supt.)
McKeefrey (Moundsville), cc
Captina, cc
Woodlands, cc
Graysville Sta. (Captina), cc
Clarington Sta. (proctor, Wetzel Cty.), cc

Wetzel County
Proctor, cc
Steelton (New Martinsville), cc
Hannibal Sta. (Hannibal, Ohio), cc
New Martinsville, cc, cm
Mendota Sta. (New Martinsville), cc
Paden City, cc, cm

Tyler County
Sistersville, cc, cm
Cochransville Sta. (New Matamoras, Ohio), cc
Friendly, cc
Long Reach (Bens Run), cc

Pleasants County
Bradley or Spring Run (St.Mary's),cc
Ravenrock, cc
Grape Island Sta. (St. Mary's), cc
St. Mary's, cc, cm
Vancluse Sta. (st. Mary's), cc
Belmont, cc
Eureaka, cc
Willow Island Sta., cc

Wood County
Waverly, cc
Compton (Williamstown), cc
Boaz (Williamstown), cc
Briscoe or Briscoe Run (Parkersburg)
Vienna (Parkersburg), cc, cm, ce(cc
Parkersburg, cc, cm, ce
Walkers Crossing Sta., cc
New England, cc
Harris Ferry (New England), cc
Lee Creek (Belleville), cc
Humphrey (Belleville), cc
Belleville, cc
Pond Creek (Belleville), cc

Jackson County
Lone Cedar (Belleville), cc
Murraysville, cc
Morgan (Murraysville), cc
Portland Sta. (Murraysville), cc
Sherman, cc
Ravenswood, cc, cm
Pleasant View (Ravenswood), cc
Willow Grove (Millwood), cc
Millwood, cc
Mt. Alto, cc

Mason County
Letart, cc
Longdale (Letart), cc
Grahams Sta. (Letart), cc
New Have, cc
Hartford, cc
Mason City, cc
Clifton, cc
West Columbia, cc
Hallwood or Spilman (West Columbia),cc
Lakin, cc
West Virginia School and Hosp.(Lakin) (Supt.)

Mason County (continued)
York Sta. (West Columbia), cc
Pt. Pleasant, cc, cm
Henderson, cc
Gallipolis Ferry, cc
Elwell (Hogsett), cc
Ben Lomond (Hogsett), cc
Hogsett, cc
Apple Grove, cc
Mercers Bottom (Apple Grove), cc
Ashton, cc
Glenwood Sta., cc

Cabell County
Crown City Sta. (Lesage), cc
Greenbottom (Lesage), cc
Millersport Sta. (Lesage), cc
Lesage, cc
Cox Landing (Lesage), cc

OHIO

Columbiana County
East Liverpool, cc, cm, ce
Wellsville, cc, cm, ce

Jefferson County
Yellow Creek (Wellsville), cc
Port Homer (Toronto), cc
Stratton, cc
Empire, cc
Toronto, cc, cm, ce
Costonia (Toronto), cc
Allikanna (Steubenville), cc
Steubenville, cc, cm, ce
Mingo Junction, cc, cm
Brilliant, cc, cm
Salt Run (Brilliant), cc
Rush Run, cc
Warrenton (Rayland), cc
Rayland, cc
Tiltonville, cc, cm
Yorkville, cc, cm

Belmont County
Martins Ferry, cc, cm, ce
Aetnaville (Bridgeport), cc
Bridgeport, cc, cm
West Wheeling (Bellaire), cc
Bellaire, cc, cm, ce
Shadyside, cc, cm
Wegee (Bellaire), cc
Dilles Bottom (Jacobsburg), cc
Powhatan Point, cc, cm

Monroe County
Clarington, cc
Hannibal, cc
Duffy (Sardis), cc
Sardis, cc
Fly, cc

Washington County
New Matamoras, cc
Grandview, cc
Wade, cc
Newport, cc
Newell Run (Newport), cc
Reno, cc
Marietta, cc, cm, ce
Gravel Bank (Marietta), cc
Constitution, cc
Briggs (Belpre), cc
Belpre, cc, cm
Rockland, cc
Center Belpre, cc
Little Hocking, cc

Athens County
Hockingport, cc

Meigs County
Reedsville, cc
Long Bottom, cc
Portland, cc
Apple Grove (Racine), cc
Letart Falls, cc
Antiquity (Racine), cc
Racine, cc
Syracuse, cc
Minersville, cc
Pomeroy, cc, cm
Middleport, cc, cm, ce
Hobson (Middleport), cc

Gallia County
Cheshire, cc
Addison, cc
Kanauga, cc
Kanauga State Hospital (Supt.)
Gallipolis, cc, cm, ce
Chambersburg (Bladen), cc
Bladen, cc
Swan Creek (Bladen), cc
Crown City, cc

Lawrence County
Miller, cc
Athalia, cc

NOTE: Mailing addresses for towns and cities without post offices are indicated in parentheses.

LIST NO. 3

COUNTIES AND COUNTY SEATS NOTIFIED OF PUBLIC HEARING

Example: Board of County Commissioners
Allegheny County
Pittsburgh, Pennsylvania

STATE	COUNTY	COUNTY SEAT
Pennsylvania	Allegheny	Pittsburgh
	Beaver	Beaver
West Virginia	Hancock	New Cumberland
	Brooke	Wellsburg
	Ohio	Wheeling
	Marshall	Moundsville
	Wetzel	New Martinsville
	Tyler	Middlebourne
	Pleasants	St. Mary's
	Wood	Parkersburg
	Jackson	Ripley
	Mason	Point Pleasant
	Cabell	Huntington
Ohio	Columbiana	Lisbon
	Jefferson	Steubenville
	Belmont	St. Clairsville
	Monroe	Woodsfield
	Washington	Marietta
	Athens	Athens
	Meigs	Pomeroy
	Gallia	Gallipolis
	Lawrence	Ironton

LIST NO. 4

MUNICIPAL ORGANIZATIONS

Pennsylvania	
McKees Rocks	Chamber of Commerce
Bellevue	North Boroughs Chamber of Commerce
Braddock	Community Board of Trade
Carnegie	Chamber of Commerce
Crafton	Business Mens Association
Etna	Business Association
Homestead	Chamber of Commerce of the Homestead District
Pitcairn	Board of Trade
Pittsburgh	Allied Boards of Trade of Allegheny County
	Chamber of Commerce of Pittsburgh
	East Pittsburgh Businessmens Assoc.
	Forest Hills Civic Club
	Mt. Oliver Merchants Association
Sharpsburg	Chamber of Commerce
Turtle Creek	Board of Trade
West View	Chamber of Commerce
Wilkinsburg	Chamber of Commerce
Wilmerding	Chamber of Commerce
Oakland	Board of Trade
Coraopolis	Chamber of Commerce
Sewickley	Sewickley Valley Board of Trade
Ambridge	Chamber of Commerce
Aliquippa	Chamber of Commerce
Monaca	Board of Trade
Rochester	Chamber of Commerce
Beaver	Board of Trade
Midland	Board of Trade
West Virginia	
Weirton	Chamber of Commerce
Wellsburg	Chamber of Commerce
Wheeling	Ohio Valley Board of Trade
Moundsville	Chamber of Commerce
New Martinsville	Chamber of Commerce
St. Mary's	Chamber of Commerce
Parkersburg	Board of Commerce
Pt. Pleasant	Chamber of Commerce
Ohio	
East Liverpool	Chamber of Commerce
Wellsville	Chamber of Commerce
Steubenville	Chamber of Commerce
Martins Ferry	Board of Trade
Bellaire	Board of Trade
Marietta	Chamber of Commerce
Gallipolis	Chamber of Commerce

LIST NO. 5

LEAGUE OF MUNICIPALITIES

Pennsylvania

Mr. C. F. LeeDecker, Secretary
Pennsylvania State Association of Boroughs
130 Sparks Building
State College, Pennsylvania

Mr. Claude C. Fogelman, Secretary-Treasurer
Pennsylvania Municipal Authorities Association
1717 Main Street
Northampton, Pennsylvania

Mr. Walter Greenwood, Executive Director
League of Cities of the Third Class in Pennsylvania
Room 302, Municipal Building
Harrisburg, Pennsylvania

West Virginia

Mr. Pat E. Maloney, Executive Secretary
West Virginia League of Municipalities
P. O. Box 3141
Charleston, West Virginia

Ohio

Mr. Allen E. Pritchard, Jr., Executive Director
The Ohio Municipal League
55 East State Street
Columbus 15, Ohio

LIST NO. 6

INDUSTRIES NOTIFIED

Addressed to the General Manager of the following companies:

Pennsylvania

The National Supply Co., Spang Chalfant Div., Ambridge, Pa.
H. H. Robertson Co., Ambridge, Pa.
National Electric Products Co., Ambridge, Pa.
Wyckoff Steel Co., Ambridge, Pa.
General Motors Corp., Fisher Body Div., Ambridge, Pa.
A. M. Byer, Co., Ambridge, Pa.
Jones & Laughlin Steel Corp., Aliquippa, Pa.
Pennsylvania Railroad, Conway Borough, Pa.
Freedom Valvoline Oil Works, Freedom Borough, Pa.
Pittsburgh Tube Co., Monaca, Pa.
Pittsburgh Screw & Bolt Corp., Pittsburgh 30, Pa.
Pittsburgh Screw & Bolt Corp., Colonial Div., Monaca, Pa.
Colonial Steel Corp., Div. of Vanadium Corp. of America, Monaca, Pa.
Pittsburgh Tool Steel Wire Co., Monaca, Pa.
St. Joseph Lead Co. of Pa., Monaca 7, Pa.
Koppers Co., Phthalic-Anhydride Plant, Monaca, Pa.
Koppers Co., Kobuta Plant, Monaca, Pa.
Pittsburgh Crucible Steel Co., Midland, Pa.
Pittsburgh Coke and Chemical Co., Grant Bldg., Pittsburgh, Pa.
Gulf Oil Corp., Neville Island, Pa.
The Neville Co., Neville Island, Pittsburgh 25, Pa.
Dravo Corp., Pittsburgh 25, Pa.
Marcus Ruth Jerome Co., Neville Island, Pittsburgh 25, Pa.
Frick and Lindsay Co., Sandusky & Robinson Sts., Pittsburgh 12, Pa.
Air Reduction Sales, 925 Liberty Ave., Pittsburgh 22, Pa.
Vilsack Fisher Co., Neville Island, Pittsburgh 25, Pa.
The Vulcan Detinning Co., P. O. Branch 25, Pittsburgh, Pa.
The Pittsburgh Barrel & Drum Co., Neville Island, Pittsburgh 25, Pa.
Standard Steel Spring Co., Coracpolis, Pa.
Lewis Foundry and Machine Co., Div. of Blaw-Knox Co., Box 1586, Pittsburgh 30,Pa
Continental Foundry & Machine Co., Coraopolis, Pa.
Russell-Birdsall & Ward, Bolt & Nut Co., Coraopolis, Pa.
West Penn Mirror Inc., Taylor Township, Pa.
Babcock & Wilcox Tube Co., West Mayfield Twp., Pa.
Moltrop Steel Products Co., Beaver Falls, Pa.
Armstrong Cork Co., Beaver Falls, Pa.
Republic Steel Corp., Beaver Falls, Pa.
Ingram-Richardson Mfg. Co., Beaver Falls, Pa.
Townsend Co., Fallston Borough, Pa.

West Virginia

Harker Pottery Co., Chester W. Va.
Taylor, Smith & Taylor, 8th & Phoenix Ave., Chester W. Va.
The Edwin M. Knowles China Co., 5th & Harrison Sts., Newell, W. Va.
Homer Laughlin China Co., Newell, W. Va.
New Castle Refractories Co., Newell, W. Va.
Weirton Steel, Div. of National Steel Corp., Weirton, W. Va.

West Virginia (continued)

Koppers Co., Tar Products Division, Follansbee, W. Va.
Wheeling Steel Co., Follansbee, W. Va.
Follansbee Steel Corp., Penn & Main Sts., Follansbee, W. Va.
Wheeling Steel Co., Beech Bottom Works, Beech Bottom, W. Va.
Beech Bottom Power Co., Beech Bottom, W. Va.
Wheeling Steel Co., Ackerman Plant Warwood, W. Va.
Wheeling Steel Co., Zinc Recovery Plant, Wheeling, W. Va.
Wheeling Steel Co., Riverside Blast Furnace, Benwood, W. Va.
Wheeling Steel Co., Benwood Works, Benwood, W. Va.
Vulcan Rail and Construction Co., Benwood, W. Va.
L. Marx and Co., Glen Dale, W. Va.
Wheeling Metal and Manufacturing Co., Glen Dale, W. Va.
Triangle Conduit and Cable Co., Moundsville, W. Va.
Glyco Products Co., Inc., New Martinsville, W. Va.
Quaker State Oil Refining Co., St. Marys, W. Va.
E. I. duPont de Nemours Co., Parkersburg, W. Va.
Penn Metal Co., Parkersburg, W. Va.
Sheet Metal Specialty Co., Follansbee, W. Va.
Pillsbury Mills, Inc., Wellsburg, W. Va.
S. George and Co., Wellsburg, W. Va.
J. L. Stifel and Sons, Inc., Wheeling, W. Va.
Allied Chemical and Dye Corp., Solvay Process Div., Moundsville, W. Va.
Columbia Southern Chemical Corp., New Martinsville, W. Va.
Parkersburg Steel Co., Parkersburg, W. Va.

Ohio

Crucible Steel Co. of America, National Drawn Works, East Liverpool, Ohio
Patterson Foundry and Machine Co., East Liverpool, Ohio
Pennsylvania Railroad Yard, Wellsville, Ohio
Toronto Paper Mfg. Co., Toronto, Ohio
Anco Glass Co., Inc., Toronto, Ohio
Ohio River Steel Co., Toronto, Ohio
Steubenville Pottery Co., Steubenville, Ohio
Liberty Paperboard Co., Steubenville, Ohio
Weirton Steel Co., Steubenville, Ohio
Wheeling Steel Corp., Steubenville, Ohio
Wheeling Steel Corp., Mingo Junction, Ohio
Pennsylvania Railroad Yard, Mingo Junction, Ohio
Wheeling Steel Corp., Yorkville, Ohio
Wheeling Steel Corp., Martins Ferry, Ohio
American Cyanamid Co., Calco Chemical Div., Marietta, Ohio
Broughtons Dairy, Marietta, Ohio
Electro-Metallurgical Co., Marietta, Ohio
Union Carbide and Carbon Co., Bakelite Div., Marietta, Ohio
Crow Bros. Poultry Co., Letart Falls, Ohio
Pomeroy Salt Co., Minersville, Ohio
Parkersburg Rig and Reel Co., Pomeroy, Ohio

LIST NO. 7

TRADE ASSOCIATIONS

Pennsylvania

Mr. R. T. Laing, Managing Director
Central Pennsylvania Coal Producers Association
Box 230
Altoona, Pennsylvania

Pennsylvania Manufacturers Association
Oliver Building
Pittsburgh, Pennsylvania

Mr. J. Ess, Executive Secretary
Association of Iron & Steel
Oliver Building
Pittsburgh, Pennsylvania

West Virginia

West Virginia Coal Association
1721 Kanawha Valley Building
P. O. Box 1111
Charleston, West Virginia

North West Virginia Coal Association
Box 1386
Fairmont, West Virginia

West Virginia Manufacturers Association
506 Security Building
Charleston 30, West Virginia

West Virginia Industrial and Publicity Commission
Charleston
West Virginia

Ohio

Ohio Coal Association
Rockefeller Building
Cleveland 13, Ohio

Ohio Manufacturers Association
303 Hartman Theater Building
Columbus 15, Ohio

Ohio Commercial Executives Association
Chamber of Commerce Building
Newark, Ohio

Ohio Reclamation Association
1303 Prospect Avenue
Cleveland, Ohio

LIST NO. 8

ATTORNEYS GENERAL

Pennsylvania

Hon. Robert E. Woodside
Attorney General
State of Pennsylvania
Harrisburg, Pennsylvania

West Virginia

Hon. John G. Fox
Attorney General
State of West Virginia
Charleston, West Virginia

Ohio

Hon. C. William O'Neill
Attorney General
State of Ohio
Columbus, Ohio

LIST NO.9

STATE AGENCIES

Pennsylvania

Mr. John W. Gettins, Secretary
Sanitary Water Board
Harrisburg, Pennsylvania

Mr. J. R. Harvey, Dist. Engineer
Pennsylvania State Health Dept.
Meadeville, Pennsylvania

Mr. Robt. W. Kremer, Dist. Engineer
Pennsylvania State Health Dept.
Greensburg, Pennsylvania

Mr. H. E. Moses, Consulting Chief Engr.
Pennsylvania Department of Health
Harrisburg, Pennsylvania

Mr. Francis A. Pitkin, Executive Director
Pennsylvania Planning & Development Commission
Harrisburg, Pennsylvania

Dr. Russell E. Teague, M.D., M.P.H.
Secretary, Pennsylvania Dept. of Health
Chairman, Sanitary Water Board
Harrisburg, Pennsylvania

West Virginia

Mr. H. K. Gidley, Director
Division of Sanitary Engineering
West Virginia Dept. of Health
Charleston, West Virginia

Dr. Clinton F. McClintic, Director
Conservation Commission
Third Floor, Main Unit, Capitol
Charleston, West Virginia

Mr. Robert F. Rocheleau
Executive Secretary-Engineer
State Water Commission
1709 Washington Street, East
Charleston 1, West Virginia

Ohio

Mr. G. A. Hall, Engineer-Secretary
Water Pollution Control Board
306 Ohio Depts. Building
Columbus 15, Ohio

Mr. A. W. Marion, Director
Dept. of Natural Resources
Ohio Departments Building
Columbus 15, Ohio

Mr. Fred H. Waring
Chief Engineer
Department of Health
Ohio Departments Building
Columbus 15, Ohio

EXHIBIT C

ROSTER OF ATTENDANCE

Following is list of persons attending hearing who submitted attendance-identification slips:

Mr. C. Fred Abel
Allegheny County Sanitary Authority,
Pittsburgh, Pa.

Mr. H.E. Anderson, Engineer
Corps of Engineers, U.S. Army
Pittsburgh, Pa.

Mr. J. E. Anderson
Coraopolis Municipal Sanitary Authority
Coraopolis, Pa.

Mr. M. D. Baker
West Penn Power Company
Pittsburg, Pa.

Mr. W. L. Barr
Follansbee Steel Corporation
Follansbee, West Virginia

Mr. C. H. Barrett, D.P.W.
City of Pittsburgh
Pittsburgh, Pa.

Mr. R. G.Call
American Gas & Electric Ser. Corp.
Power, W. Virginia

Mr. Joseph W. Carlson, Asst. Chief Engr.
County of Allegheny
Pittsburgh, Pa.

Mr. T. Case,Plant Engineer
A. M. Byers Co.
Ambridge, Pa.

Mr. William E.Conklin
City Attorney
Chester, W. Virginia

Mr. Edwin R. Cotton
Potomac River Commission
Washington, D.C.

Mr. J. E. Culleton, Chief Engineer
National Supply Co.
Ambridge, Pa.

Mr. Clyde C. Cupps
Standard Steel Spring Co.
Newton Falls, Ohio

Mr. G. M. Dreher
Jones & Laughlin Steel Corp.
Pittsburgh, Pa.

Mr. Donald T. Duke
East Liverpool City Water Works
East Liverpool, Ohio

Mr. Robert W. Ewing
A. E. Masten & Co.
Wheeling, W. Va.

Mr. Dale Fulton
Martins Ferry, Ohio

Mr. D. H. Gamble
Follansbee Steel Corp.
Follansbee, W. Va.

Mr. Norman A. Grondine, Watzman & Grondine, Attys. for Borough of McKees Rocks and Borough of Carnegie
Pittsburgh, Pa.

Mr. G. A. Hall
Ohio Department of Health
Water Pollution Control Board
Columbus, Ohio

Mr. D. C. Harrod
Hall Laboratories, Inc.
Pittsburgh, Pa.

Mr. J. R. Harvey, District Engineer
Pennsylvania Dept. of Health
Meadville, Pa.

Mr. Henry F. Hebley
Coal Advisory Commission
Pittsburgh, Pa.

Mr. Daniel M. Heekin
The Heekin Can Co.
Cincinnati, Ohio

Mr. E. A. Higgins
Steubenville Chamber of Commerce
Steubenville, Ohio

Mr. Donald Hissam
City of Chester
Chester, W. Va.

Mr. W. W. Hodge
Koppers Company Inc. & Mellon Institue
Pittsburgh, Pa.

Mr. G. A. Howell
U. S. Steel Corporation
Pittsburgh, Pa.

Mr. W. F. Hueston
Standard Steel Spring Co.
Coraopolis, Pa.

Mr. F. Hamiller
U. S. Steel Corporation,
Pittsburgh, Pa.

Mr. D. W. Jandevort
Spang Chalfant
Ambridge, Pa.

Mr. Lyle C. Kimple
Borough of Beaver
Beaver, Pa.

Mr. R. S. Kline
Jones & Laughlin Steel Corp.
Pittsburgh, Pa.

Mr. J. F. Laboon
Allegheny County Sanitary Authority
Pittsburgh, Pa.

Mr. Alfred LeFeber
Alfred LeBeber & Assoc.
Cincinnati, Ohio

Mr. Charles P. Mead
City of Wheeling, W. Va.

Mr. W. J. Mould
Steubenville Pottery Co.
Steubenville, Ohio

Mr. Malcolm Y. Mullen
American Bridge Div.
U. S. Steel Corp.
Ambridge, Pa.

Mr. J. J. Munns
Weirton Steel Co. and City of Weirton
Weirton, W. Va.

Mr. George E. Muns
Crucible Steel Co. of America
Pittsburgh, Pa.

Mr. Robert L. Plummer
City of Wheeling, W. Va.

Mr. Elmer N. C. Rapp
Ambridge Municipal Sewage Authority
Ambridge, Pa.

Mr. L. B. Remsen, Jr.
Hall Laboratories
Pittsburgh, Pa.

Mr. Clarence Rest
City of Steubenville
Steubenville, Ohio

Mr. L. J. Riegler
Borough of Ben Avon
Ben Avon, Pa.

Mr. Art Robinson
Ohio Water Pollution Control Board
Columbus, Ohio

Mr. William B. Rodgers
Allegheny County Sanitary Authority
Pittsburgh, Pa.

Mr. J. A. Sample
Weirton Steel Co. & City of Weirton
Weirton, W. Va.

Mr. E. L. Scheehle
Martins Ferry, Ohio

Mr. Charles J. Schuck
Wheeling Sanitary Commission
Wheeling, W. Va.

Exhibit C
Sheet 3 of 3

Mr. George M. Scott, Mayor
Chester, W. Va.

Mr. A. L. Seymour
Gannett Fleming Corddry & Carpenter
Pittsburgh, Pa.

Mr. Robert L. Shannon
Koppers Co., Inc.
Pittsburgh, Pa.

Mr. L. J. Sitomer
The Neville Co.
Pittsburgh, Pa.

Mr. Sidney C. Smith
C. C. Smith's Sons
Wheeling, W. Va.

Mr. H. A. Stobbs
Wheeling Steel Corp.
Wheeling, W. Va.

Mr. J. H. Strassburger
Weirton Steel Co. and City of Weirton
Weirton, W. Va.

Mr. David D. Taylor
City of Steubenville, Ohio

Mr. James H. Thomas
City of Wheeling Sewer Commission
Wheeling, W. Va.

Mr. A. R. Todd
Wheeling Water Works
Wheeling, W. Va.

Mr. Edward F. Twomey
Morris Knowles Inc.
Pittsburgh, Pa.

Mr. W. W. Towne
U. S. Public Health Service
Cincinnati, Ohio

Mr. Stephen Vajda
Jones & Laughlin Steel Corp.
Pittsburgh, Pa.

Mr. Myron A. Warne
Michael Baker Jr., Inc.
Rochester, Pa.

Mr. Frank M. Williamson
Gannett, Fleming Corddry & Carpenter Inc.
Pittsburgh, Pa.

OHIO RIVER

Pollution-Abatement Needs

Pittsburgh-Huntington Stretch

These findings on treatment requirements for maintaining oxygen and bacterial-quality objectives form part of the comprehensive plan of the . . .

OHIO RIVER VALLEY
WATER SANITATION COMMISSION

OHIO RIVER VALLEY
WATER SANITATION COMMISSION

414 WALNUT ST. CINCINNATI 2, OHIO

To the Chairman and
Members of the Commission

A staff study has been completed relating to water-quality conditions in the Pittsburgh-Huntington stretch of the Ohio River and directed toward determining requirements for the treatment of sewage. Findings from this study have been reviewed by your Engineering Committee and certain conclusions reached.

This report sets forth the findings and the recommendations for treatment. Since the latter calls for a degree of treatment higher than the minimum specified in the Compact the Commission authorized at its meeting of January 28, 1953, the conduct of a public hearing in accordance with procedures outlined in Article VI of the Compact. The hearing will be held in Pittsburgh, beginning on March 31. Members of the hearing board are: Ohio commissioner Hudson Biery, chairman; West Virginia commissioner W. W. Jennings; and Pennsylvania commissioner E. A. Holbrook.

Preparation of the repnrt was a joint enterprise undertaken by Robert K. Horton, staff sanitary engineer, and Harold W. Streeter, staff consultant. Mr. Streeter brought to this task the background of forty years study of pollution conconditions in the Ohio River and was the source of inspiration and direction to the staff in the conduct of this complex evaluation. Earl Philip Baker, Jr., assistant sanitary engineer, aided in the compilation of hydrologic data.

Respectfully submitted,

Edward J. Cleary

EDWARD J. CLEARY
Executive Director
and Chief Engineer

March 1, 1953
Cincinnati, Ohio

Contents

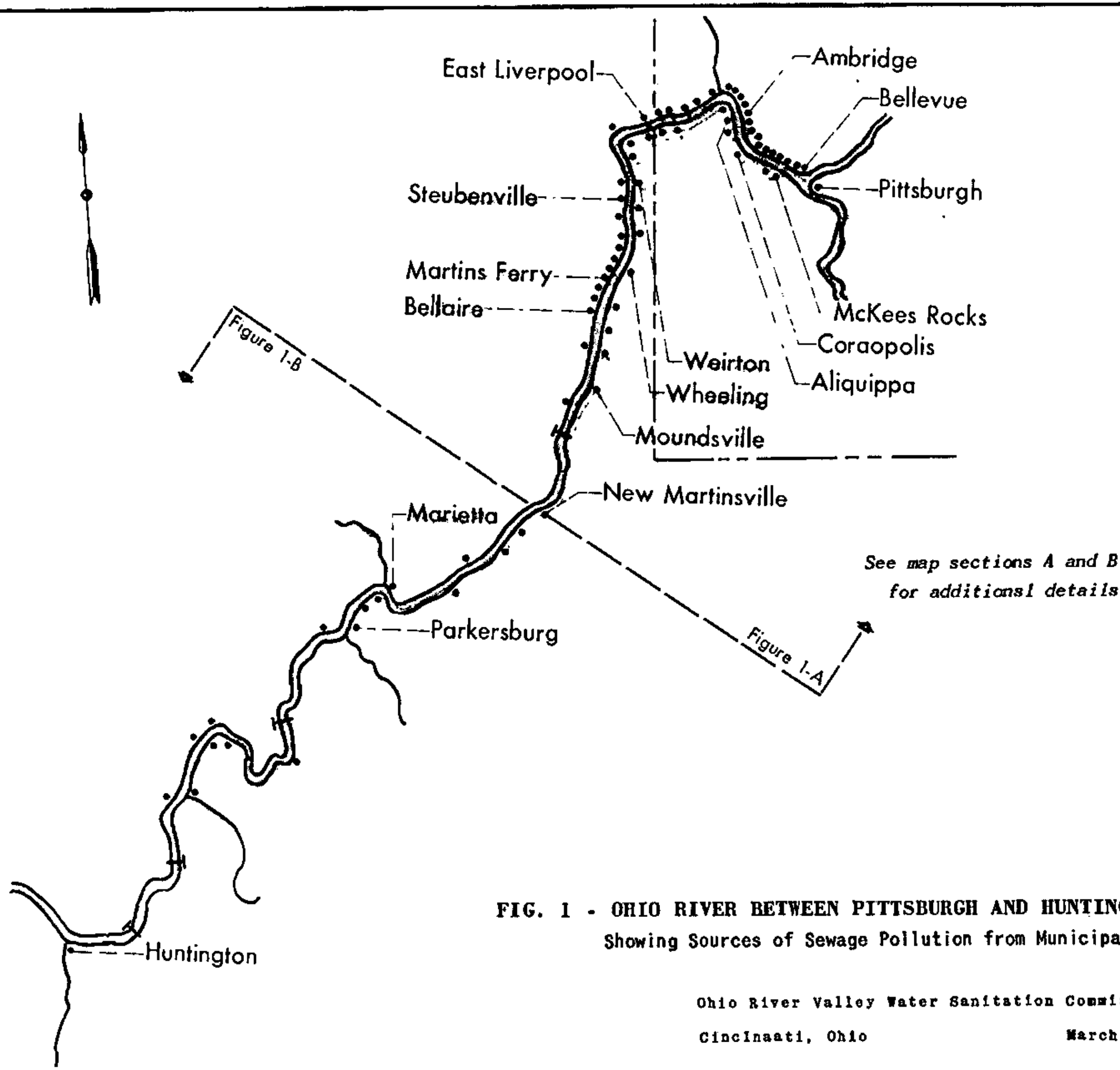

FIG. 1 - OHIO RIVER BETWEEN PITTSBURGH AND HUNTINGTON
Showing Sources of Sewage Pollution from Municipalities

Ohio River Valley Water Sanitation Commission
Cincinnati, Ohio March 1953

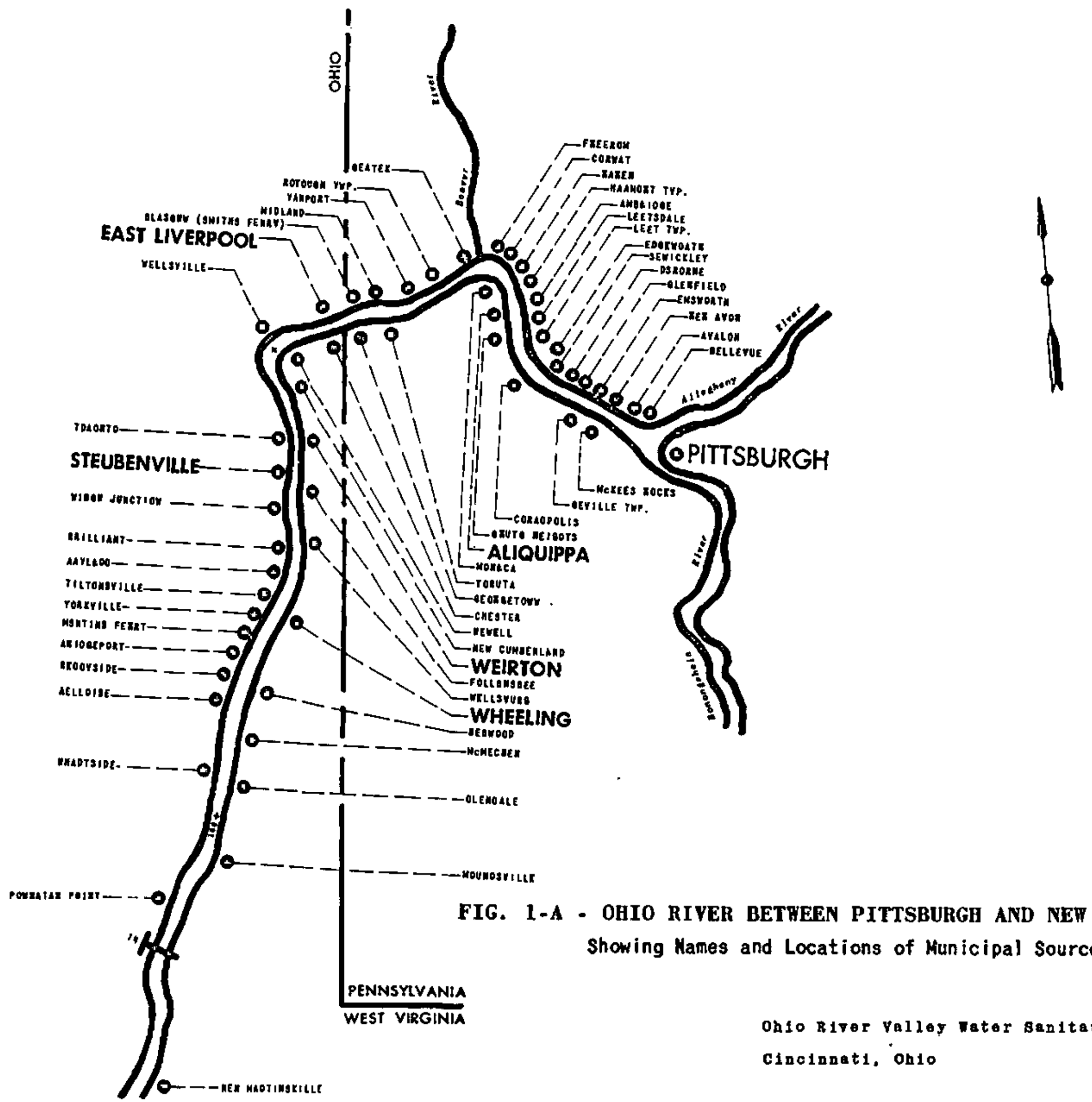

FIG. 1-A - OHIO RIVER BETWEEN PITTSBURGH AND NEW MARTINSVILLE
Showing Names and Locations of Municipal Sources of Pollution

Ohio River Valley Water Sanitation Commission
Cincinnati, Ohio March 1953

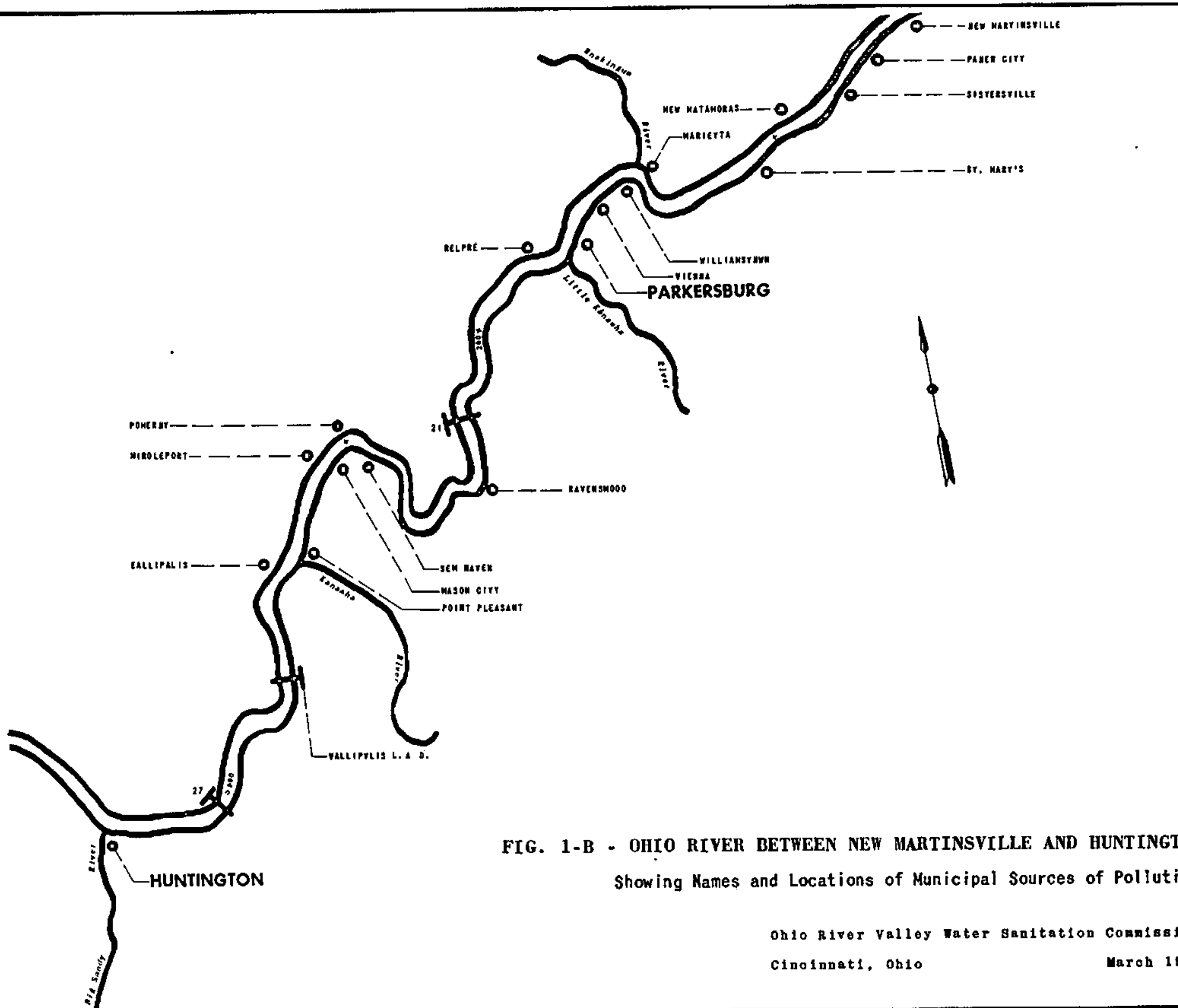

FIG. 1-B - OHIO RIVER BETWEEN NEW MARTINSVILLE AND HUNTINGTON

Showing Names and Locations of Municipal Sources of Pollution

Ohio River Valley Water Sanitation Commission

Cincinnati, Ohio March 1953

OHIO RIVER POLLUTION–ABATEMENT NEEDS

Pittsburgh–Huntington Stretch

CONCLUSIONS and RECOMMENDATIONS

This investigation has been made for the purpose of evaluating pollution conditions resulting from sewage discharged into the Pittsburgh-Huntington stretch of the Ohio River and has been directed toward the determination of remedial measures in terms of sewage-treatment requirements.

Article I of the Ohio River Valley Water Sanitation Compact pledges the eight signatory states to take such action that the waters within the compact district shall be placed and maintained in a satisfactory sanitary condition, available for use as public and industrial water supplies, suitable for recreational purposes, capable of maintaining fish and other aquatic life, free from nuisances and adaptable to other legitimate uses. The sewage-treatment requirements recommended in this report are intended to achieve these objectives.

On the basis of this investigation it is concluded that a dissolved-oxygen content to satisfy the stipulations of the Compact can be achieved in that stretch of the Ohio River between the Pennsylvania-Ohio-West Virginia state line and Huntington by treatment of present waste discharges in accordance with the following plan:

> Treatment of all sewage discharged to the river between Pittsburgh and Huntington in accordance with minimum requirements of the Compact (namely, substantially complete removal of settleable solids and not less than forty-five percent removal of total suspended solids); plus
>
> Additional treatment of sewage discharged to the Ohio River in Pennsylvania above the Allegheny County-Beaver County line in accordance with requirements established by the Pennsylvania Sanitary Water Board (namely, such treatment as will remove approximately fifty percent of the total biochemical-oxygen-demand (BOD); plus
>
> Appropriate treatment of organic industrial wastes now being discharged directly into the river (such appropriate treatment to be defined at a later date).

Treatment in excess of the minimum defined in the Compact is required for all sewage in order to secure satisfactory reduction of bacterial pollution. Present bacterial loads, though reduced in effect by existing acid conditions in the upper river, result in coliform concentrations in excess of the water-quality objectives established by the Commission.

Any material increase in the present total biochemical-oxygen-demand (BOD) load contributed to the Ohio River in the Pittsburgh area, after the proposed fifty-percent reduction, will tend to lower the minimum dissolved-oxygen (DO) content of the river below four parts per million (ppm) at critical stream flows, and will require re-evaluation of waste-treatment needs.

Recommendations

It is recommended that the following standard of treatment, subject to revision as changing conditions may require, be established for all sewage discharged from municipalities or other political subdivisions, public or private institutions, or corporations discharged or permitted to flow into that stretch of the Ohio River between Pittsburgh, Pa. and Huntington, W. Va.:

(a) Substantially complete removal of settleable solids; and

(b) Removal of not less than forty-five percent of the total suspended solids; and

(c) Treatment of sewage discharged in Pennsylvania above the Allegheny-Beaver county line in accordance with requirements of the Pennsylvania Sanitary Water Board (namely, approximately fifty percent reduction in BOD); and

(d) Reduction in coliform organisms in accordance with the following schedule:

Not less than 80% reduction during the months May through October.

Not less than 85% reduction during the months November through April.

PURPOSE and SCOPE

This report is the third of a series of investigations concerned with treatment requirements for wastes discharged to the Ohio River. Purpose of the report is to present staff findings on pollution conditions in a 300-mile stretch of the river and to submit recommendations for corrective measures that can be considered at a public hearing.

The recommended measures apply only to the control of sanitary-sewage discharges (as referred to in the second paragraph of Article VI of the Compact). Requirements relating to the control of pollution from industrial-waste discharges will be detailed in subsequent reports.

The section of the Ohio River with which this investigation deals may be defined as that extending from the point at Pittsburgh where the river is formed by the confluence of the Allegheny and Monongahela Rivers (designated as Mile 0.0 and referred to herein as the Point) to U. S. Corps of Engineers Dam No. 27, located about five miles upstream from Huntington, W. Va. and being 301.0 miles downstream from Pittsburgh. A map is shown on page 3.

Nine municipalities secure their water supply from the Pittsburgh-Huntington stretch of the river (see Table I). The total population served is more than 175,000.

Wastes discharged into this portion of the river have a population equivalent (biochemical-oxygen-demand basis) of some 3,300,000. Major sources of pollution are indicated in Table VII.

Sewage-treatment requirements have been evaluated with reference to the need for establishing and maintaining quality conditions in the Ohio River that will satisfy general requirements of the Compact as set forth in Article I. This has meant that consideration be given to the following three criteria of water quality:

(1) a dissolved-oxygen content suitable for normal aquatic life, natural-purification processes and other legitimate uses;

(2) a bacterial quality suitable for water supplies; and

(3) a bacterial quality suitable for recreational uses including bathing.

These criteria are the same as those dealt with previously in the report on the Huntington-Cincinnati stretch of the river (Ohio River Pollution-Abatement Needs, Huntington-Cincinnati stretch; February 1952). The investigation has involved a study of existing oxygen-demanding loads that are imposed on the stream and a determination of maximum allowable loads at critical stream flows. It has included also a study of present coliform-bacteria concentrations at various waterworks intakes, the conditions under which these concentrations exceed quality objectives adopted by the Commission, and the corrective measures that should be applied to upstream sewage discharges to bring these concentrations within the adopted limits.

Finally, the investigation has concerned itself with areas that might lend themselves to recreational uses, and the extent to which sewage treatment will be necessary in order to utilize such areas during the recreation season. In this latter connection, the degree of recreational benefit that will result from treatment measures aimed only at protecting water supplies also has been evaluated.

Basic information on pollution loads was supplied by the states of Ohio, Pennsylvania and West Virginia. Supplemental data were obtained from the Ohio River Pollution Survey Report (House Document 266, 78th Congress), reports of the Allegheny County Sanitary Authority (of Pennsylvania) and the U. S. Public Health Service, special surveys made by this Commission, and from records of raw water quality at the several municipal water supply intakes, including data collected by the Water Users Committee of the Commission.

HYDROMETRIC DATA

Discharge records for the U. S. Geological Survey gages at Sewickley and Huntington were used as the basis for flow-probability studies. These gages are located approximately at the upper and lower ends of the river stretch under consideration. Furthermore, the data from these gages provide the longest continuous records of any of the gaging stations on the Ohio River between Pittsburgh and Huntington.

From these records the following data were tabulated for each year from 1934 to 1949 inclusive (1949 being the latest year for which a complete record is available): Minimum daily flow, minimum weekly flow, minimum two-week flow, and minimum monthly (i.e..calendar-month) flow. These data are shown in Table II. From the tabulation it will be noted that the various minimum flows recorded during the 16-year period are as follows:

	Sewickley	Huntington
Minimum day	2,150 cfs	3,200 cfs
Minimum week	2,481	5,960
Minimum two-weeks	2,899	6,300
Minimum month	3,081	7,343

Flow adjustment for reservoir operation

The recorded flows given in Table II have been adjusted to show the effect of low-flow regulation from multiple-purpose reservoirs in the upper watershed of the Ohio River. Adjustments have been made in accordance with procedures followed in previous investigations on the Cincinnati Pool and the Huntington-Cincinnati stretch of the Ohio River.

Adjusted flows are shown in Table III. The months during which low-flow increases may be expected are June through October.

In making these adjustments, consideration has been given only to those reservoirs already in operation or to those now under construction. No allowance has been made for reservoirs that have been proposed, but the construction of which is uncertain.

Reservoirs providing low-flow regulation and the amount of flow increase from each are detailed in Table IV. The values of flow increase shown in the tabulation are considered to be conservative. This information has been supplied by the Ohio River Division of the U. S. Corps of Engineers.

Drought-flow probabilities

On the basis of adjusted flow records, studies were made to determine the probability of droughts of varying severity. These studies were made in accordance with Gumbel's statistical theory of extreme values.

Results of these studies are shown in Table V. To illustrate use of the table, it may be pointed out that at the Sewickley gage the drought flow to be expected once in ten years as a daily average value is 3,090 cfs (cubic feet per second), and as a monthly average value is 3,870 cfs. For nine years out of ten -- or 90 percent of the years -- drought flows may be expected that are equal to or greater than the values indicated.

Seasonal-flow expectancies

In addition to investigating the probability of minimum stream flows, studies were also made to determine flow frequencies during particular seasons of the year. Seasonal-flow frequencies were needed principally in connection with the investigation of bacterial conditions in the river.

Studies on seasonal flows involved an analysis of flows occurring during two critical periods: a winter season when temperatures are low and stream flows are high, and the summer bathing season. The critical winter season was taken as the months November through March, and the summer bathing season was considered to be the months June through August.

Results of these studies are given in Table VI. The table shows, for the Sewickley and Huntington gages, the flows that may be expected at varying frequencies during the two seasons.

Runoff at intermediate locations

For convenience in estimating runoff at intermediate locations between Pittsburgh and Huntington the chart shown in Fig. 2 was developed. This chart shows the drainage area tributary to any point along this stretch of the river.

The procedure used in estimating expected flows at intermediate locations may be illustrated as follows: Suppose it is desired to estimate the minimum weekly flow that may be expected once in ten years at Mile Point 185.0 (just below Parkersburg). The minimum ten-year weekly flows at Sewickley and Huntington are 3,250 cfs and 6,980 cfs (Table V), and the difference is 3,730 cfs.

The increase in minimum flow between the two gaging stations, therefore, is 0.102 cfs per square mile (3,730 cfs divided by the difference in drainage area, 36,400 square miles). By applying this unit increase in flow to the difference in drainage area between Sewickley and Mile Point 185.0, the minimum ten-year flow at Mile Point 185.0 is estimated to be 5,130 cfs (3,250 cfs at Sewickley plus 0.102 cfs per sq. mi. multiplied by 18,420 sq. mi.).

Critical-flow duration

For the evaluation of oxygen conditions the minimum weekly-average flows have been used. The reason for using a week as the significant interval over which to measure consecutive low flow is that this interval is approximately equal to the time of passage of pollution through the critical reaches of the stream (where oxygen content is lowest). This has been found to be the case immediately below Pittsburgh and also immediately below Huntington.

Although no distinct oxygen depression has been indicated immediately below Wheeling with existing pollution loads, it appears likely that the time-of-passage through a critical reach here if it existed, would not differ markedly from that found in other sections of the river.

In the studies on bacterial pollution between Pittsburgh and Huntington the calendar-month average flows have been used. The reason for this is that the bacterial-quality yardstick adopted by the Commission is expressed in terms of average coliform concentrations during a calendar month.

Time of flow

Time-of-flow data used in the analysis of oxygen and bacterial changes in the river were obtained from a Commission report titled "The Ohio River -- Estimates of Time of Flow", prepared by Edgar Landenberger of the U. S. Corps of Engineers and a member of the Commission's engineering committee. Mr. Landenberger's work is based on hydrometric observations made in connection with the 1939-40 Ohio River pollution survey of the U. S. Public Health Service (House Document 266).

In this report, Mr. Landenberger developed a graphical method for showing times-of-flow from points of origin in three sections of the Ohio River by a series of slope-lines plotted on a horizontal river mileage scale, and with ordinates representing times-of-flow in hours. The general slope of each line is determined by the total time-of-flow through the section corresponding to a given discharge as indicated by the reading at a reference gage sensitive to changes in flow. (The basic method is described fully in Mr. Landenberger's report).

Temperature

Temperature data for these investigations were obtained from the Ohio River Pollution Survey Report of the U. S. Public Health Service (House Document 266), and from results of current surveys being made by the Commission's Water Users Committee at certain waterworks intakes. For seasonal periods, stream temperatures have been averaged by months during such periods.

OXYGEN CONDITIONS

Sources of pollution

Estimated BOD (biochemical-oxygen-demand) loads now being discharged into the Ohio River between Pittsburgh and Huntington are shown in Table VII. No attempt has been made to list all individual sources of pollution. However, data in the table for each area or locality represent total estimated loads, including those from municipal sources as well as those from industrial sources that are discharged either through community sewers or directly to the river. Population equivalents of waste loads have been determined on the basis of 0.25 lb. of total first-stage BOD or 0.17 lb. of 5-day BOD per capita.

No breakdown is given of loads from individual industrial plants. However, a list of those industries known or reported to be discharging all or part of their wastes directly to the river (most of which contribute some BOD load) is given in Table VIII. Information on specific waste loads from a particular industrial plant is considered confidential and for use only in dealing on an individual basis with the company concerned.

In compiling Table VII, the 1940 and 1950 census populations were taken from reports of the U. S. Bureau of the Census. The 1940 population equivalents were derived from data given in House Document 266 (78th Congress), Part II, Table OH-3, page 212. The 1950-52 population equivalents were derived in part from the 1940 figures, adjusted for changes in census population, and in part from additional industrial waste load data furnished by the states of Pennsylvania, West Virginia and Ohio.

As shown in Table VII, the 1950 census population for the Pittsburgh area is 1,338,500. The sewered population for this area has been estimated to be 1,290,000. The total pollution load from the area, in terms of population equivalents, includes the sewered population of 1,290,000 plus an estimated industrial-waste contribution equivalent to the raw sewage of 570,000 people.

This figure for the industrial-waste contribution has been derived from data given in Appendix XII of the Allegheny County Sanitary Authority's report of January, 1948 titled, "Proposed Collection and Treatment of Municipal Sewage and Industrial Wastes" (hereafter designated as the ACSA Report). In deriving this figure, the estimated total industrial-waste equivalent of 650,000 population in 1945 for the whole of Allegheny County was first adjusted to 1950 on the basis of increased census population, and then reduced in proportion to the ratio of population in the area considered to that of Allegheny County, both as of 1950.

It should be pointed out that the most recent reports from the Allegheny County Sanitary Authority and the Pennsylvania Department of Health indicate that of the total sewered population in Allegheny County, 1,463,400, the sewage from about 1,045,000 people (or 71% of the total) will be discharged eventually through the Authority's collection system for treatment and disposal at a single plant near McKees Rocks. Additional plants are to be built separately by those involved for handling the remainder of the load.

Some uncertainty in assembling load information must be acknowledged in estimating equivalent-population loads contributed by the major streams tributary to the Ohio River. After considering various alternatives, it was decided to base them on the measured contribution, in pounds per day, of 5-day BOD during summer periods of low water during the period of the Ohio River pollution survey of 1940 by the U. S. Public Health Service; fairly long periods of daily observations were covered under these conditions. The total actual populations of the tributary drainage areas would give little if any clue to the effects of these populations at the tributary outlets, because of wide variations in the distribution of these populations along the tributaries and their branches.

It is believed that the load data shown in Table VII are sufficiently accurate for present purposes. As will be shown below, oxygen conditions in the river are not critical except in the extreme upper portion, where load information is most accurate. This would indicate that more precise measurement of loads in the lower portions would be unjustified at this time.

Effect of acid conditions

In undertaking to evaluate the more critical conditions of oxygen depletion which would be expected to prevail under existing pollution loads, it should be recognized that these conditions are now masked to a considerable extent by the presence of acidity in the upper portion of the river during the summer low-flow months; it is during this period that the most powerful effects of deoxygenation resulting from the addition of wastes exerting a biochemical-oxygen-demand on the river should be anticipated.

For this reason, it is considered desirable, and in fact quite necessary, to assume for purposes of estimate that these acid conditions are non-prevalent, and that the normal processes of deoxygenation would proceed as in any other stretch of the river not affected by acidity. This is the same assumption that has been made in estimates prepared by the Allegheny County Sanitary Authority concerning the required degree of treatment for sewage discharged into the river from the county area.

Although some time may elapse before existing acid conditions in the upper river are ameliorated, it must not be assumed that such a condition will be continued indefinitely. Acid pollution of the Ohio and its upper tributaries, the Allegheny and Monongahela Rivers, is recognized as a major pollution problem in this area, and the ultimate abatement of such pollution is commanding the best attention of the signatory states and the Commission.

Critical flows and temperature

The critical conditions for dissolved-oxygen maintenance in the river would be expected under summer drought flows, when stream temperatures are high and dilution afforded by the river is low. In the present study, the most critical flow used in evaluating oxygen conditions has been the minimum weekly-average flow expected once in ten years, as given in Table V for the Sewickley and Huntington gages.

At Sewickley this flow would be 3,250 cfs (cubic feet per second) and at Huntington 6,980 cfs. On this basis, the initial BOD load discharged from the Pittsburgh district, with a total population equivalent of 1,860,000 would amount to 465,000 lb. per day (assuming 0.25 lb. per capita of total first-stage BOD). When diluted with a river flow of 3,250 cfs, this would mean an initial BOD concentration of 26.5 ppm (parts per million) immediately below Pittsburgh.

Computation of oxygen profiles

A dissolved-oxygen profile has been computed for the entire stretch of the river from Pittsburgh to Huntington at an assumed ten-year minimum weekly flow; that is, at a flow increasing by increments from 3,250 cfs at the Sewickley gage to 6,700 cfs at Dam 27 (eleven miles upstream from the Huntington gage). The entire river stretch has been divided into thirteen sections, each beginning and ending at a known source of pollution.

Intermediate sources of pollution within each section have been included in the initial BOD for that section by applying the relation

$$L_a = L_b \times 10^{k_1 t}$$

Where L_a is the BOD at the initial point of the section,

L_b is the BOD at the intermediate point,

k_1 is the deoxygenation coefficient,

and t is the time of flow from the initial to the intermediate point.

The initial BOD for each section also includes the residual BOD from the next section upstream, allowing for time of flow through the section. The method of computation has involved applying the "oxygen-sag" formula for each section, adjusting the initial BOD for added pollution or dilution, and taking the calculated dissolved-oxygen content at the end of each section as the initial DO for the next section downstream. In this manner, it has been possible to allow for successive changes in the status of pollution or dilution in proceeding downstream.

Two sets of computations have been made, one assuming no treatment and the other 50 percent BOD removal at Pittsburgh and 35 percent removal at all downstream sources of pollution. The resulting oxygen profiles are shown in Fig. 3.

Deoxygenation and reaeration coefficients

In computing the oxygen profiles, using the oxygen-sag formula, a value of the deoxygenation coefficient (k_1) equal to 0.13 has been adopted, this being the normal value at 25 degrees Centigrade river temperature, with a value of 0.10 at 20 degrees. For the reaeration coefficient, a value of 0.23 has been adopted between Pittsburgh and Weirton, and a value of 0.20 below Weirton.

These values have been derived from two series of observational data which checked with each other closely when converted to a stream temperature of 25 degrees Centigrade (77 degrees Fahrenheit). Both series, one in 1914 and the other in 1940-41, were made during summer low-water flows by the U. S. Public Health Service in connection with stream-pollution investigations in those years (Public Health Bulletin No. 146 and House Document 266, Part II). The computations were facilitated by using a nomographic solution of the oxygen-sag equation published in 1949 (Sewage Works Journal, XXI, 5, 884, September, 1949). The oxygen-sag formula was used because it lends itself to readjustment to any changes in the BOD status of a stream at intermediate points throughout a long river section.

The value of the deoxygenation coefficient (k_2) adopted for these calculations is somewhat lower than that used in Appendix XII of the ACSA Report. This has led to the computation of a lower dissolved-oxygen minimum than estimated in that report, though the basic value at 20 degrees Centigrade was practically the same in both cases.

In the ACSA Report, a deoxygenation coefficient of 0.282 was derived from a 20-degree value of 0.188 by applying a temperature-correction factor given in Public Health Bulletin No. 146 (USPHS) published in 1925. Subsequently a long series of experimental observations by the U. S. Public Health Service at the Cincinnati Station of Stream Pollution Investigations established a more reliable temperature correction factor under stream-flow conditions, which factor has been used in the present calculations.

This factor, when applied to the 20-degree value of the deoxygenation coefficient used in the ACSA Report, would give a value of 0.235 at 25 degrees Centigrade, which agrees very closely with the value of 0.23 used in the present calculations. The effect of using this lower value has been to give a lower minimum DO below Pittsburgh than would be obtained by assuming a higher rate of reaeration. Its use in this connection appears to be thoroughly justified by the data now available.

Oxygen conditions shown by profiles

On examining the profiles in Fig. 3, it will be noted that the lower profile, assuming no treatment, reaches a minimum DO content of 0.5 ppm (parts per million) at Emsworth, with recovery to a content of 4.9 at Aliquippa, 5.6 at Rochester (also Beaver River mouth), and 6.6 at the Pennsylvania-Ohio-West Virginia state line, some 40 miles downstream from the Point at Pittsburgh. From Steubenville to Moundsville, a slight drop from 7.4 to 7.2 ppm is noted, because of the added BOD load in this section. From Moundsville to Marietta a definite recovery is shown, with about 95 percent of oxygen saturation from this point downstream to Dam 27.

In the upper profile, with assumed treatment as previously indicated, the DO minimum point at Emsworth of 4.4 ppm is shown, with recovery to 7.1 ppm at the state line, and further recovery downstream along a course similar to that of the "no treatment" profile but slightly above it.

It thus appears that with 50 percent BOD removal at Pittsburgh, a gain of about 4 ppm in dissolved oxygen at the minimum point of the curve is indicated, with BOD loads estimated as of 1950. It should be noted, however, that under these conditions the minimum DO at Emsworth would be only 51 percent of saturation, and any material increase in BOD load above the state line probably would reduce this minimum DO to an undesirable level.

Although the "treatment" profile shows a good margin of safety in this respect at the state line, the trend of this profile below Ambridge would suggest that any considerable increase in BOD load below the Point, with 35 percent BOD removal in this section, might set up a secondary oxygen-sag which would affect the oxygen trend below the state line.

The same principle would be applicable in the Steubenville-Moundsville section, where a well-defined secondary oxygen-sag is shown. In this case, any delayed BOD action resulting from acid conditions above and below the state line would tend to accentuate this downward trend of the profile.

Some evidence of such a delayed action was revealed by the summer low-water results of observations by the Public Health Service in 1940, when a sharp reversal in oxygen "balance" occurred below Dam 8, which is located about five miles below the state line. In this case a loss in oxygen balance between Dams 8 and 11 was noted, amounting to nearly 100,000 lb. per day in excess of the BOD added in this section. This loss was almost 25 percent of the total BOD load, including Pittsburgh's, discharged to the river above Dam 2, being somewhat greater than that which would be expected under normal stream conditions from the unoxidized portion of this total load.

Conclusions

It thus appears that with treatment of sewage discharged to the Ohio River in Pennsylvania above the Allegheny County-Beaver County line in accordance with requirements of the Pennsylvania Sanitary Water Board (fifty percent BOD reduction), together with treatment of all sewage discharged below the county line in accordance with minimum requirements of the Compact, and together with appropriate treatment for organic industrial wastes, satisfactory oxygen conditions should be attainable at critical stream flows in the Ohio River between the Pennsylvania-Ohio-West Virginia state line and Huntington. This conclusion is reached on the basis of no material increase in BOD loads over those estimated as of 1950-52.

Some increase in such loads, though probably involving added treatment to maintain a satisfactory dissolved-oxygen content in the river above the state line, should not seriously affect the minimum oxygen content below the state line unless 1950-52 loads were somewhat more than doubled, and unless continuance of present acid conditions in the extreme upper section of the river should bring about a secondary delayed BOD action below the state line. In such an event, any material increase in BOD loads below the state line might necessitate an increase in treatment requirements in the section between Weirton and Moundsville over and above those of primary treatment.

So far as the lower part of the Pittsburgh-Huntington stretch of the river is concerned, the only section in which oxygen conditions would appear to be questionable is the stretch extending above the Gallipolis Dam, at which point the dissolved oxygen content during the months of June through September, 1939, averaged 6.2 ppm, or about 75 percent of saturation, with an average flow of over 20,000 cfs. With critical minimum flows in this section approaching 7,000 cfs as a weekly average once in 10 years, it is quite conceivable that the DO content of the river at Gallipolis would reach critically low levels, especially if oxygen conditions at the mouth of the Kanawha River, some 15 miles upstream from the dam, should be unfavorable during prolonged summer drought periods.

Somewhat inconclusive evidence was revealed by the Public Health Service survey of 1939-41 that organic sludge deposits above Gallipolis Dam exerted an oxygen demand on the river during prolonged summer low-water periods. Further observations would be needed, however, to establish the true facts of this situation. In view of the great importance of this question in connection with future developments of high dams in the Ohio River, further studies on conditions in the Gallipolis Dam pool are recommended to establish whether or not organic sludge deposits may cause excessive deoxygenating effects on the river in the longer and deeper pools created by dams of this type.

BACTERIAL CONDITIONS

Bacterial conditions in the extreme upper portion of the Pittsburgh-Huntington stretch of the river reflect the presence of acid pollution. The latter tends to reduce the bacterial content of the river below that which would be expected to result from known discharges of sewage and from the normal action of self-purification. These effects, however, are highly variable, and for this reason difficult to evaluate.

It has appeared desirable, therefore, to assume the absence of acid conditions in estimating bacterial-reduction requirements in this section of the river, as likewise has been done in estimating oxygen conditions under existing BOD loads. This assumption has seemed proper because the effects of acid pollution are confined to a relatively limited section immediately below Pittsburgh, and because there is reason to believe that measures to reduce this type of pollution eventually will be developed.

Computed and observed coliform profiles

In one respect, however, it has been necessary to take account of the effects of acid conditions; namely, in checking computed coliform profiles against the results of actual observations made in the river. An example is shown in Fig. 4; here computed coliform profiles have been drawn for summer and winter flow conditions prevailing in 1940-41, when systematic observations were carried out by the U. S. Public Health Service in connection with the Ohio River pollution survey of those years. The average results of these observations are shown in relation to the computed profiles.

It will be noted from this study that average coliform "most probable numbers" (MPN) observed at Emsworth, Dashield, and Montgomery dams (at mile points 6.3, 13.3 and 31.7) were much lower than those shown by the summer profile, but agreed closely in the winter profile. As the average river flow during the summer period, 5,500 cubic feet per second (cfs) at Sewickley gage, was very low -- whereas the average winter flow, 35,500 cfs, was roughly seven times the summer flow -- the deviations of the observed MPN values below the profile at summer flows were clearly due to the effect of acid conditions which did not prevail at the higher winter flow.

Aside from these deviations, the agreement between the profiles and the observed coliform numbers was very good in most cases, probably being within the limits of observational error. This agreement, which was somewhat better in the winter profile than in the summer profile, has served to indicate that the use of the profile method of estimating trends in coliform numbers throughout the entire Pittsburgh-Huntington stretch of the river should be valid for any assumed condition of flow and sewage loads at different points.

Coliform densities at waterworks intakes

In order to determine the flow conditions under which the coliform densities in the river may be expected to be highest under existing (1950-52) sewage loads in the summer and in the winter, a study was made of the results of coliform MPN enumerations carried out at waterworks intakes at Weirton, Wheeling, Pomeroy, and Huntington during a period of 26 months from August, 1950 through September, 1952. These results have been reported by the Water Users Committee of the Commission from tests made routinely at each plant laboratory. Results for the first seven months beginning in August, 1950 were collected through the U. S. Public Health Service Environmental Health Center, and made available to the Commission when the latter undertook to continue this activity.

These results constitute the most recent available record of bacterial quality at these important water intakes, two being located in the most heavily polluted section of the stretch and two at points in the least heavily polluted section. Moreover, they are expressed in the same terms of MPN as the Commission's adopted bacterial-quality objectives, and have been obtained by means of test methods recommended in connection with the application of these objectives.

Records of routine coliform observations at these and other waterworks intakes in the stretch are also available from reports made to the respective state departments of health. These records, however, have been reported in terms of "indicated numbers" of coliform bacteria rather than MPN, and are based on a different method of testing; hence the results are not directly comparable with those reported by the Water Users Committee. Nevertheless, they have tended to confirm the general trends shown by the committee's reports, and in due time may be convertible to terms of equivalent MPN results, though a sufficient volume of concurrent results has not been available at this writing to justify drawing a relationship curve. This relation is not constant but tends to vary with the coliform densities.

Coliform densities vs river flow

The results of coliform analyses at waterworks intakes are shown in Table IX and graphically in Figs. 5, 6 and 7 for Weirton, Wheeling, and Huntington, at which the largest volume of data is available (note observed values in Figs. 5, 6 and 7). The charts show monthly average MPN values plotted against corresponding average river flows, using logarithmic scales in order to condense the plots. They show little relation of MPN to summer river flows, but indicate an inverse relationship at Weirton and Wheeling at winter flows, with the higher MPN densities tending to fall in a flow range of about 50,000 to 65,000 cfs.

At Pomeroy and Huntington, which are distantly removed from major upstream sources of pollution, the relation tends to be a direct one, with the higher MPN values occurring at flows over 100,000 cfs. This reversal in trend as compared with Weirton and Wheeling agrees with previous findings in the Huntington-Cincinnati stretch. It indicates that at points located closely to major sources of pollution, coliform densities in the river tend to vary inversely with flow; whereas at the more distant points densities tend to vary directly with flow.

Coliform densities in summer-fall season

In order to develop a comprehensive picture of coliform bacterial trends throughout the Pittsburgh-Huntington stretch during the summer-fall season, profiles have been drawn for the following flow conditions:

(1) a flow of 3,870 cfs at Sewickley, representing the minimum monthly average flow to be expected once in ten years regardless of time of occurrence (which is usually in September or October); and

(2) a flow of 5,500 cfs at Sewickley, representing the minimum monthly average flow to be expected once in ten years during the bathing season of June through August.

These profiles have been drawn on the assumption of non-acid conditions throughout the entire river stretch and are shown in Figs. 8 and 9.

In Fig. 8 it will be noted that with no bacterial-reduction treatment of sewage discharged into the river, the coliform content would fail to meet the Commission's water-supply objective throughout the 150 mile section extending below Pittsburgh, and would exceed the Commission's bathing-water objective in the entire river length above Huntington. With 80 percent removal of coliform organisms from all sewage discharged into the stretch, the water-supply objective would be met in all except a limited section between Weirton and Wheeling, and the bathing-water objective would be achieved in an aggregate river length of about 100 miles.

In Fig. 9, with a flow of 5,500 cfs at Sewickley, the 80 percent reduction in coliform bacteria should provide water of a quality that meets the water-supply objective at all intakes between Pittsburgh and Huntington, and also should assure that the bathing-water objective is achieved in about 150 miles of river. Both profiles have been drawn on the assumption that the bacterial quality of water discharged into the Ohio River by its tributaries would be at least as good as that of the main river at the points of confluence.

Comparison of these two summer profiles with others drawn for higher flows indicates that in the critical section below Pittsburgh, the general level of coliform-bacteria densities would tend to diminish with increased summer flows, and hence would be greatest at minimum flows.

Coliform densities in winter-spring season

Because of the indication from a study of winter coliform results at Weirton and Wheeling that the higher coliform densities in the river at these intakes occur at flows ranging from about 50,000 to 65,000 cfs at Sewickley, coliform-bacteria profiles have been drawn for these two flows, and also for a flow of 90,000 cfs, the latter as a check on the conclusion thus drawn. The three profiles are shown in Fig. 10. In this chart it will be noted that the profiles drawn for flows of 50,000 and 65,000 cfs follow each other closely, and that both profiles lie above the one drawn for a flow of 90,000 cfs. This would indicate that from the standpoint of general coliform levels at the water intakes below Pittsburgh, the flow range of 50,000 to 65,000 cfs is the more critical one.

Taking 50,000 cfs as the most critical winter flow in this respect, the profile for this flow has been re-plotted in Fig. 11, together with two other profiles showing the effects of 80 percent and 85 percent reductions in coliform organisms throughout the entire Pittsburgh-Huntington stretch. These profiles indicate that with 80 percent reduction, water of a quality meeting the Commission's objective would be provided at all intakes below the Pennsylvania-Ohio-West Virginia boundary, and would fall short of meeting the objective at the state line by a very narrow margin. With 85 percent reduction, a wider margin of safety would be provided both at the state line and at points downstream.

As deviations above average expected coliform densities in the river are more likely to occur during the winter, when flow conditions are subject to greater disturbance, a uniform minimum reduction schedule of 85 percent would appear to be the safer one under these circumstances. Moreover, this schedule would meet the requirements at Weirton and Wheeling more fully than would 80 percent reduction, and in the latter case would afford a first approximation to adequate relief of the excessive bacterial loads now indicated at that point (see Figs. 5 and 6).

In this connection, it should be pointed out that the increase in coliform densities now shown as occurring between the Weirton and Wheeling intakes is disproportionately high in comparison with the known total population contributing sewage to the river between these two points, suggesting the possibility that some local sources of pollution may be affecting the quality of water at the Wheeling intake. For this reason, treatment requirements for sewage in the upper section of the river should preferably be gauged by the needs existing at Weirton rather than those at Wheeling. Weirton is the nearer point to Pittsburgh and therefore, it would seem, is the point exposed to the greater pollution hazard.

Conclusions

On the basis of this investigation, it appears that 80 percent bacterial-reduction treatment during the months of May through October should provide adequate protection to all water supplies at normal summer-fall flows ranging down to 5,500 cfs at the Sewickley gage. At drought flows lower than 5,500 cfs at Sewickley (which might be expected to occur once every three or four years, but which would last for only a month at a time), the objective should be met at all points except in the section between Weirton and Wheeling, where coliform concentrations might exceed the objective by a narrow margin.

During the months of June through August, 80 percent bacterial-reduction treatment should provide water quality meeting the Commission's bathing-water objective in at least 150 miles of the river in all years except one out of ten. Bathing areas would be available in the lower part of the Pittsburgh-Huntington stretch, extending from about Mile Point 120.0 to Huntington. Provision of bathing areas in the upper portion of the stretch would not be practicable with any reasonable bacterial-reduction schedule, because of the congestion of sewered population in this section of the river.

During the winter season of November through April, a uniform schedule of not less than 80 percent reduction of coliform organisms would substantially meet the Commission's water-supply objective at all water intakes below the Pennsylvania-Ohio-West Virginia state line. However, the consclusion is reached that 80 percent treatment would not provide an adequate margin of safety for protection of water supplies, and that during the winter season treatment should be increased to not less than 85 percent reduction in coliforms. A greater margin of safety is needed during the winter season, when flow conditions are subject to greater disturbance than in the summer, and consequently deviations in coliform-bacterial loads above the average are more likely to occur. Moreover, on the basis of actual observations at Weirton and Wheeling, an 85 percent minimum reduction would meet more fully the bacterial requirements at these two points, where coliform loads are higher than at any other intakes between the state line and Huntington.

TABLES and FIGURES

Table I - Municipal water supplies taken from the Ohio River between Pittsburgh and Huntington

Municipality	State	Location of intake (miles below Pittsburgh)	Municipality	State	Location of intake (miles below Pittsburgh)
Midland	Pennsylvania	35.9	Wheeling	W. Virginia	86.8
E. Liverpool	Ohio	40.2	Bellaire	Ohio	94.0
Toronto	Ohio	59.1	Sistersville	W. Virginia	137.3
Weirton	W. Virginia	62.5	Pomeroy	Ohio	248.3
Steubenville	Ohio	65.3			

Table II - Minimum recorded river flows at Sewickley and Huntington gages

Year	Sewickley gage					Huntington gage				
	minimum recorded flow in cfs for indicated period				Month of minimum flow	minimum recorded flow in cfs for indicated period				Month of minimum flow
	Day	Week	Two Weeks	Calendar month		Day	Week	Two Weeks	Calendar month	
1934	2,150	2,481	2,971	4,597	July	3,200	6,740	7,140	12,770	Sept.
1935	4,220	4,390	4,593	5,561	Oct.	3,200	6,340	7,760	11,840	Oct.
1936	2,660	2,943	3,209	4,880	Sept.	4,400	6,640	7,610	11,690	Sept.
1937	3,500	3,724	4,137	10,300	Sept.	3,200	7,440	8,650	26,780	Sept.
1938	3,380	3,604	3,689	4,965	Oct.	3,940	6,570	6,660	9,106	Oct.
1939	2,550	2,679	2,908	3,113	Sept.	4,880	6,030	6,860	7,837	Sept.
1940	3,340	3,664	3,809	5,815	Oct.	7,460	9,930	10,310	11,790	Oct.
1941	3,190	3,749	4,276	6,894	Oct.	4,100	6,280	7,530	11,890	Oct.
1942	5,150	7,164	9,564	14,960	Sept.	9,590	15,660	21,720	29,670	Sept.
1943	2,650	2,770	2,899	4,904	Sept.	5,330	7,030	7,250	10,650	Oct.
1944	3,190	3,589	3,708	4,008	Aug.	5,550	7,390	7,990	8,409	Aug.
1945	4,570	6,100	6,906	11,470	July	5,380	11,330	12,960	24,520	July
1946	2,450	2,644	2,909	3,081	Sept.	3,220	5,960	6,300	7,343	Sept.
1947	2,920	3,191	3,266	3,854	Oct.	5,270	9,460	10,480	11,660	Oct.
1948	4,560	4,806	5,116	6,751	Sept.	6,260	10,500	11,900	15,830	Sept.
1949	4,100	4,664	5,456	4,835	Oct.	7,080	13,286	13,357	15,210	Oct.

Table III - Minimum recorded river flows adjusted for reservoir operation (Sewickley and Huntington gages)								
	Sewickley gage				Huntington gage			
	Minimum adjusted flow in cfs for indicated period				Minimum adjusted flow in cfs for indicated period			
Year	Day	Week	Two Week	Calendar Month	Day	Week	Two Week	Calendar Month
1934	3,190	3,521	4,011	5,637	4,610	8,150	8,550	14,180
1935	5,260	5,430	5,633	6,601	4,610	7,750	9,170	13,250
1936	3,700	3,983	4,249	5,920	5,810	8,050	9,020	13,100
1937	4,540	4,764	5,177	11,340	4,610	8,850	10,060	28,190
1938	4,080	4,304	4,389	5,665	5,010	7,640	7,730	10,176
1939	3,250	3,379	3,608	3,813	5,950	7,100	7,930	8,907
1940	4,040	4,364	4,509	6,515	8,530	11,000	11,380	12,860
1941	3,890	4,449	4,976	7,591	5,170	7,350	8,600	12,960
1942	5,850	7,864	10,264	21,960	10,660	16,730	22,790	30,740
1943	3,350	3,470	3,599	5,604	6,230	7,730	8,150	11,550
1944	3,890	4,289	4,408	4,708	6,250	8,090	8,690	9,109
1945	5,270	6,800	7,606	12,170	6,080	12,030	13,660	25,220
1946	3,150	3,344	3,609	3,781	3,920	6,660	7,000	8,043
1947	3,620	3,891	3,966	4,554	5,970	10,160	11,180	12,360
1948	4,760	5,006	5,316	6,951	6,460	10,700	12,100	16,030
1949	4,300	4,864	5,656	5,035	7,280	13,486	13,557	15,410

Table IV - Increases in river flow resulting from operation of multiple-purpose reservoirs				
Name of reservoir	Date of completion	Minimum flow increase (cfs)	Increase added to flows of record: Date of records	Increase (cfs)
			Prior to 1938	1,410
Tygart	1938	340	1938 to July 1943	1,070
Berlin	July 1943	170	July 1943 to April 1944	900
Mosquito Creek	April 1944	200	April 1944 to 1948	700
Youghiogheny	1948	500	1948 to 1953	200
East Branch Clarion	January 1953	200		
	Total	1,410		

Table V - Probability of drought flows at Sewickley and Huntington gages (based on adjusted flow records)								
	Sewickley gage				Huntington gage			
Drought Severity	Minimum Daily	Minimum Weekly	Minimum 2 Week	Minimum Calendar Month	Minimum Daily	Minimum Weekly	Minimum 2 Week	Minimum Calendar Month
Most probable drought	4,120	4,520	4,700	6,310	6,150	8,460	9,520	14,080
Once in 5 years	3,430	3,670	3,920	4,690	4,830	7,470	8,110	10,180
Once in 7 years	3,260	3,460	3,730	4,280	4,500	7,230	7,760	9,220
Once in 10 years	3,090	3,250	3,530	3,870	4,170	6,980	7,400	8,230
Once in 15 years	2,900	3,010	3,310	3,410	3,800	6,700	7,000	7,130
Once in 20 years	2,760	2,850	3,160	3,090	3,540	6,510	6,730	6,730

Table VI - Seasonal flow frequencies at Sewickley and Huntington				
Percent of Months	Monthly average flows (in cfs) equal to or greater than values shown below may be expected for indicated percentage of months in each season			
	Winter season (November through March)		Bathing season (June through August)	
	Sewickley	Huntington	Sewickley	Huntington
97.5	10,000	19,000	5,500	12,000
95	12,000	21,000	6,200	14,500
90	14,000	28,000	7,700	19,000
80	20,000	43,000	10,500	26,000
70	26,000	59,000	12,600	32,000
60	33,000	76,000	13,800	37,500
50	40,000	93,000	14,700	41,500
40	47,000	109,000	16,200	45,000
30	55,000	129,000	19,300	49,000
20	64,000	154,000	24,500	56,500
10	77,000	188,000	31,000	85,000

Table VII - Estimated BOD loads discharged to the Ohio River between Pittsburgh and Huntington (loads shown include industrial discharges)

Point or area	State	Miles below Pittsburgh	Census population 1940	Census population 1950	Estimated Sewered population 1940	Estimated Sewered population 1950	Estimated BOD load in population equivalents 1940	Estimated BOD load in population equivalents 1950
Pittsburgh & environs	Pa.		1,010,000	1,338,500	970,000	1,290,000	1,390,000	1,860,000
Allegheny county exclusive of Pittsburgh area	Pa.		401,539	176,737	451,360	173,400	651,360	283,400
Harmony & Ambridge	Pa.	16	18,968	20,930	25,000	20,930	25,000	21,000
Aliquippa-Conway	Pa.	20	27,023	33,521	27,000	33,500	120,000	125,000
Freedom	Pa.	24	3,227	3,000	3,200	3,000	4,900	4,600
Monaca	Pa.	25	7,061	7,415	8,000	8,400	8,000	8,400
Rochester	Pa.	25	7,441	10,902	10,000	10,900	10,000	11,000
New Brighton	Pa.			9,535				
Beaver River		25						56,800
Beaver & Buro Twp.	Pa.			4,537				
Midland	Pa.	37	6,373	6,491	6,300	6,400	34,300	35,000
Chester	W.Va.	43						1,350
E. Liverpool	Ohio	44	23,555	24,217	21,000	21,600	26,155	26,900
Newell	W.Va.	45		900				3,900
Wellsville	Ohio	48	7,672	7,854	7,600	7,800	7,600	7,900
Toronto	Ohio	60	7,426	7,253	7,000	6,800	13,700	14,680
Weirton	W.Va.	62	16,700	24,005	16,700	24,000	36,500	60,000
Steubenville	Ohio	68	37,651	35,872	32,000	30,000	44,000	50,430
Follansbee	W.Va.	71	4,834	4,435	4,800	4,400	36,800	34,000
Mingo Junction	Ohio	71	5,192	4,464	5,100	4,400	5,100	5,260
Brilliant	Ohio	75						2,050
Wellsburg	W.Va.	75	6,255	5,787	5,500	5,100	6,400	5,900
Rayland-Tiltonville	Ohio	83						2,750
Yorkville	Ohio	84						2,900
Martins Ferry	Ohio	89	14,729	13,220	14,700	13,200	14,700	18,200
Bridgeport-Brookside	Ohio	90	5,828	5,154	5,600	5,000	5,600	5,000
Wheeling	W.Va.	91	61,099	58,891	67,300	65,000	90,100	87,000
Benwood	W.Va.	94				1,680		1,680
Bellaire	Ohio	95	13,799	12,573	13,500	12,300	13,500	12,300
Moundsville	W.Va.	102	14,168	14,772	16,000	16,700	16,000	16,700
New Martinsville	W.Va.	128	3,491	4,084	3,400	4,000	3,400	4,000
Sistersville	W.Va.	138	2,702	2,313	2,800	2,400	2,800	2,400
Marietta	Ohio	172	14,543	16,006	13,000	14,300	29,500	39,440
Muskingum River		172						154,000
Little Kanawha River		185						57,200
Parkersburg	W.Va.	185	30,103	29,684	36,000	35,500	82,000	92,000
Hocking River		199						22,200
Letart Falls	Ohio	235						1,500
Pomeroy-Middleport	Ohio	252	6,937	7,102	6,000	6,100	6,000	7,270
Pt. Pleasant	W.Va.		3,538	4,596	3,500	4,500	3,500	4,500
Kanawha River		266						147,000
Gallipolis	Ohio	270	7,832	7,871	5,000	5,000	5,000	9,500

Table VIII - Industries known or reported to be discharging wastes directly to the Ohio River in the stretch between Pittsburgh and Huntington

Pennsylvania		
	Allis-Chalmers Manufacturing Company	Pittsburgh
	Cruikshank Brothers	Pittsburgh
	Schoen Wheel & Axle Division Carnegie-Illinois Steel Corporation	McKees Rocks
	Pittsburgh Coke and Chemical Company	Neville Township
	Gulf Oil Corporation	Neville Township
	Neville Company	Neville Township
	Dravo Corporation	Neville Township
	Marcus Ruth Jerome Company	Neville Township
	National Cylinder Gas Company	Neville Township
	Frick and Lindsay Company	Neville Township
	Air Reduction Sales	Neville Township
	Vilsack Fisher Company	Neville Township
	The Vulcan Detinning Company	Neville Township
	Pittsburgh Barrel and Drum Company	Neville Township
	Pittsburgh Screw and Bolt Company	Neville Township
	Sterling Varnish Company	Haysville
	The Canfield Oil Company	Coraopolis
	The Pittsburgh Forging Company	Coraopolis
	Standard Steel Spring Company	Moon Township
	Division Blaw-Knox Company Lewis Foundry & Machine Company	Moon Township
	Continental Foundry and Machine Company	Moon Township
	Russell Birdsall and Ward Bolt and Nut Company	Moon Township
	Bethlehem Steel Company	Leetsdale
	Spang-Chalfant Division The National Supply Company	Ambridge
	The National Electric Products Company	Ambridge
	Wycoff Steel Company	Ambridge
	A. M. Byers Company	Harmony Township
	Jones & Laughlin Steel Corporation	Aliquippa
	Pennsylvania Railroad	Conway
	Freedom Valvoline Oil Works	Freedom
	Colonial Division Pittsburgh Screw & Bolt Corporation	Monaca
	Division of Vanadium Corporation of America Colonial Steel Corporation	Monaca
	Pittsburgh Tool Steel Wire Company	Monaca
	St. Joseph Lead Company of Pennsylvania	Potter Township
	Phthalic Anhydride Plant Koppers Company	Potter Township
	Kobuta Plant Koppers Company	Potter Township
	Pittsburgh Crucible Steel Company	Midland
West Virginia		
	Harker Pottery Company	Chester
	Taylor, Smith and Taylor	Chester
	Knowles China Company	Newell
	Homer Laughlin China Company	Newell
	New Castle Refractories Company	Newell
	Weirton Steel Company	Weirton
	Koppers Company, Tar Products Division	Follansbee
	Wheeling Steel Company	Follansbee

Table VIII (continued) - Industries known or reported to be discharging wastes directly to the Ohio River in the stretch between Pittsburgh and Huntington

West Virginia (continued)		
	Follansbee Steel Corporation	Follansbee
	Sheet Metal Specialty Company	Follansbee
	Pillsbury Mills, Inc.	Wellsburg
	S. George and Company	Wellsburg
	Beech Bottom Works Wheeling Steel Company	Beech Bottom
	Beech Bottom Power Company	Beech Bottom
	Ackerman Plant Wheeling Steel Company	Warwood
	Zinc Recovery Plant Wheeling Steel Company	Wheeling
	J. L. Stifel and Sons, Inc.	Wheeling
	Riverside Blast Furnace Wheeling Steel Company	Benwood
	Benwood Works Wheeling Steel Company	Benwood
	Vulcan Rail & Construction Company	Benwood
	L. Marx and Company	Glen Dale
	Wheeling Metal & Manufacturing Company	Glen Dale
	Triangle Conduit & Cable Company	Moundsville
	Glyco Products Company, Inc.	New Martinsville
	Columbia Southern Chemical Corporation	New Martinsville
	Quaker State Oil Refining Company	St. Marys
	E. I. duPont Company	Parkersburg
	Penn Metal Company	Parkersburg
	Parkersburg Steel Company	Parkersburg
	Ohio River Salt Corporation	Mason
	Marietta Manufacturing Company	Point Pleasant
Ohio		
	National Drawn Works Crucible Steel Company of America	East Liverpool
	Patterson Foundry & Machine Company	East Liverpool
	Pennsylvania Railroad Yard	Wellsville
	Toronto Paper Manufacturing Company	Toronto
	Anco Glass Company, Inc.	Toronto
	Ohio River Steel Company	Toronto
	Steubenville Pottery Company	Steubenville
	Liberty Paperboard Company	Steubenville
	Weirton Steel Company	Steubenville
	Wheeling Steel Corporation	Steubenville
	Wheeling Steel Corporation	Mingo Junction
	Pennsylvania Railroad Yard	Mingo Junction
	Wheeling Steel Corporation	Yorkville
	Wheeling Steel Corporation	Martins Ferry
	Calco Chemical Division American Cyanimide Company	Marietta
	Broughton's Dairy	Marietta
	Electro-Metallurgical Company	Marietta
	Bakelite Division Union Carbide & Carbon Company	Marietta
	Crow Bros. Poultry Company	Letart Falls
	Pomeroy Salt Company	Minersville
	Parkersburg Rig & Reel Company	Pomeroy

Table IX - Coliform densities and stream flows at four waterworks intakes (data from monitor survey coliform densities and stream flows are monthly averages)

MONTH	WEIRTON		WHEELING		POMEROY		HUNTINGTON	
	Flow in 1,000 cfs	Coliform MPN per 100 ml	Flow in 1,000 cfs	Coliform MPN per 100 ml	Flow in 1,000 cfs	Coliform MPN per 100 ml	Flow in 1,000 cfs	Coliform MPN per 100 ml
1950								
August	9.55		9.91	54,500	15.3	740	21.2	560
September	23.7		24.6	37,400	36.7	13,200	50.7	1,800
October	16.2	23,800	16.8	42,900	17.7	1,100	24.4	990
November	63.0	41,100	64.1	62,400	60.7	10,500	83.8	1,400
December	90.7	17,600	94.0	39,200	128.6	11,300	177.4	3,000
1951								
January	98.7	13,100	102.5	16,000	124.2	3,600	171.4	4,200
February	101.0	11,600	104.6	19,000	149.3	10,100	206.2	6,000
March	83.5	25,900	86.6	32,400			175.0	4,500
April	91.9	29,000	95.4	36,800			167.4	2,300
May	40.3	27,700	41.8	18,300			82.2	
June	49.6	13,000	51.5	65,100			74.3	
July	25.4	11,300	26.3				37.2	1,900
August	4.68	2,700	4.85	62,600			10.1	1,500
September	4.53	10,700	4.70	19,600			11.1	
October	4.76	11,900	4.83				7.5	
November	25.2	23,000	26.2	47,200			41.5	2,300
December	54.0	26,900	56.0	81,300			110.4	5,500
1952								
January	132.5	10,100	137.5	132,000			226.0	4,500
February	68.8	8,800	71.4	43,800			162.8	3,250
March	82.3	15,800	85.4	45,100			161.4	4,500
April		16,100		32,000			127.6	4,500
May		18,200		98,800			116.3	3,600
June				17,400			30.2	2,300

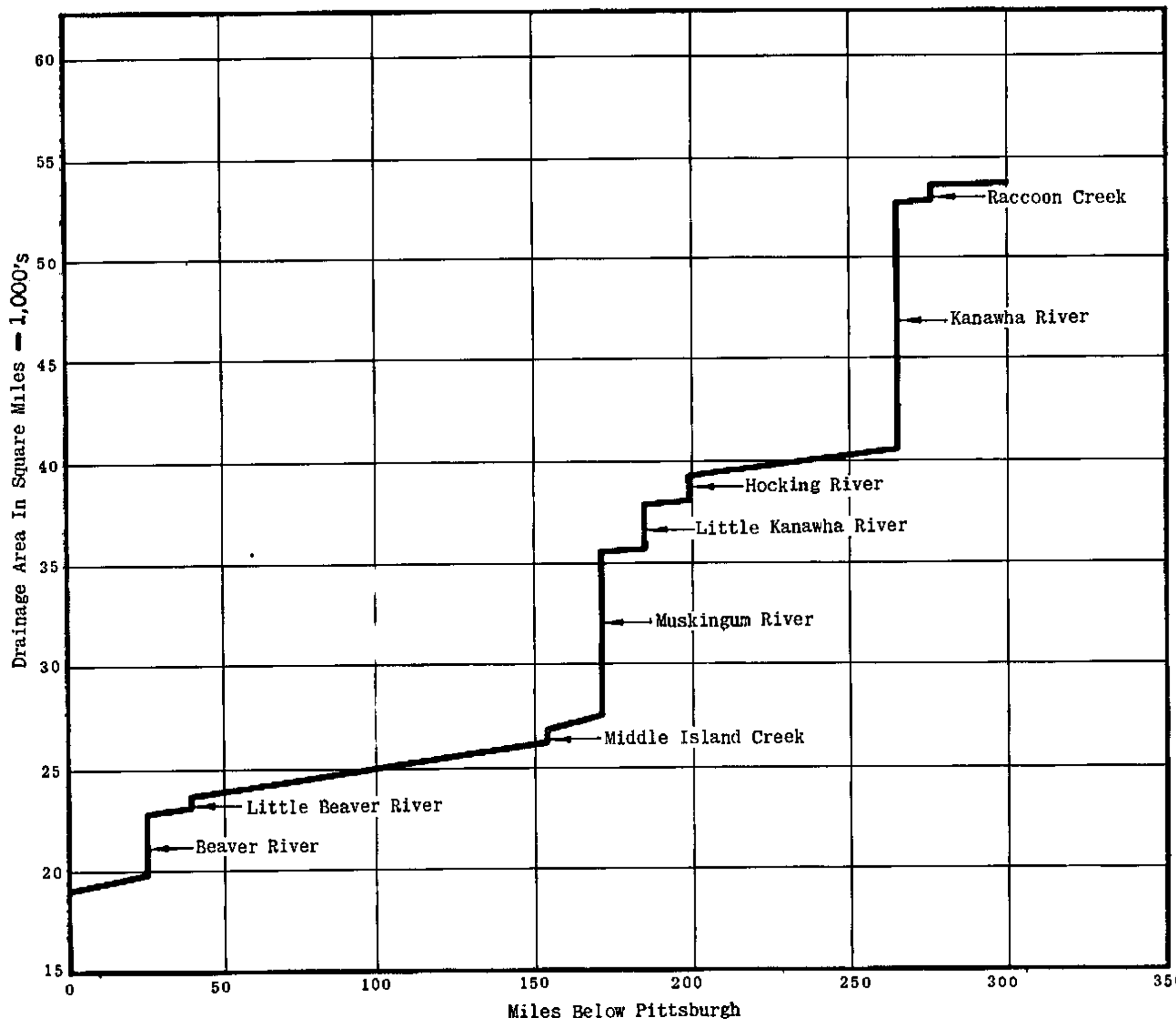

FIG. 2 - DRAINAGE AREA ABOVE POINTS IN OHIO RIVER
between Pittsburgh and Huntington

March 1953

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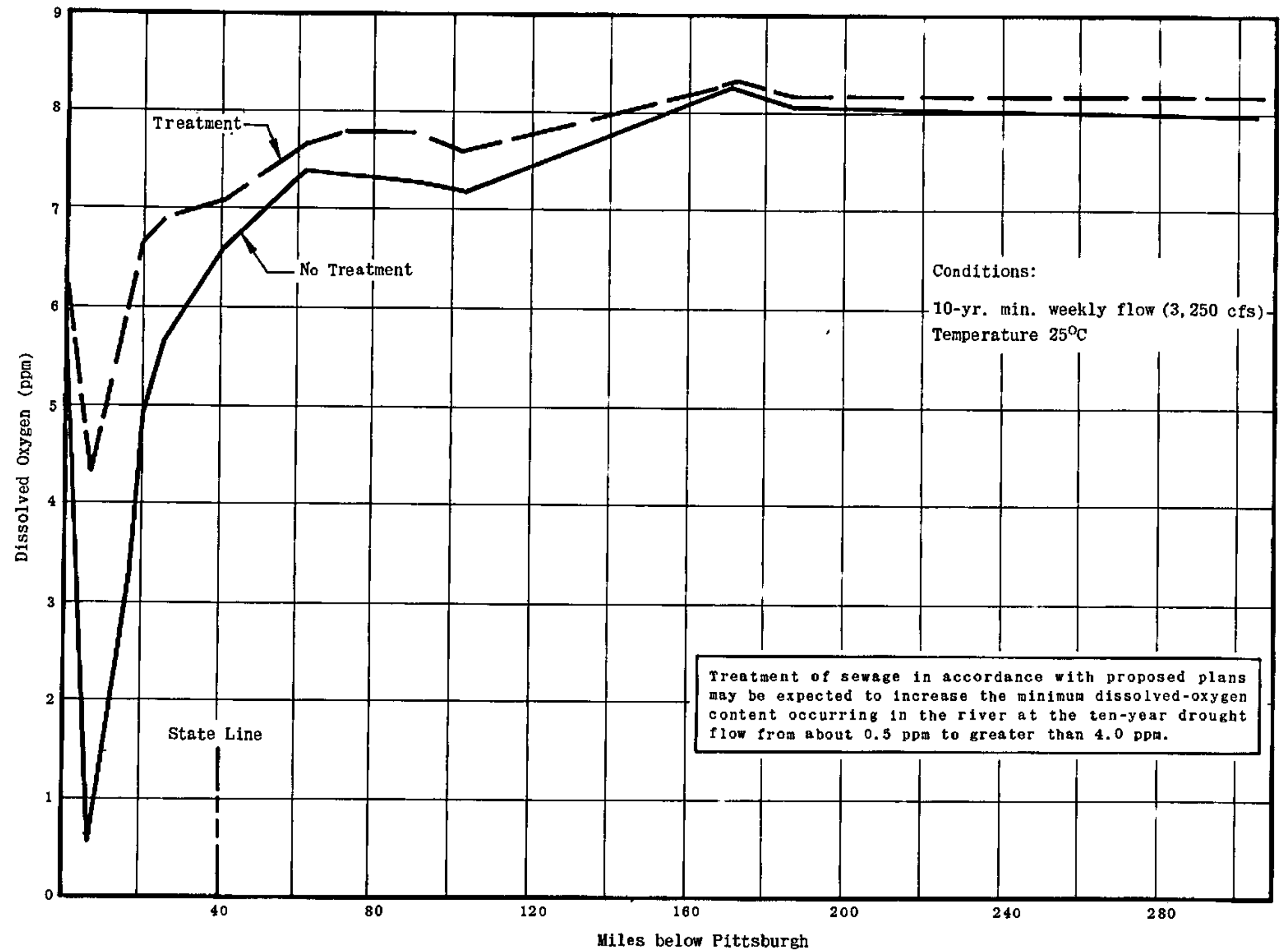

FIG. 3 - DISSOLVED OXYGEN PROFILES in Ohio River between Pittsburgh and Huntington

March 1953

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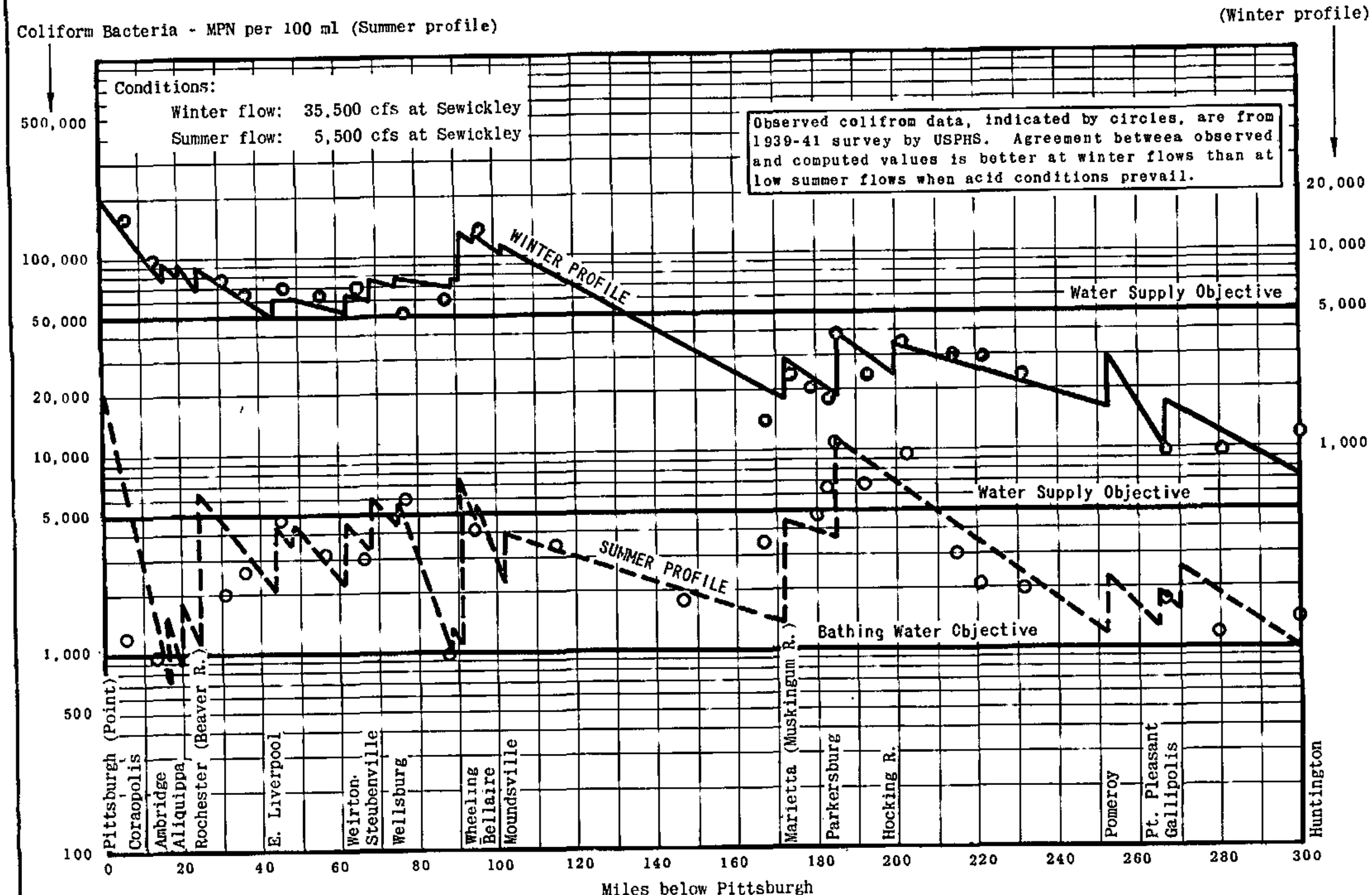

FIG. 4 - COMPUTED AND OBSERVED COLIFORM PROFILES in Ohio River between Pittsburgh and Huntington

March 1953

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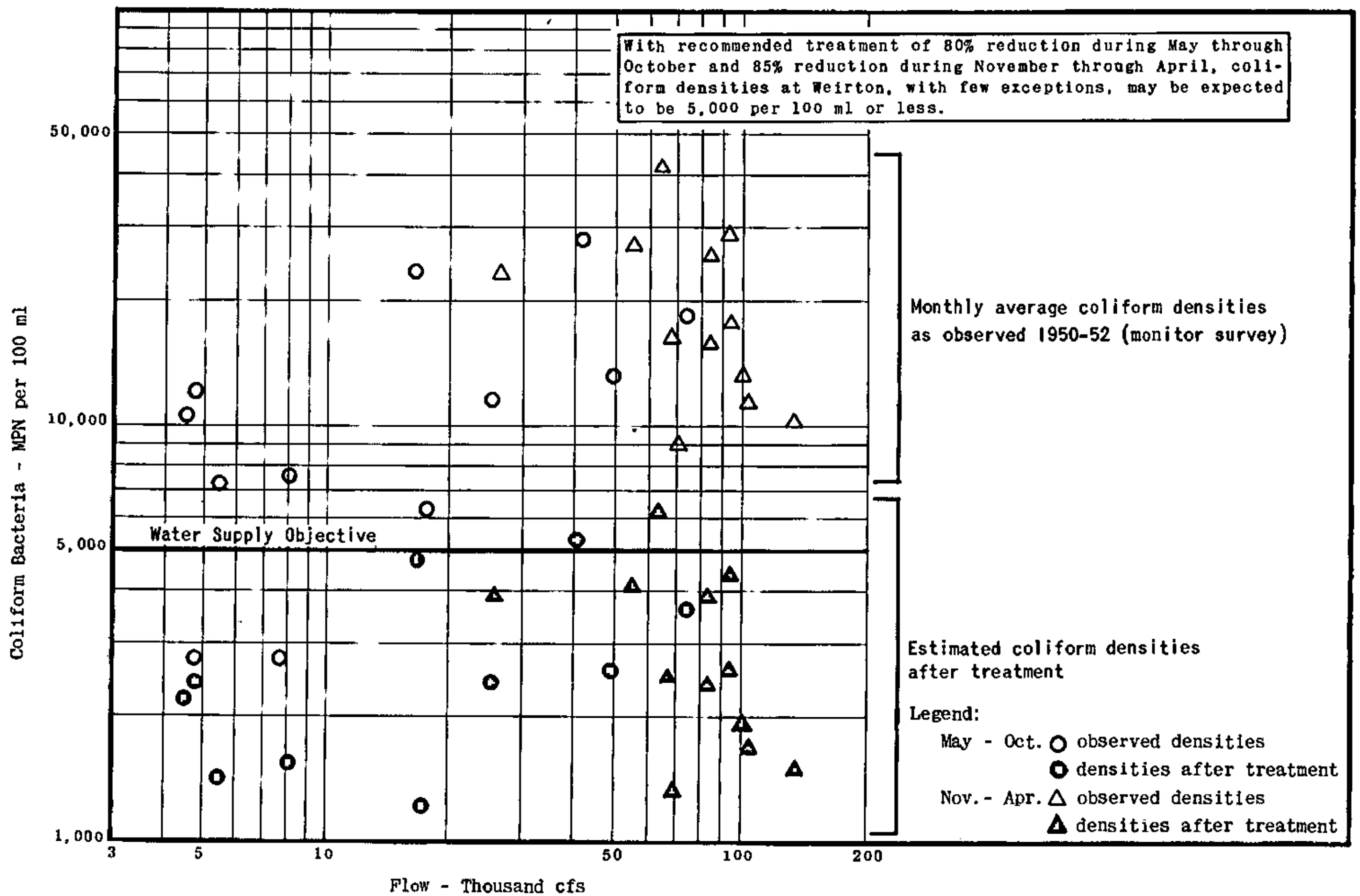

FIG. 5 - OBSERVED COLIFORM DENSITIES AT WEIRTON INTAKE
and effect of bacterial-reduction treatment

March 1953

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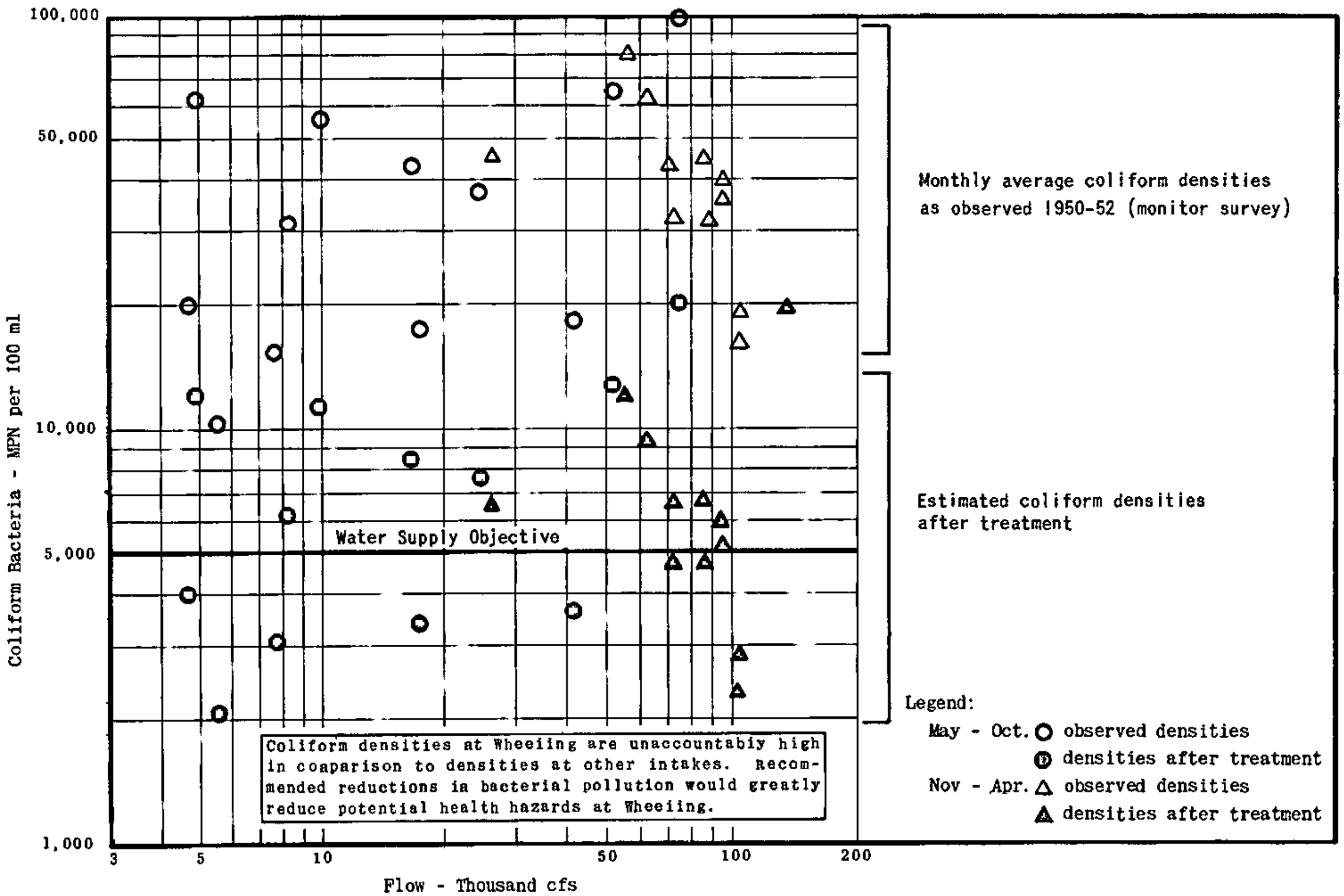

FIG. 6 - OBSERVED COLIFORM DENSITIES AT WHEELING INTAKE
and effect af bacterial-reduction treatment

March 1953

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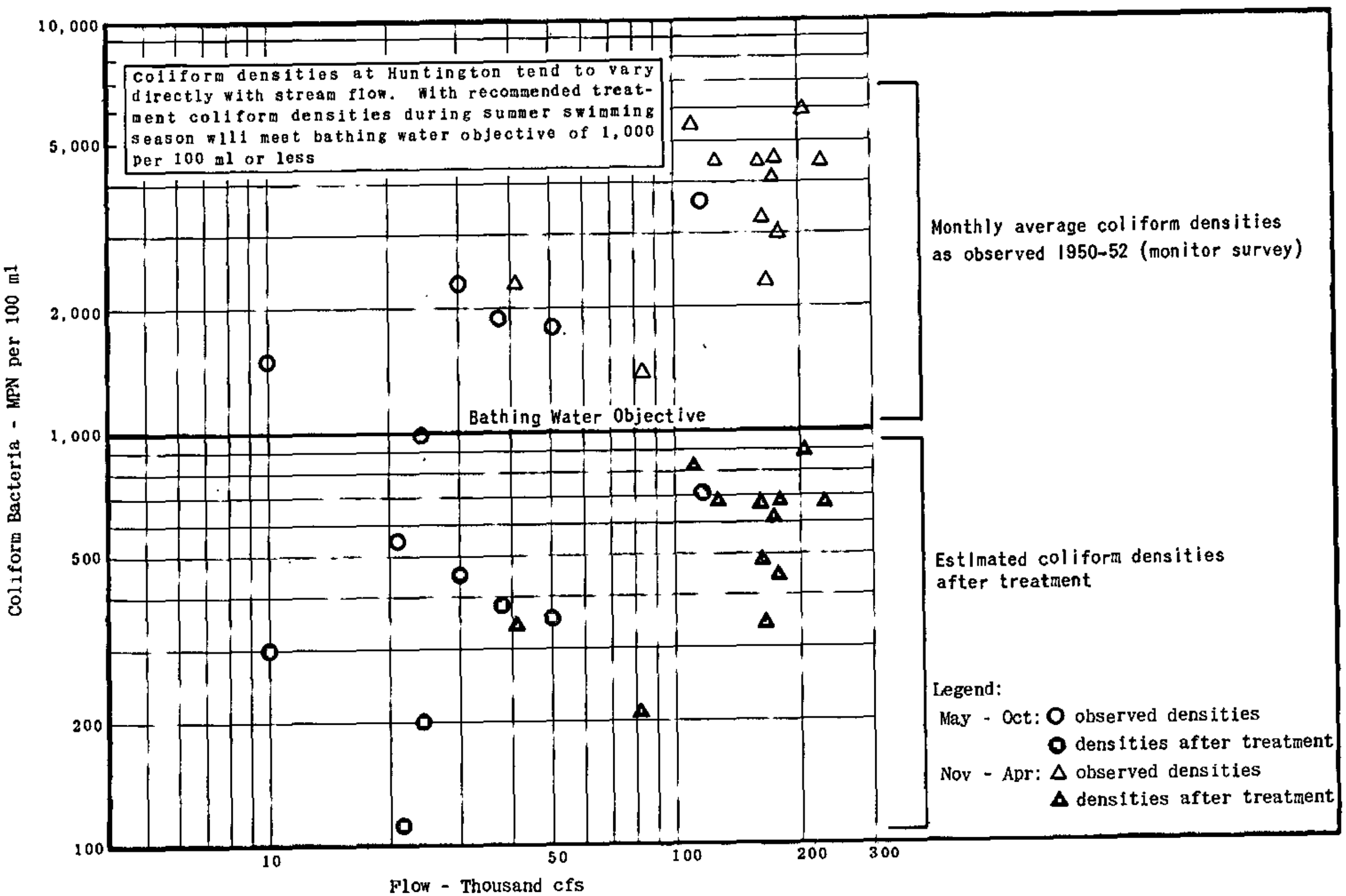

FIG. 7 - OBSERVED COLIFORM DENSITIES AT HUNTINGTON INTAKE
and effect of bacterial-reduction treatment

March 1953

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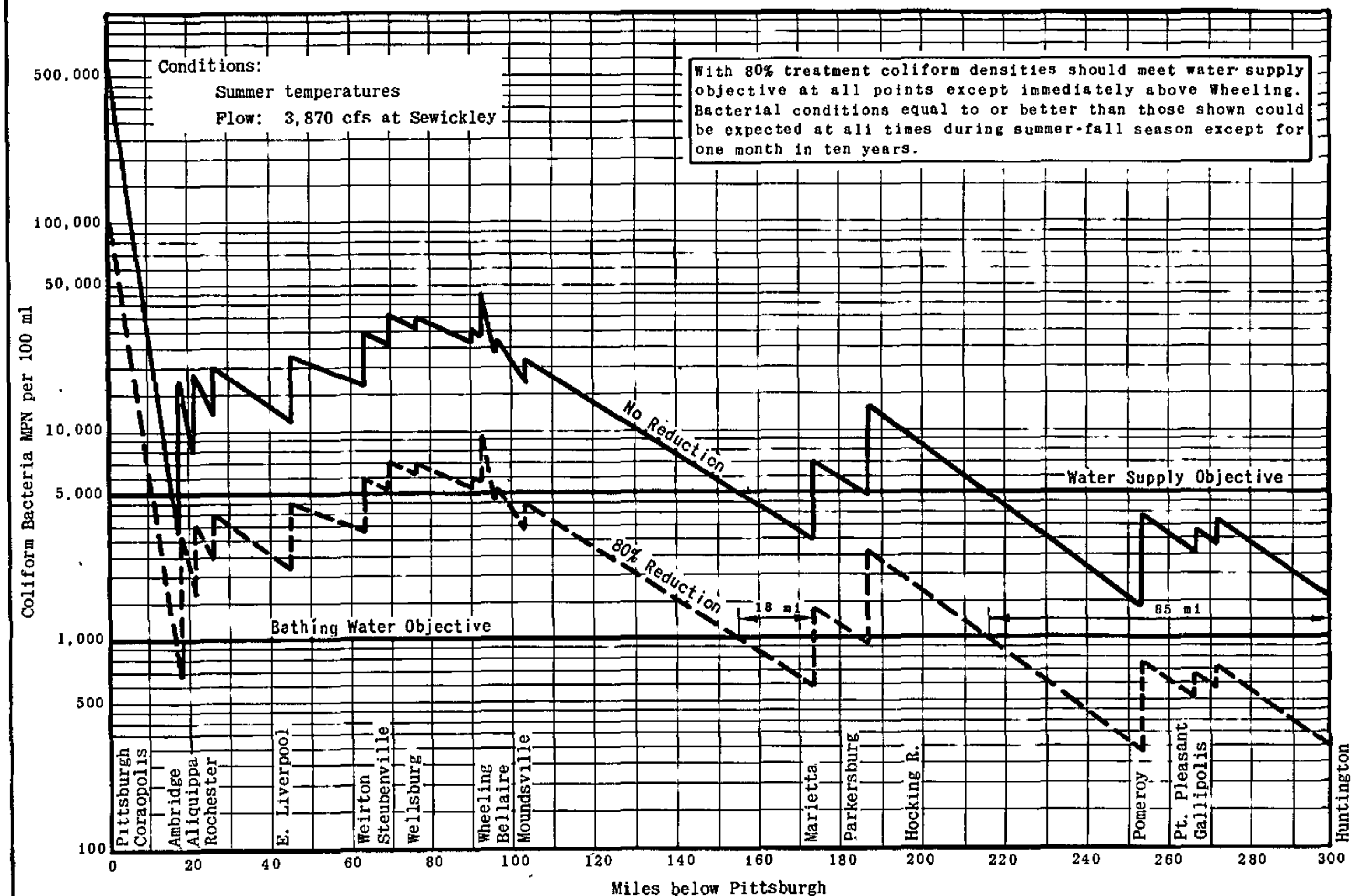

FIG. 8 - EFFECT OF BACTERIAL-REDUCTION TREATMENT AT TEN-YEAR MINIMUM FLOW; Ohio River between Pittsburgh and Huntington

March 1953

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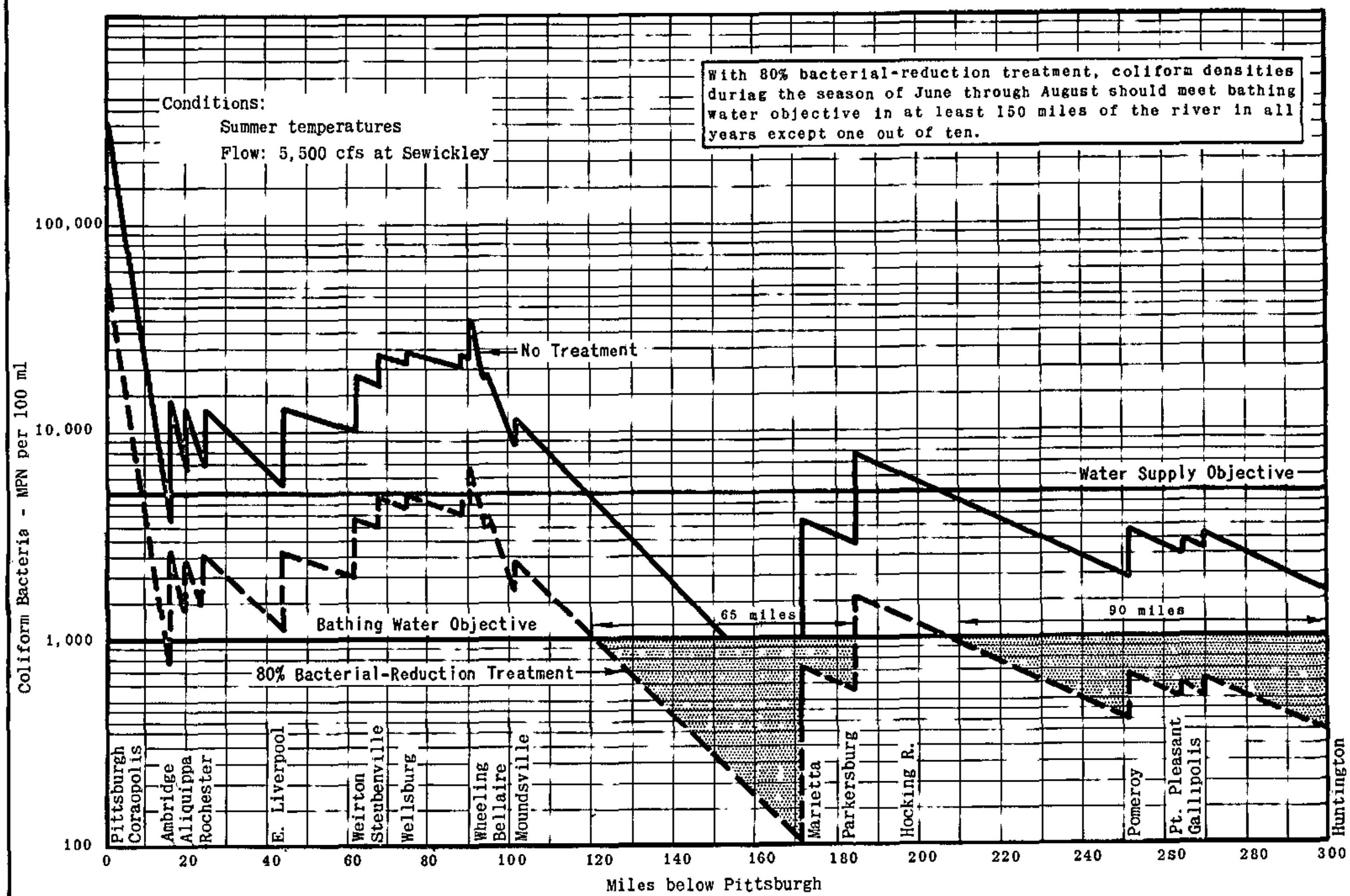

FIG. 9 - EFFECT OF BACTERIAL-REDUCTION TREATMENT AT LOW FLOW DURING MONTHS JUNE THROUGH AUGUST; Ohio River between Pittsburgh and Huntington

March 1953

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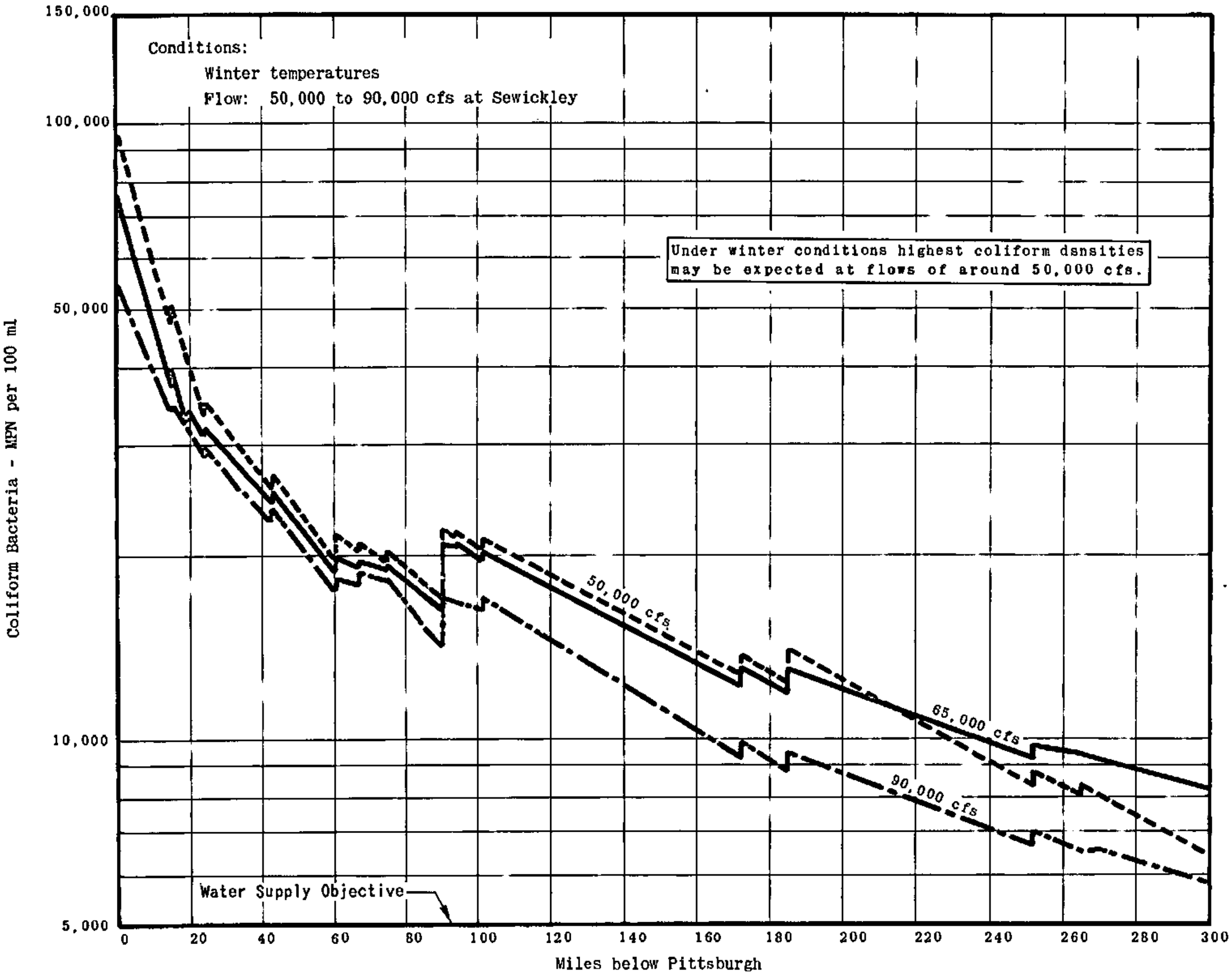

FIG. 10 - COLIFORM PROFILES AT WINTER TEMPERATURES AND VARYING FLOWS; Ohio River between Pittsburgh and Huntington

March 1953

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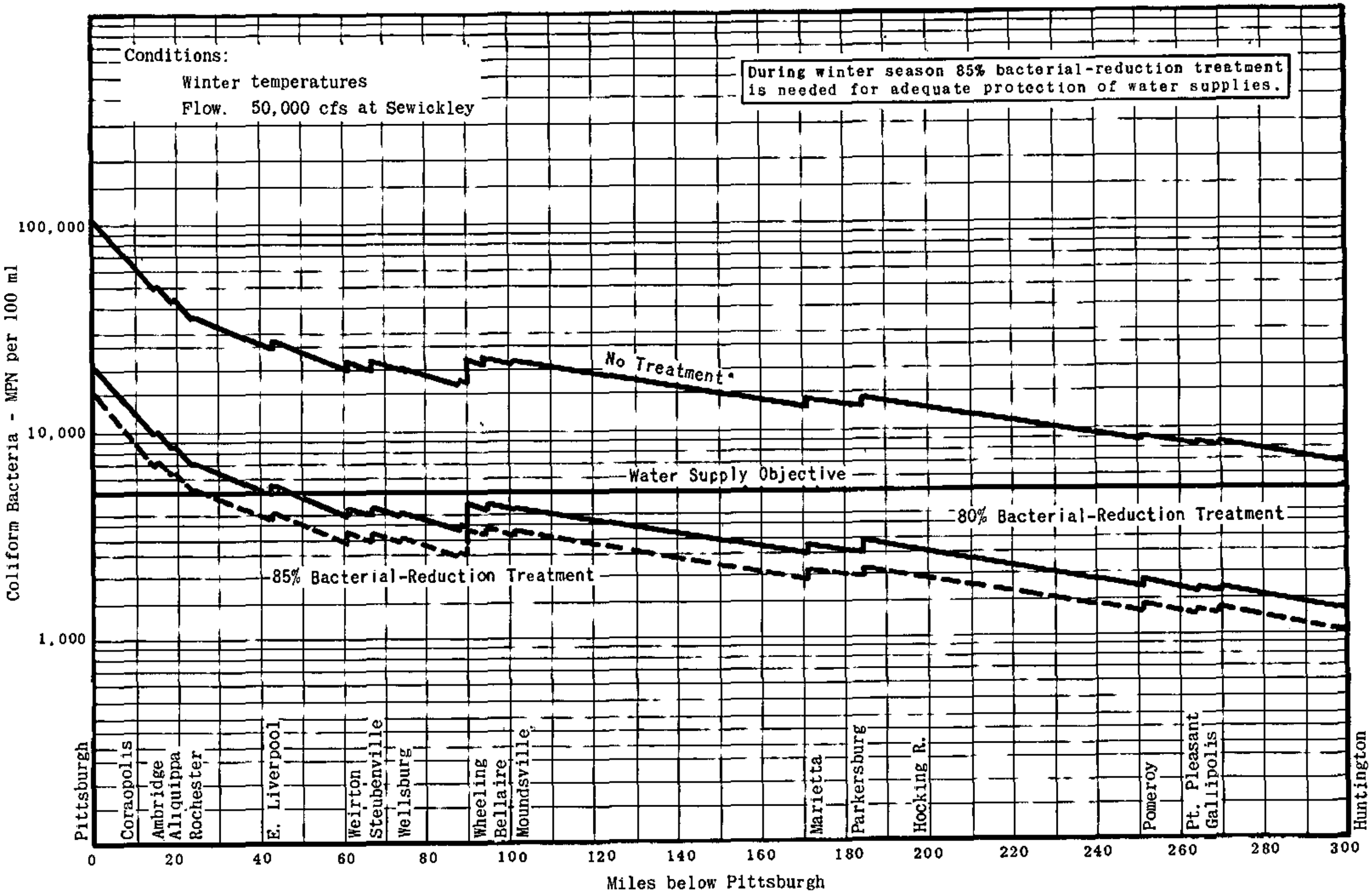

FIG. 11 - EFFECT OF BACTERIAL-REDUCTION TREATMENT DURING WINTER SEASON; Ohio River between Pittsburgh and Huntington

March 1953

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BACTERIAL-QUALITY OBJECTIVES

for the Ohio River

A guide for the evaluation of sanitary condition of waters used for potable supplies and recreational uses.

OHIO RIVER VALLEY WATER SANITATION COMMISSION

An interstate agency representing Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Virginia and West Virginia

OHIO RIVER VALLEY
WATER SANITATION COMMISSION

414 WALNUT STREET CINCINNATI 2, OHIO

June 1, 1951

To the Chairman and
Members of the Commission:

This is the final report of bacterial-quality objectives for the Ohio River, which you adopted on April 4, 1951 and ordered published. The report sets forth the objectives for both water supply and recreational uses, the manner in which the objectives are to be interpreted, and the background for their validity.

In large measure this report is the work of Harold W. Streeter, U. S. Public Health Service (retired) who now serves the Commission in a consultant capacity. Mr. Streeter, an international authority on water-quality investigations has been studying Ohio River conditions since 1914. Drawing upon this experience and supplementing it with new information gathered by the Commission and its signatory states, Mr. Streeter prepared findings that were scrutinized by your Engineering Committee and other authorities over a period of a year.

The Engineering Committee recommended adoption of these objectives since they provide a sound basis for the Commission to reach decisions on acceptable limits and control of bacterial contamination. Heretofore, the task was complicated by a wide divergence of viewpoints and standards throughout the nation.

Respectfully submitted,

Edward J. Cleary

EDWARD J. CLEARY
Executive Director
and Chief Engineer

Bacterial - Quality Objectives
for the Ohio River

Adopted by the

OHIO RIVER VALLEY WATER SANITATION COMMISSION

on the basis of findings reported by

Harold W. Streeter, Consultant

and approved by members of the Engineering Committee

C. W. Klassen, Chairman
Fred H. Waring
Earl Devendorf
F. Clark Dugan
B. A. Poole
H. E. Moses
M. LeBosquet
W. W. Towne
Edgar Landenberger
O. Lloyd Meehean
Harry K. Gidley
Richard Messer

June 1, 1951

TABLE 1 — SUMMARY OF CERTAIN STATE AND REGIONAL BACTERIAL QUALITY STANDARDS FOR SOURCES OF WATER SUPPLY.

State or Region	Class	Units	Limiting Coliform Numbers per 100 Ml	Remarks
New York	A-1 & A-2	Mo. Av. MPN	50	1
	A-4	Mo. Av. MPN	5,000 and not over 20% samples above 5,000.	2
New England	A	MPN	50	1
Tenn. Valley	I	Geom. Av. MPN	50	1
Authority	II	Geom. Av. MPN	5,000	2
	III	Geom. Av. MPN	20,000	3
Tennessee (state)		Av. MPN	5,000	4
West Virginia	AA	Mo. Av. MPN	100	5
	A	Mo. Av. MPN	1,000	5
	B	Mo. Av. MPN	10,000	3
Indiana	- -	Max. MPN	5,000	
Washington		Av. MPN	50	1
Potomac River	A	Mo. Av.	50	1
Commission	C	Mo. Av.	5,000	2
Incodel	Zone 1	Av.	10% not over 100	5
		Max.	10,000	
	Zone 2	Av.	25% not over 100	2
		Max.	10,000	
Ohio River	Desirable	Mo. Av.	50	1
Committee	Desirable	Mo. Av.	5,000	2
(House Doc.	Doubtful	Mo. Av.	5,000 - 20,000	3
266)	Unsuitable	Mo. Av.	Over 20,000	
U. S. P. H. S.	II	Mo. Av.	50	1
Recommenda-	III	Mo. Av.	5,000	2
tions		Max.	20% over 5,000	
(Bull. 296)				
	IV	Mo. Av.	Over 5,000	2, 3
		Max.	5% over 20,000	

Remarks: 1—Chlorination 2—Filtration and chlorination 3—Auxiliary treatment

4—General sanitation 5—Good sources

OBJECTIVES summarized:

As a guide in the establishment of treatment requirements for sewage discharged in the Ohio River, and as a yardstick for evaluating sanitary conditions in waters used for potable supplies and recreational purposes, the Ohio River Valley Water Sanitation Commission on April 4, 1951, adopted these bacterial-quality objectives:

Water Supply Uses—The monthly arithmetical average "most probable number" of coliform organisms in waters of the river at water intakes should not exceed 5,000 per 100 ml in any month; nor exceed this number in more than 20 percent of the samples of such waters examined during any month; nor exceed 20,000 per 100 ml in more than 5 percent of such samples.

Recreational Uses—For bathing or swimming waters, monthly arithmetical average "most probable number" of coliform organisms should not exceed 1,000 per 100 ml during any month of the recreation season; nor exceed this number in more than 20 percent of the samples examined during any such month; nor exceed 2,400 per 100 ml on any day. For non-bathing or non-swimming waters, the monthly arithmetical average "most probable number" of coliform organisms should not exceed 5,000 per 100 ml in any month of the recreational season, nor should exceed this number in more than 20 percent of the samples examined during any such month.

The limits for potable supply sources are premised on the desirability of a return to normal water-treatment methods (coagulation, sedimentation, rapid-sand filtration, and pre - and/or post-chlorination) with a minimum of chlorine residuals in the finished water, in order to insure palatability as well as bacterial safety of water supplies drawn from the river. Too many water treatment plants must now resort to auxiliary processing as a regular practice because of excessive pollution loads. It cannot be denied, however, that the availability of such facilities for emergency use is highly desirable.

Recommendations for recreational waters are tentative, pending further knowledge of the epidemiology of bathing-water sanitation, and are intended to provide reasonable safeguards to bathers along the river against more serious water-borne diseases. For recreational uses not involving bathing or swimming, a bacterial-quality goal at the water supply level is recommended.

It is recommended that the improved methods of coliform-bacteria enumeration employed in the Commission's Ohio River water quality survey of September, 1950, be adopted as standard procedure for future routine tests in connection with bacterial-quality investigations.

As an aid in the interpretation of these objectives and the manner in which they are to be applied, see the next section for detailed explanation.

INTERPRETATION and APPLICATION

Application of bacterial-quality objectives for the Ohio River involves evaluation of existing pollution levels with reference to those which should be attained to meet potable supply and recreational requirements. Such an evaluation — in terms of coliform-bacterial densities — cannot be expected to be precise in the same degree that is possible with chemical analyses of the river water.

Methods now available for enumerating bacteria of the coliform group are subject to errors far beyond those of chemical determinations, or even of biochemical tests such as "biochemical oxygen demand". This fundamental fact should be kept in mind when interpreting and applying bacterial-quality objectives expressed in terms of "most probable numbers" of coliform organisms. Experienced judgment and common sense, together with a thorough knowledge of local conditions affecting sewage pollution, are essential to a rational application of these objectives.

Averages and single results—According to an estimate by Velz, the upper 95 percent confidence limit for the result of a single-coliform test with three tubes planted in each dilution is 3.6 times the MPN determined from the test. (Velz, C. J., Inservice Training Course lecture, March 14-15, 1949, University of Michigan, School of Public Health, Ann Arbor, Mich.)

If the MPN resulting from the test were 2,300 per 100 ml. there is a 95 percent probability that the true number of coliform organisms in the sample would range up to, but not exceed, 8,300 per 100 ml. An average of 25 results would theoretically narrow the range to one-fifth of that for a single result, bringing the upper 95 percent confidence limit to about 72 percent above the observed mean of the 25 results. This illustrates the statistical advantage of averages versus individual results with regard to their stability and range of error.

Sampling effect—Another source of error in evaluating coliform density in river waters is due to sampling. For ordinary catch-sampling in a well-mixed stream, this error may run 15-20 percent for a single sample. Where the stream is not well mixed across a section, the error may run considerably higher, especially if samples are collected at single mid-stream points. This latter error is variable and practically impossible to evaluate, except by direct measurement in a particular situation. Sampling errors generally are compensating; their range may be greatly reduced by averaging. They probably are of a lower order than those involved in the coliform determination itself.

In the Commission's Ohio River water quality survey of September, 1950, results from coliform tests made on daily samples were obtained for a period of two weeks at 36 sampling points, of which 27 points were located in the Ohio River, and nine points at the mouths of principal tributaries. Methods followed in these tests, carefully standardized by the USPHS Environmental Health Center at Cincinnati, involved planting three tubes in each of three or more dilutions, arranged in decimal series. Results of the standard confirmed test were reported from the survey; 24-hr and 48-hr presumptive results were also recorded. A separate report on this survey has been prepared by the Commission. Reference here is only to a section of the coliform results, which have provided excellent illustrative material for application of bacterial-quality objectives.

Period averages and daily maximums—A summary of the period-average and daily-maximum confirmed results of the coliform tests at each sampling point, together with the percentages of days on which the coliform MPN exceeded 5,000 and 20,000 per 100 ml, respectively, is given in Table 2. A plot of the period-averages at the various sampling points, with ordinates representing the corresponding percentages of samples in which MPN exceeded 5,000 per 100 ml, is given in Fig. 1. A similar plot for the percentages of samples showing MPN's exceeding 20,000 per 100 ml is also given. For those sections of the two curves within an average MPN range up to 20,000, trends of plotted points follow nearly straight lines, and the correlation coefficient in each case is over 0.90, indicating a high degree of correlation in this range.

Inspection of Table 2 shows that average coliform MPN was less than 5,000 at only four sampling points (Nos. 5, E, 26, and 27), though it exceeded this figure only slightly at a fifth point (No. 9). At these five points the frequency of daily samples exceeding 5,000 MPN was 25 percent or less, averaging 14 percent, and the frequency exceeding 20,000 MPN was less than 10 percent, averaging 5 percent.

It is noted that with an average coliform MPN of 5,000 (Fig. 1) intersections of the two curves at this vertical show 20 percent and 5 percent, respectively, as frequency of individual MPN's exceeding 5,000 and 20,000. These intersections have provided a basis for adjusting the "over-run" frequency allowances made in connection with the bacterial-quality objectives recommended for potable supply requirements. They reflect more accurately the natural run of variability in the river's coliform content when measured by the improved method of routine tests followed in the survey of September, 1950.

The maximum daily coliform MPN recorded at any of the five sampling points above noted was 23,000 per 100 ml, being 9,300 at two of them, and 23,000 at the other three points. It thus appears that at average-coliform levels of 5,000 or below, natural variability in the Ohio would tend to limit the daily maximum MPN to about 23,000. Within the range of expected error this approximates the 20,000 level marking the safe-load limit for water-filtration plants using auxiliary treatment.

A further study of the ratios of maximum-to-average MPN's recorded in Table 2 brings out some interesting points concerning the general run of these ratios, and a few divergences from this trend. At all except five of the 36 sampling points, the maximum-to-average ratio was less than 6.0, and at 23 of the points, was less than 5.0. At the five points where these ratios were exceeded, divergence was found to be due to a single exceptionally high daily result in each case, exerting a marked influence on the period average. Although these departures from the general trend of the ratios were a small minority, they raise an important ques-

TABLE 2 — AVERAGE AND DAILY MAXIMUM RESULTS OF COLIFORM DETERMINATION IN OHIO RIVER WATER QUALITY SURVEY — SEPTEMBER, 1950.

Sampling Point No.	Confirmed Coliform MPN Average	Confirmed Coliform MPN Maximum	Ratio Max/Avg	MPN Greater than: 5000/100 ml days	5000/100 ml %	20000/100 ml days	20000/100 ml %
A	24,500	75,000	3.1	11	92	7	58
B	88,700	930,000	10.5	7	58	3	25
1	81,700	230,000	3.0	12	100	12	100
C	14,400	43,000	3.0	8	67	4	33
2	9,600	43,000	4.5	6	50	1	8
3	8,000	23,000	2.9	5	42	2	17
4	15,500	93,000	6.0	4	36	3	25
5	4,400	23,000	5.2	2	17	1	8
6	6,400	23,000	3.6	3	25	2	17
D	321,000	930,000	2.9	12	100	11	92
7	18,400	43,000	2.4	7	58	5	42
8	7,900	43,000	5.5	4	33	1	8
E	3,800	9,300	2.4	3	25	0	0
9	5,300	23,000	4.3	2	17	1	8
10	11,100	43,000	3.9	3	25	6	50
11	40,800	230,000	5.6	7	58	5	42
12	39,900	150,000	3.8	10	83	5	42
13	70,000	430,000	6.2	12	100	10	83
F	162,000	930,000	5.8	12	100	11	92
14	40,900	230,000	5.6	10	83	6	50
15	76,000	430,000	5.7	6	50	4	33
G	192,000	930,000	4.9	8	67	5	42
16	210,000	930,000	4.4	9	75	8	67
17	94,000	430,000	4.6	12	100	11	92
H	11,700	75,000	6.4	3	25	2	17
18	44,400	230,000	5.2	8	73	6	55
19	211,000	2,300,000	10.9	8	67	4	33
20	156,000	290,000	1.9	12	100	12	100
21	14,700	43,000	2.9	9	75	6	50
22	28,000	93,000	3.3	11	92	9	75
23	12,100	43,000	3.6	7	58	3	25
I	29,500	93,000	3.2	9	75	6	50
24	15,100	43,000	2.9	9	75	4	33
25	7,600	23,000	3.0	4	33	2	17
26	3,300	9,300	2.8	1	8	0	0
27	2,500	4,300	5.6	0	0	0	0

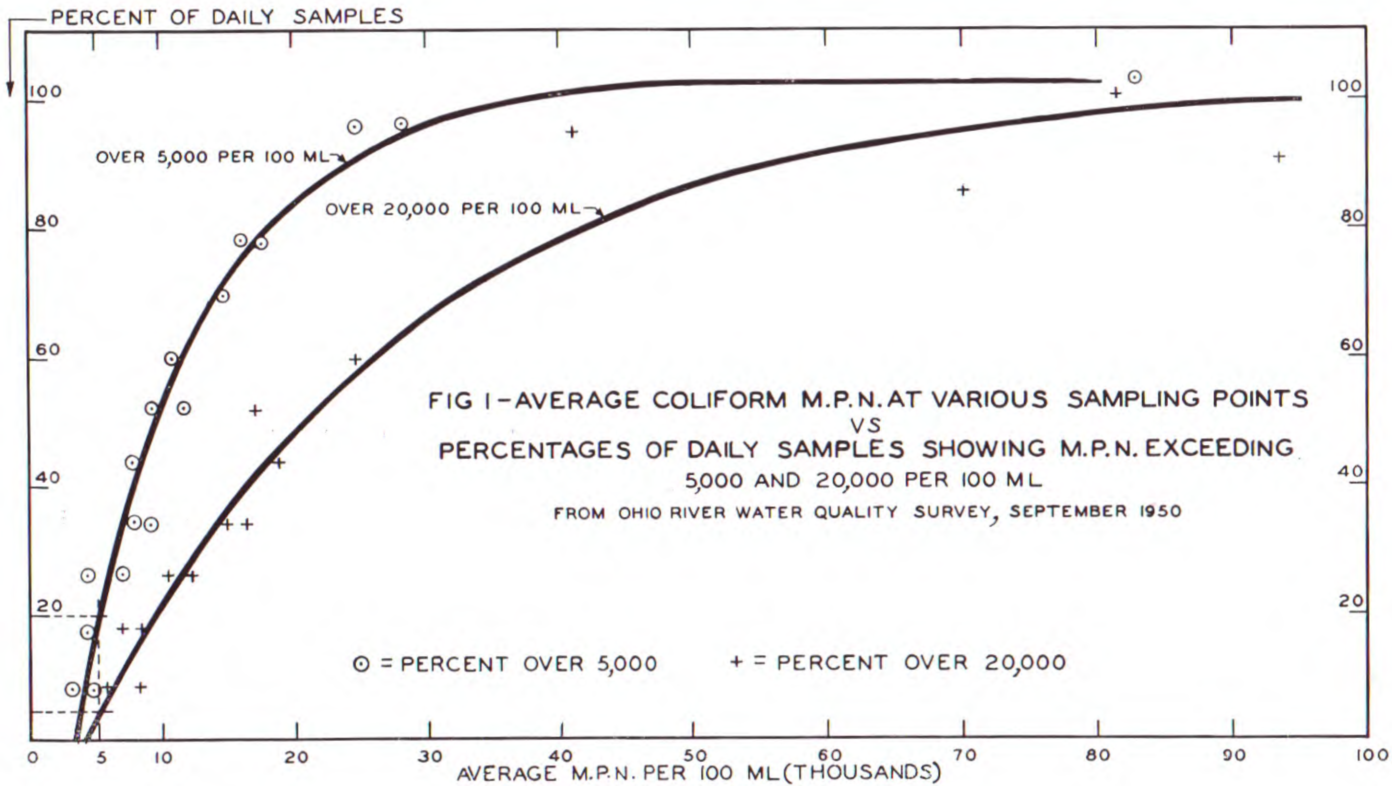


FIG 1 – AVERAGE COLIFORM M.P.N. AT VARIOUS SAMPLING POINTS VS PERCENTAGES OF DAILY SAMPLES SHOWING M.P.N. EXCEEDING 5,000 AND 20,000 PER 100 ML

FROM OHIO RIVER WATER QUALITY SURVEY, SEPTEMBER 1950 tion as to the application of water-supply objectives to situations of this kind. A single high result, far out of line with the others, may exert an undue influence on the average at a given point. It tends to show an average water condition materially worse than otherwise would be indicated.

At three of the five points in question, average coliform MPN's were so high, even excluding single maximum results, that quality of the river water at these points would fail to meet an objective of 5,000 per 100 ml by a wide margin. At the other two points, exclusion of single high results would bring period average only slightly above the objective level. In the first case, it would be immaterial, for all practical purposes, whether or not high results were discarded, as the evaluation would be substantially the same in either event.

No rational conclusion in the second case could be reached until an analytical check had been made to determine whether the exceptionally high result recorded at each point was due to error in the test, or whether its occasional recurrence was normally to be expected at that point. Local sources of pollution might be revealed by a sanitary survey of the immediate drainage area. Any wide departure from the normal maximum-to-average ratio would call for a thorough check on the point in question before any final judgment could be reached.

Recreational waters—Application of bacterial-quality objectives to waters used or intended to be used for recreation involves the same general principles and raises the same questions of interpretation as those arising for water-supply objectives. In this case it would seem that wide departures in daily maximum MPN's from the average run of the data might have greater public health significance for natural bathing waters because of the direct exposure of bathers without the intervention of any artificial purification process. For this reason it has been thought expedient in revising the bathing-water objective, to provide a limiting maximum, subject as it may be to the possibility of wide errors in routine determination. In this case judgment should be exercised in applying such a maximum, lest a bathing water of generally good sanitary quality be unjustly condemned and its recreational values thereby sacrificed.

A check should be made on the coliform-enterococci ratio in accordance with the recommendations of Scott and Clark.

Waters draining agricultural lands—Where the sanitary survey shows a water intake or a bathing area to be definitely unaffected by some source or sources of sewage pollution, as in streams draining solely agricultural lands, the coliform limits herein recommended should be interpreted with considerable latitude.

Need for standard coliform test—A final point to be emphasized in the application of the objectives is the desirability of a concerted effort on the part of the signatory states to bring about at the earliest time practicable the adoption of a standard method of routine coliform tests for Ohio River and its tributary waters based on the same procedures as followed in the Ohio River Commission water quality survey.

This method would involve planting three tubes in each sample dilution, with a sufficient range of dilutions (at least three) to insure an accurate determination of the "most probable manner" in each sample. The standard "confirmed" test should be made on all samples, as prescribed in Standard Methods. Variations in the ratio of confirmed results to those obtained from 24-hr and 48-hr presumptive tests in connection with the September survey were sufficiently wide to suggest that it would be inadvisable to depend on either of these two presumptive tests for comparable results at all stream points.

BACKGROUND and VALIDATION

by Harold W. Streeter, *Consultant*
Ohio River Valley Water Sanitation Commission

In a communication received from the Commission's executive director, under date of March 6, 1950, I was requested to review "available information and practice on the use and validity of bacterial-quality standards as related to water supply and recreational requirements", and "to prepare a report and submit recommendations for the establishment of bacterial-quality objectives for the Ohio River". This report deals with conclusions reached from such a study, and explains the reasons for such conclusions. It follows the general outline of an interim report made to the Engineering Committee of the Commission at its meeting on July 11, 1950, and is modified to incorporate further data.

The study followed two general lines of inquiry:

(1) A review of representative state and regional standards currently proposed to meet the requirements of the two stream uses indicated in the reference; and

(2) An analysis of available research and observational data bearing on the fundamental bases of current standards, and their application to conditions of pollution and water uses in the Ohio River. In this connection, particular attention has been given to the practical aspects of the problem, as viewed from the standpoint of the long-range plans and policies which are understood to motivate the Commission's program for establishing effective pollution control both in the Ohio River and in its tributary streams.

In carrying out the study, advantage has been taken of interchanges in views with the Commission staff, with Mr. M. LeBosquet and his associates in the U. S. Public Health Service and with Mr. F. H. Waring, chief engineer of the Ohio State Department of Health, with whom frequent meetings have been held in connection with another project touching somewhat closely the problems of the Ohio River. These conferences, together with the views of the Engineering Committee obtained at its July 11, 1950 meeting, have been of much value to me in orienting my viewpoint with the general policies of the Commission. Special acknowledgement is also made to Mr. LeBosquet for his kindness in loaning files containing valuable information on stream standards, and also for his helpful advice. Thanks are also due to Messrs. F. M. Middleton and H. F. Clark of the Environmental Health Center at Cincinnati for their kindness in collecting certain bacteriological data for me while visiting water treatment plants along the Ohio River, and also

to Mr. Waring for making available the files at his office containing annual summaries of similar data as reported during past years from plants in Ohio located on the river.

Because of the difference between bacterial-quality requirements for water supplies and for recreational water uses, especially for bathing, this study has been divided into two parts, each dealing separately with its own phase of the problem. In the section of the report which immediately follows, attention will be confined to water supply requirements, and the bacterial-quality objectives which have been and may be established in order to meet such requirements.

Water Supply Objectives

The history of bacterial-quality standards to meet water supply requirements dates back for some thirty-five years in the United States to the International Joint Commission standard, which was adopted in 1914 on recommendation by a board of consulting sanitary engineers headed by the late George W. Fuller. This standard provided in effect that the yearly average coliform bacteria index in the international boundary waters of Canada and the United States as delivered for treatment should not exceed 500 per 100 ml. In recommending this standard the board pointed out that the index would be expected to exceed this limit at times during the year, and to be less at other times. The standard was based on an assumed efficiency of coliform bacterial removal of 99.6 percent by the average filtration plant treating these waters, and the production of an effluent containing not over 2.0 coliform bacteria per 100 ml., the upper limit then provided in the U. S. Treasury Department drinking water standard.

During the period of 1915 to 1916, the U. S. Public Health Service began a series of observational studies of the efficiency of water treatment plants which, after being discontinued because of World War I, were resumed in 1924 and continued through 1929. These studies covered a year's observation of the performance of 31 representative municipal water filtration plants, including 10 plants on the Ohio River, and five year's operation of a large-scale experimental filtration plant at Cincinnati, equipped with modern treatment devices and designed in two parallel sections throughout, so that any two different methods or combinations of treatment could be observed under the same raw water and other conditions. The results of these investigations, published in a series of reports, provided the only available information on the efficiency and limitations of various combinations of water treatment at that time, and have served as the basis for bacterial-quality standards for sources of treated water supplies in many of our states up to the present time.

Within the limits of observational error, it was found that the average water filtration plant of the rapid-sand type, with postchlorination to low residuals (0.05 - 0.30 ppm by the OT test), could deliver an effluent meeting the bacterial requirements of the 1925 drinking water standard (average coliform index not exceeding 1.0 per 100 ml) from raw waters containing an average of not over 5,000 coliforms per 100 ml. For relatively short periods of time, such as a month, this average would not ordinarily be exceeded by a degree sufficient to vitiate its applicability as a working limit, though for longer periods, such as a year, or several months, variations above the average would be greater in degree, and sometimes too high for safety.

In connection with the same series of studies, the effects of certain auxiliary measures of water treatment on the overall efficiency of bacterial removal were investigated. These measures included prechlorination and multi-stage coagulation-sedimentation, both of which have been in use, either separately or in combination, at some plants on the Ohio River. It was found that prechlorination and double-stage sedimentation, when added to normal filtration treatment, would permit higher average numbers of coliform bacteria in the raw water and enable plants thus equipped to take care of temporary overloads of bacterial pollution, ranging up to 20,000 coliform bacteria per 100 ml. or thereabouts. Thus two general levels of permissible raw water pollution were established observationally, the lower one applicable to normal filtration with low-residual postchlorination, and the higher one to the same treatment reinforced by auxiliary measures such as above described, providing a safety factor, when needed, to offset peak loads on the normal filtration process. This was the general concept of the proper function of auxiliary treatment at that time, as an adjunct to normal filtration.

With increased sewage pollution of the Ohio River, and the concomitant problem of industrial wastes pollution, the role of auxiliary treatment has changed gradually from that of a temporary safety measure to one of continuous integration with the treatment process as a whole. This step has brought about a chain of circumstances, ranging from increased chlorine residuals through and after treatment to measures such as aeration, activated carbon treatment, chlorine dioxide treatment, and "breakpoint" chlorination, designed to deal with tastes and odors resulting in part from intensified chlorination, and in part from increased sewage and industrial pollution. Multistage coagulation-sedimentation, together with pre-settling, also have been resorted to in an effort to meet increasing bacterial loads.

The past twenty-five years has thus been a record of a continuing struggle to deal with this problem at the water intake, with consequent deterioration in the quality of water supplies except for bacterial content, which has been held down mostly within safe limits as defined by current drinking water standards. With this historical background in mind, a brief review of state and regional bacterial-quality standards for sources of water supply, together with a somewhat more detailed review of the present bacterial efficiencies of a few representative water treatment plants on the Ohio River studies some twenty-five years ago, will follow in the order just named.

State and Regional Standards

In connection with this study, a review has been made of eleven state and regional standards proposing bacterial-quality requirements for sources of water supply. In Table 1 (page 4) is given a summary of these requirements, as taken from the latest source material available. These are the only standards of this character found among the laws and regulations of some forty-odd states relating to the control of stream and lake pollution. A majority of them, it will be noted, are based on recommendations for regional or general pollution control, only five of them having been drawn up for individual states. Eight of the eleven standards named are set up as parts of a classification of streams according to various water uses. In two cases (New England's Class A and Washington's general standard), bacterial-quality limits set for sources of water supply have been based evidently on requirements for waters treated by chlorination alone. In one case (Tennessee), the standard recommended is indicated as a general one for streams of the state, including those used for water supplies after normal filtration treatment. In eight of the standards, a limit of 5,000 coliform bacteria per 100 ml. is given for waters subjected to normal filtration-postchlorination treatment.

In seven of these eight cases, the standard is given as an average, and in one case (Indiana), as a maximum.

In all of the eleven standards, the coliform group of bacteria is taken as the index organism, and is expressed numerically either in terms of the "most probable number", or unspecified. In one standard (T.V.A.) the geometric mean is used rather than the arithmetic mean. In two of the standards (New York and U.S.P.H.S. recommendations), an over-run above 5,000 coliforms per 100 ml. is limited to 20 percent of samples tested, and in the latter case, an over-run above 20,000 per 100 ml., to 5 percent. This is a wise provision in standards expressed as long-term averages, as it places a definite limit on variations above the average. It should take account, however, of the natural variability of a stream or lake in this respect, as otherwise an upper limit may be set which cannot be controlled.

In reviewing these standards, the recurrence of the figure, 5,000 per 100 ml., suggests the influence of the U. S. Public Health Service's studies of the 1920's. It is significant in this connection that this standard has stood for a period of nearly twenty-five years where it has been used, and has in fact gained in favor with the years, having been incorporated into some of the more recent standards. The reason for this survival of an old standard probably lies mainly in the fact that it has served its purpose well, and also that little change has occurred in the basic processes of water filtration since it was originally recommended, though some of them, such as chlorination and multi-stage sedimentation, have been intensified, as previously noted, where excessive raw water pollution has forced such additional defensive measures. That only two of the ten standards reviewed have mentioned a higher coliform limit as permissible with auxiliary treatment suggests that in a majority of cases a definite reservation exists concerning any compromise with a standard which assumes more than normal filtration treatment as a desirable practice. This is a highly significant fact, which should not be lost sight of in the preesnt situation of water treatment along the Ohio River.

Efficiency of Filtration Plants

In view of the marked increase in pollution of raw water supplies in general along the Ohio River during the past twenty-five years, and the consequent necessity for reinforcement of the filtration plants treating these raw waters, an important aspect of this study has been to compare the present bacterial efficiency of a few representative plants along the river with that which was observed at the same plants some twenty-five years ago in connection with the survey previously mentioned. It has been possible to obtain comparable data from only six of the ten plants previously studied, namely, at East Liverpool, Steubenville, Huntington, Ironton, Cincinnati, and Louisville. From records of these six plants, monthly average coliform results for one year from each plant during the period of 1945-1949 have been compared with those obtained at the same plants for a year during the period of July, 1923 through June, 1924, in connection with the U.S.P.H.S. surveys. For the recent period, 1945-49, the years selected have not been in all cases the same, because it has been desired to avoid years in which any material change in treatment has beenmade.

At all of the plants included in this review, coliform enumerations are expressed in terms of the "indicated number" (Phelps index), and in all except the final effluent samples, are determined from fermentation tests with single-tube plantings in decimal series dilutions. As this is the same procedure as was followed in the routine coliform tests in 1923-1924, the results obtained at that time are directly comparable with those at the present time, making some allowance for minor changes in the methods followed in making confirmatory tests. In final effluent and distribution tap samples, the standard test in five 10-ml. portions is the rule, with additional single-tube plantings in 1 ml. in some cases. In general, enumerations of coliform bacteria in raw and other samples up to the final effluent are based on the standard presumptive test. In the final effluent and tap samples, the results are in some cases expressed in terms of the "gas-former" index (48-hour gas), presumptive index (24-hour gas), and confirmed index. In such cases, an opportunity is thus afforded to compare the final results in these three terms.

Of the six plants selected for study, all except the Ironton plant now use high chlorine residuals. At Cincinnati, "breakpoint" prechlorination has been added recently in an endeavor to minimize objectionable tastes and odors. At Ironton, chlorine residuals have remained at less than 0.2 ppm, which is about the same level as in 1923-1924. At the other five plants, residuals have been increased from about the same levels as at Ironton 25 years ago until they now range from 0.3 to 0.8 ppm or more. In some cases an effort is made, through the addition of ammonia, to maintain chloramine residuals throughout the distribution system. In general, tastes and odors in the treated water supplies have been considerably more serious in recent years than they were in 1923-1924, when the major cause of such troubles was the occasional presence of phenols in the river.

It is somewhat difficult to determine whether the intensified difficulties in respect to tastes and odors have been due mainly to increased industrial wastes pollution, increased sewage pollution, or both combined, together with the necessity of using much higher chlorine residuals. Probably all of these elements have exerted some influence. It seems quite likely that if industrial pollution were completely eliminated as a causitive factor in the present taste and odor problem, this problem would still continue to exist in those sections of the river where sewage pollution is high, if only for the reason that intensified chlorination would still be necessary in order to combat sewage pollution at the water intakes.

The exception at Ironton is notable because unusual coagulation-sedimentation facilities, together with the fact that this plant is still working at an output well below its designed capacity, have enabled this plant to meet increased bacterial loads without resorting to heavy chlorination. Incidentally, it is understood that taste and odor troubles have been somewhat less acute at Ironton than in most of the other water supplies along the river, though industrial wastes pollution has caused some increase in these difficulties.

In Table 3 is given a tabulation of the comparative annual average numbers of coliform bacteria recorded in the raw water and final effluent at each plant during the year 1923-1924 and during one year of the 1946-1949 period. Also shown are the same results for each plant during the poorest month of the year, when the confirmed coliform index averaged the highest in the plant effluent. Except at Ironton, it is noted that yearly average coliform numbers have increased measurably in the raw water during the 25 years since 1923-24. It is not clear why this exception at Ironton should exist, unless it may be due to the combined influence of the high dam at Gallipolis, and the effect of the pool above Dam 26, which would tend to retard the lateral diffusion of pollution from Huntington and cause it to follow more closely the left bank of the river. This is borne out by the fact that the yearly average coliform index at Ashland had increased from 11,500 per 100 ml. in 1923-24 to 30,000 per 100 ml. in 1949. In the last

TABLE 3—AVERAGE INDICATED NUMBERS OF COLIFORMS PER 100 ML. IN RAW AND FINAL CHLORINATED EFFLUENT WATERS OF SIX OHIO RIVER FILTRATION PLANTS DURING ONE-YEAR PERIODS.

Plant	Year	Annual Average		Poorest Month Average		% of Raw in Effluent	
		Raw	Effluent	Raw	Effluent	Annual	Poorest Month
E. Liverpool	1949	3300	0.05	8600	0.30	.0015	.0035
	1923-24	2680	.40	3890	1.30	.015	.033
Steubenville	1946	640	.06	4630	.40	.0094	.0086
	1923-24	330	.20	210	.60	.061	.290
Huntington	1947	2260	.04	1510	.13	.0018	.0086
	1923-24	2370	.80	5280	1.60	.034	.030
Ironton	1945	6200	.02	3270	.17	.0003	.0052
	1923-24	14900	.01	19100	3.40	.00007	.018
Cincinnati	1945	4360	.08	8550	.32	.0018	.0037
	1923-24	2980	.50	9910	2.0	.017	.020
Louisville	1949	4570	.14	8900	1.0	.0031	.011
	1923-24	2220	.10	2300	.30	.0045	.013

Note: Raw water numbers based on presumptive tests; effluent numbers on confirmed test.

two columns of Table 3 are shown the percentages of raw water coliforms observed in the final effluents of the six plants during the recent period, as compared with those recorded during the period 1923-24. It is also to be noted that despite the increased bacterial loads during the more recent periods, the average coliform content of the final effluents has been lower than during the period 1923-24. This trend is reflected in the lower percentages of raw water coliforms remaining in the final effluents, as compared with 1923-24.

That this increased bacterial efficiency is due almost wholly to more intensified chlorination is suggested by the results shown in Table 4, in which the average coliform numbers and their residual percentages observed in the unchlorinated filtered effluents of four plants during periods between 1945 and 1949 are compared with those observed in 1923-24. In these four cases direct comparison is possible because the filtered effluent samples during both periods represent the purification efficiencies accomplished by each plant without chlorination. Such a comparison has not been possible with the other plants on the river because of prechlorination not practiced in 1923-24, or because the filtered effluent samples were not directly comparable during the two periods.

It will be noted that two of the four plants show slightly greater, and two of them, slightly lower efficiencies of coliform removal during the two periods. In all cases no marked improvement in filtration process efficiency in itself is indicated. This evidences that the overall gain in bacterial efficiency of filtration processes along the river during the past 25 years has been accomplished very largely through the more liberal application of chlorine, and not through any material improvement in those features of filtration plant design and operation which in themselves would tend to bring about augmented bacterial efficiencies.

TABLE 4—COMPARATIVE NUMBERS AND PERCENTAGES OF COLIFORMS REMAINING IN UNCHLORINATED FILTER EFFLUENTS OF FOUR OHIO RIVER FILTRATION PLANTS.

Plant	Year	Coliforms per 100 Ml. Raw	Filtered	% of Raw in Filtered
Ironton	1949	5770	0.29	.005
	1923-24	14900	1.6	.011
Portsmouth	1949	2250	3.6	.11
	1923-24	3490	1.7	.05
Cincinnati	1945-48	4330	6.2	.14
	1923-24	2980	3.4	.11
Louisville	1947-49	3400	20.0	.59
	1923-24	2220	17.0	.77

In order to show somewhat more graphically the overall increase in bacterial removals effected by intensified chlorination, the figures given in Table 3 have been utilized to estimate, on the basis of the observed efficiencies, the maximum average coliform numbers in the raw waters as delivered to each of the six plants which would permit the delivery of final effluents containing an average coliform content of not over 1.0 per 100 ml., the limit set by the current drinking water standard, during each of the two periods covered in Table 3. This has been done by the simple process of dividing the number of raw water coliforms by the corresponding number recorded in the final effluent, thus giving the raw water content which would yield a number of 1.0 per 100 ml. in the effluent if the same bacterial removal efficiency should hold at the higher level.

This procedure is of course an approximation, but appears to be justified for purposes of estimate because previous studies have indicated that in general, the bacterial removal efficiency tends to increase with the bacterial loading on a treatment process up to a point where it levels off, and then remains fairly constant at higher loads. In the case at hand, except at Steubenville, where the bacterial load is relatively low in the raw water, the tendency for plant efficiencies to reach a fairly stable level would be expected to be attained at average coliform densities above 2,000 per 100 ml. or thereabouts, which density is exceeded by all of the raw waters except at Steubenville during both of the two periods studied.

On a yearly average basis, the raw water coliform limits thus estimated are shown to range from 11,000 to 66,000 (omitting the result for Ironton as being far out of line with the others), and to average 38,000 during the periods of 1945-49. During the period 1923-24, they ranged from 1,500 to 22,200, averaging 6,500, a figure which incidentally was not far from the coliform limit found for the average Ohio River plant in the U.S.P.H.S. studies carried out at that time. During the poorest months of the two periods, the estimated coliform limit in the raw waters averaged 18,000 for 1945-49, and 4,200 for 1923-24, the latter of which again was not far from the limit observed for the average Ohio River plant at that time.

In this connection it should be noted, however, that during these poorest months the efficiency of three of the six plants studied was such that their estimated limiting average coliform load would tend to approximate 10,000 per 100 ml., ranging from 8,900 to 11,600. Although this indicated load limit doubtless could be increased by more

TABLE 5—ESTIMATED AVERAGE INDICATED NUMBERS OF COLIFORMS IN RAW WATERS OF SIX OHIO RIVER FILTRATION PLANTS GIVING NOT OVER 1.0 PER 100 ML. IN FINAL EFFLUENTS.

(Based on average efficiencies during one-year periods)

Plant	Average Annual		Poorest Month	
	1945-49	1923-24	1945-49	1923-24
E. Liverpool	66000	6500	29000	3000
Steubenville	11000	1500	11000	350
Huntington	56000	2960	11600	3300
Ironton	310000*	140000*	19000	5600
Cincinnati	62000	6000	29000	4960
Louisville	33000	22000	8900	7700
Average	38000	6500	18000	4200

(*) Omitted from average.

highly intensified chlorination, it is nevertheless a significant indication that under conditions of normal operation, with the relatively high chlorine residuals being carried, occasional months occur in which the average plant efficiencies are shown to deteriorate to the extent indicated. (See Table 5)

Discussion

In interpreting the foregoing data, the following indications are noteworthy:

1. Increasing sewage pollution of the river has brought about a general need for augmenting treatment facilities in order to offset increased bacterial loads at the water intakes.

2. This has been accomplished for the most part by adding prechlorination to existing filtration facilities, and by carrying much higher chlorine residuals through the treatment process to the distribution system. Complete plant reconstruction has been undertaken only in two cases, though strengthening of certain stages of treatment has been carried out at several plants.

3. A general increase has been noted in the bacterial efficiency of practically every plant along the river, though most of them have shown a tendency for lowered efficiency during occasional months, sometimes under unusually heavy average bacterial loads, and at other times, under unfavorable conditions, which apparently occur more frequently during periods of marked seasonal changes, though not necessarily closely related to such changes.

4. On the basis of yearly average efficiencies, all except one of the plants studied can produce effluents of average drinking water bacterial quality from estimated raw water coliform bacteria loads ranging above 30,000 per 100 ml., and averaging roughly 40,000. As yearly average data tend to mask significant lapses in the bacterial efficiency of practically every plant studied, they may be considered only as indicating general trends in comparison with average efficiencies observed in 1923-24.

5. On the basis of performances observed during the poorest months of single years, by which is meant the months when the coliform numbers in the final effluents averaged the highest during the year, a somewhat different picture is shown. In this case, the estimated safe limit of coliform loading

would tend to center around 10,000 per 100 ml. for a significantly large proportion of the plants studied. This limit would represent that which could be handled safely under more adverse conditions of plant operation, but with existing facilities for high-residual chlorination. It would not provide in all cases a working factor of safety, though in others a fairly liberal margin in this respect would prevail.

Bacterial-Quality Objectives

In establishing bacterial-quality objectives for the Ohio River to meet water supply requirements, a distinction should be made between those which are tolerable and those which are desirable. From the standpoint of tolerance, a limiting average coliform density of 10,000 per 100 ml. would be adequately safe, but would involve the continued dependence on intensified chlorination as an integral part of every water filtration plant. This in turn would entail a continuance of existing difficulties with unpalatability in water supplies derived from the river, largely as the result of the need for carrying high chlorine residuals into the distribution systems. Although such a condition might be tolerated during emergencies, and treatment plants should be equipped to meet them, it cannot in my opinion be considered as a desirable situation permanently, from the standpoint of the nearly three millions of people who depend on the river as their only source of domestic and industrial water supply.

It has been shown conclusively that normal filtration processes, with low-residual or "marginal" chlorination, can deliver both safe and palatable effluents from raw waters containing monthly average numbers not exceeding 5,000 per 100 ml., provided of course that such waters are free from taste-producing industrial pollutants. In view of plans now underway to reduce and ultimately eliminate all harmful industrial pollution from the Ohio River, a return to normal filtration methods would be a highly desirable concomitant of such a development.

It therefore is recommended that pollution-control measures along the Ohio River and in its tributaries be aimed to meet an ultimate bacterial-quality objective such that the monthly arithmetical average "most probable number" of coliform bacteria in the river at all water supply intakes will not exceed 5,000 per 100 ml. in any month; nor will exceed this figure in more than 20 percent of the samples of raw water examined during any month; nor will exceed 20,000 per 100 ml. in more than 5 percent of such samples.

In making this recommendation, the month has been taken as the period of the average for two reasons. First, it is the shortest common period for reporting bacterial results which will permit a fairly stabilized average to be taken. Secondly, it usually is based on at least 25 daily results from individual tests, and thus involves a range of statistical error which is roughly one-fifth or less the expected error of an individual coliform result. In view of the very large errors of individual results which have been shown to be involved in the ordinary MPN determination, it would be highly unwise, in my opinion, to base any limiting standard on a single maximum expressed in such terms. The month appears to be the best compromise between a period which is either so short as to involve large errors of measurement, or so long that seasonal and other natural variations in the coliform content of a stream would exert an undue influence on an average.

Use of an arithmetic average has been followed in stating this objective because the main statistical reason for using a median, or a geometric mean, namely, a definite pattern of logarithmic skewness in the frequency distribution of individual results, has not been found in the normal trend of these results when taken over periods as short as a month, though various degrees of skewness, highly irregular in pattern, have been noted in some months and at some points, owing to the effect of a few high results. Moreover, in the case at hand, every individual result has its significance in showing the average condition of a stream during short periods of time; hence any tendency to suppress the full effect of even a few high results would tend to distort the true significance of an average, where the public health is so vitally concerned, and where, as in the Ohio River, sewage pollution dominates every situation.

Provision of "over-run" frequency controls in the objective as stated is designed to place a definite limit to the frequency of high results above those which would normally be expected as being due to natural variance in the stream content, at average levels not exceeding 5,000 per 100 ml. A slight revision in these "controls" has resulted from an analysis of the results of the Commission's Ohio River Water Quality Survey of Sept., 1950, in which improved methods of coliform enumeration were followed.

As a rough guide in estimating the degree of reduction in bacterial pollution to meet such an ultimate objective, an analysis has been made of a ten-year record of monthly average raw water coliform densities reported at ten water filtration plants during the years 1926-1935, inclusive. This study has indicated that under normal stream conditions in the Ohio River, an average coliform density of 5,000 per 100 ml. may not be expected to be exceeded in any month of the year if the yearly average coliform density is held within an upper limit of 2,000 per 100 ml. Referring to Table 3, it will be noted that the yearly average coliform densities recorded at the six intakes listed in the table were slightly more than twice this limit at Cincinnati and Louisville during 1945 and 1949, respectively, somewhat over three times the limit at Ironton in 1945, about 65 percent higher at East Liverpool in 1949, very slightly higher at Huntington in 1947, and lower at Steubenville in 1946. At Ashland, Kentucky, however, where the reported raw water coliform index averaged 30,000 per 100 ml. in 1949 (the highest along the river), a reduction of nearly 95 percent in the bacterial load would be required. The excessive load on this plant is quite evidently due to the influence of sewage pollution from the Huntington district, which apparently tends to follow the left bank of the river downstream.

The foregoing recommendation may be criticized on the ground that it is unduly conservative, because it fails to credit the increased bacterial efficiencies which have been developed at the several Ohio River filtration plants in a continued effort to combat increased raw water pollution. The provision of added facilities to accomplish this purpose has been an expensive undertaking, and represents a very considerable investment. Some plant supervisors are honestly convinced that the bacterial-quality standards of past years are outmoded, and should be modified so as to take account of the greater bacterial efficiencies of water treatment processes made possible by intensified chlorination, and other auxiliary measures of reinforcement.

In this writer's opinion, the answer to these arguments rests in the simple fact that water consumers along the river are not obtaining the consistently palatable water supplies to which they are entitled, despite the ingenious and costly methods which have been developed in an effort to combat such unpalatability. As the only major change in water treatment has been intensification of chlorination, the inference seems quite clear that this practice lies at the root of present difficulties, though doubtless aggravated by the effects of certain industrial pollution. Reduction of bacterial loads in accordance with the objectives herein recommended would go far to obviate the necessity of heavy chlorination, and thus make it possible, with the improved chlorination techniques of recent years, to produce even more palatable water supplies than were being delivered some 25 years ago.

Pending the time when adequate pollution control has become established in the river and its tributaries, a monthly average coliform number not exceeding 10,000 per 100 ml. in any month should serve the purpose of maintaining reasonably safe water supplies, though at the price of continuation of present practices of intensified chlorination. If sewage pollution of the river could be brought within the boundaries of such a temporary standard, it is possible that at plants equipped with improved coagulation-sedimentation facilities, some reduction in the present high level of chlorine residuals could be effected, and in some cases carried to a level of "marginal" chlorination, as has been done at the Ironton plant during the past 25 years, despite heavy bacterial loads in the raw water. Although a monthly average coliform load up to 10,000 per 100 ml. doubtless could be carried without undue difficulty at practically every Ohio River filtration plant with present equipment, an objective at this level would serve only as a temporary expedient, and in my opinion would not afford a permanent solution of the problem.

Recreational Water Objectives

The approach to considering bacterial-quality objectives to meet recreational requirements is quite different, and in some respects more difficult, than that of water supply requirements. In this case, no background of systematic observation and experiment exists, except a few studies of bathing beaches such as have been made in Connecticut and California, correlating known sanitary conditions with bathing water quality. Although some recent studies instituted by the U. S. Public Health Service have made a more direct approach to the problem by undertaking to correlate bathing water quality with the incidence of water-borne diseases among the bathing population, these studies are still in progress, and may require some time before definite results will be available. In Illinois, a novel approach has been made through a study aimed to correlate sanitary surveys with coliform-enterococcus levels in lake waters. Further results of this study will merit the closest attention, and likewise those of the U.S.P.H.S. Meanwhile it is possible only to review existing standards proposed in several states and regional areas, and attempt to appraise their public health significance as applied to streams like the Ohio River.

In Table 6 is given a summary of 11 state and regional standards for bathing and recreational waters. In five of these standards are parts of classification schemes for natural waters used for different purposes. In 9 of the 11 standards, a limiting coliform bacterial density of 1000 per 100 ml. is given, either as an average or as a maximum. This, in fact, is the most recurrent figure appearing in the standards, and may well be taken as a base line for discussion. For desirable bathing waters, preferred coliform densities range from 50 to 100 per 100 ml. as averages, especially where classification of bathing waters has been adopted or proposed. Between this level and that of 1,000 per 100 ml. seems to be an intermediate zone, in which many stream and lake waters of relatively low degrees of pollution fall. Current bacteriological surveys of some 25 bathing beaches along the Ohio shore of Lake Erie have disclosed a considerable number of beaches comparatively free of local pollution falling into this intermediate class on the basis of their average coliform bacteria counts.

TABLE 6 — SUMMARY OF BACTERIAL-QUALITY REQUIREMENTS FOR BATHING WATERS IN CERTAIN STATE AND REGIONAL STANDARDS

State or Region	Class	Units	Limiting Coliform Numbers per 100 Ml.
New York	B-1	Av. MPN	1000
		Max. MPN	2400
New England	B	Max. MPN	1000
Connecticut	A	Av. MPN	0 - 50
	B	Av. MPN	50 - 500
	C	Av. MPN	500 - 1000
	D	Av. MPN	Over 1000
Tennessee Valley Authority	I	Geom. Av. MPN	50
	II	Geom. Av. MPN	1000*
West Virginia	AA	Mo. Av. MPN	100
	A	Mo. Av. MPN	1000*
Potomac River Commission	B	Av. MPN	50 - 500
		Max. MPN	1000
Indiana	—	Max. MPN	1000
Washington	—	Av. MPN	50
A.P.H.A. Joint Comm. (1948)	—	Av. MPN	1000
		Max. MPN	2400
Ohio R. Committee (House Doc. 266)		Av.	100
		Max.	1000
California		Av. MPN	1000
		Max. MPN	20% samples over 1000

(*) Also for general recreation.

For waters devoted to general recreational pursuits other than bathing, only a few standards have been found in which coliform bacterial requirements are specified. The Tennessee Valley Authority indicates in its recommended standard a limiting average coliform MPN (geometric mean) of 1,000 per 100 ml. for Class II waters, stating that such waters should be good for general recreation. West Virginia's coliform standard for Class A waters also indicates 1,000 per 100 ml. as suitable for general recreation. The Tennessee (state) standard does not specify whether its general coliform limiting average level of 5,000 per 100 ml. also applies to recreational waters, and hence is omitted from Table 6. The New England, Potomac River Commission, Indiana, and Ohio River Committee standards give a coliform density of 1,000 per 100 ml. as a maximum for bathing waters. Among the standards allowing densities in excess of this amount, New York (state) specifies a maximum of 2,400 per 100 ml., and California a frequency of 20 percent above 1,000 which is the limiting average for both of these standards.

It thus appears that in the very few cases where a general recreational standard is given, it is at the same average level as that of a majority of the bathing water standards (i.e. 1,000 coliforms per 100 ml.). A fairly logical reason for this in some cases would be that in general, recreational uses of streams and lakes, especially for camping, picnicking, etc., tend to merge to a considerable extent with bathing uses, as in many cases people will seek for such purposes water areas where bathing is permissible, even if only incidentally to other recreational pursuits. For some types of recreation, notably boating, bacterial-quality requirements should be definitely less stringent than for bathing, as in such cases little or no hazard of human ingestion of the water is involved. Thus along the Ohio River it is common to observe active boating in sections of the river where the quality of the water would permit bathing. For this particular activity, a common-sense view would seem to be that it could be readily pursued, with practically no hazard, in natural bodies of water which in general are fit sources of filtered water supplies, that is, which average not over 5,000 coliform bacteria per 100 ml.

With reference to bathing water standards, special mention has been made of a study by the Illinois Department of Public Health concerning the relation between sanitary surveys and the coliform-enterococcus levels in a lake pollution investigation. In a paper presented in October, 1949 by Scott and Clark*, the authors, from a statistical study of coliform-enterococcus ratios as correlated with a "relative pollution factor" ranging numerically from 1 to 5, concluded that in areas subject to sewage pollution, a satisfactory water would contain: (a) coliform MPN less than 700 if enterococci is 23 or more, or (b) coliform MPN 700 or over, but less than 2,400, if enterococci is less than 23 (all expressed per 100 ml.). In areas not subject to sewage pollution, a satisfactory water would contain: (a) coliform less than 2,400, if enterococci is 23 or more, or (b) coliform MPN over 2,400, but less than 7,000, if enterococci is less than 23. In setting up this scale, the authors in effect have taken an enterococci MPN level of 23 per 100 ml. as the dividing line between significant sewage pollution and pollution resulting from birds, rodents, and land wash.

In a paper given before the American Society of Civil Engineers in January, 1950, Cox** has reviewed the public health significance of bacteriological findings in natural bathing waters. He notes the efforts of bacteriologists to develop more specific tests for fecal bacteria, including tests for "sewage streptococci", indicating that in his view these investigations have not yet developed any tests more specific or of public health significance than the standard plate count and the test for coliform organisms. He concludes that bacterial tests should serve only as a general guide, forming part of the information pertaining to any given bathing beach, and that bacterial standards for natural waters used for bathing cannot be placed on a precise quantitative basis as disclosing the intrinsic quality of the water, or certain public health safety for the bathers. He indicates approval of beach waters in the New York City area if epidemiological data pertaining to bathers, and the sanitary survey, are both satisfactory, and the average coliform content of the water is not in excess of 2,400 per 100 ml., except when the other two criteria justify the use of the lower average of 240 per 100 ml. Cox also points out the well-known distinction between the types of infections con-

*Scott, R. M. and Clark, E. S. Correlation of the Sanitary Survey and the Coliform-enterococcus Levels in a Lake Pollution Investigation. Presented at the Society of Illinois Bacteriologists meeting, Springfield, Illinois, Oct. 13, 1949.

**Cox, C. R. Acceptable Standards for Natural Waters Used for Bathing. Presented before Sanitary Engineering Division, A.S.C.E., January, 1950.

tracted from natural bathing waters and those of artificial swimming pools, the latter including skin, mucous membrane, and other bather-to-bather infections, whereas the former usually are intestinal, resulting from ingestion of the water by bathers.

These two studies, though somewhat contradictory to each other in their specific findings, are illuminating in expressing trends of recent thought on the subject of bathing waters. According to both studies, coliform densities ranging up to 2,400 per 100 ml., or even higher if sewage pollution is known to be absent, are not necessarily out of line with good sanitation, though a rigid interpretation of the Illinois findings would tend to limit the coliform densities to something less than 1,000 if definite evidence of sewage pollution is present.

In connection with the present investigation, a study has been made of the possibility of utilizing the findings of Kehr and Butterfield* several years ago as a rough check on the rationality of various proposed bathing water standards, as viewed from the standpoint of water-borne disease hazards. Without going into their study in detail, it may be noted here that they derived from a number of studies in England, Indonesia, and California, where the successful enumeration of both coliforms and typhoid and para-typhoid organisms was carried out in sewage and sewage-polluted waters at the time of outbreaks of these enteric diseases, a correlation between the morbidity rates from typhoid fever in different areas and the ratios of E. coli to E. typhosa in the sewage and sewage-polluted waters of the areas. Although present typhoid morbidity rates in the Ohio Valley are extremely low, the rates for certain other enteric diseases, such as dysentery and diarrhea-enteritis, are sufficiently high to indicate a carrier reservoir which might be a factor in bathing water sanitation.

According to the U. S. Census mortality reports for various diseases, the average typhoid mortality rate for seven Ohio River states in the years 1945-47 was 0.4 per 100,000 (as compared with a rate of 0.2 per 100,000 in the U. S. registration area). Assuming a morbidity:mortality ratio of 10 to 1, this would indicate a morbidity rate of 4 per 100,000, or 0.04 per 1,000. From Kehr and Butterfield's curve, the corresponding ratio of E. typhosa: E. coli in the sewage and sewage-polluted waters of such an area would be 6 E. typhosa per million coliforms, or about 170,000 coliforms for each E. typhosa organism. This of course is an extremely low infection ratio for typhoid fever, but nevertheless measurable according to the Kehr-Butterfield results.

In order to apply these data to an evaluation of the typhoid hazard in bathing waters of an area, it is necessary to assume the average volume of water ingested per bather per day. For purposes of estimate, let this volume be assumed as 10 ml., which probably would be high for trained swimmers, and low for children. Now let:

R = the number of coliforms per single E. typhosa in the bathing water.

B = the number of bathers per day.

V = the volume of water, in ml. ingested per bather daily.

C = the average coliform content of the bathing water per ml.

Then the chance of exposure (P_e) of (B) bathers to a single E. typhosa on any day is:

$$P_e = BVC/R$$

and the exposure interval, in days, between successive ingestions of a single organism is:

$$I_e = 1/P_e = R/BVC$$

*Kehr, R. W. and Butterfield, C. T. Notes on the Relation Between Coliforms and Enteric Pathogens. Public Health Reports, Apr. 9, 1943. Reprint No. 2469.

For illustration, let us assume R = 170,000; V = 10 ml., and C = 10 per ml., or 1,000 per 100 ml. Then the chance that a single bather would be exposed to ingestion of one E. typhosa organism would be:

$$P_e = 1/1,700$$

During a 90-day bathing season, *if he bathes every day*, his risk of exposure would be 90/1700, or 1/19. If he bathes every other day, the risk then will be 1/38.

Butterfield and Kehr estimated that about 2 percent, or one out of every 50 persons exposed to ingestion of a single E. typosa organism, actually contract the disease. On this basis, it may be estimated that our bather's risk of contracting typhoid fever during a 90-day season would be 1/19 × 50, or 1/950, a very remote hazard.

From estimates compiled from surveys of water-borne diseases by Wolman and Gorman*, and by Eliassen and Cummings**, it appears that water-borne diarrhea-enteritis morbidity rates tend to average about 20 times those of typhoid fever. In the seven Ohio River states, the ratio based on mortality records was 22 to 1 during the years 1945-47.

If the ratio of 20 : 1 be applied to the typhoid risk for an individual bather, his risk of contracting diarrhea-enteritis during a 90-day season would be 20/950, or about 1/50. This again is a rather remote hazard.

If similar estimates are made for groups of bathers, it must first be assumed that every bather of a group bathes regularly every day, or that a certain proportion of the group bathes daily. For a group of 100 regular bathers, the typhoid risk under the conditions assumed above thus would be about 1/10 for a 90-day season. For the same group, the diarrhea-enteritis risk would be about 2/1 during a 90-day season, again assuming each member of the group to bathe regularly every day. This is of course a tangible hazard, though reduced in proportion to the percentage of the group bathing each day.

When viewed from the standpoint of calculable risk, a bathing water coliform standard of 1,000 per 100 ml. or thereabouts would seem to involve no great hazard for the individual bather, or even for moderate sized groups of bathers. From the computations shown above, it can be readily estimated that a water meeting this standard should provide a high degree of protection for groups of several hundreds of people against typhoid infections, and reasonable protection for smaller groups against diarrheal diseases. Moreover, a standard at this level is probably the most stringent one which could be met in the Ohio River under any conditions of pollution which can be visualized during the near future, even with some degree of pollution control established. Pending the outcome of future epidemiological studies of bathing waters, it probably would be the most logical tentative objective at which immediate measures of pollution control could be aimed. If adopted as a tentative objective, however, it should be properly safeguarded against excessive "over-run", both in degree and in frequency.

It is therefore recommended that for bathing and other recreational requirements other than boating, a bacterial-quality objective be established tentatively for the Ohio River under the following conditions:

Waters suitable for this purpose should show a monthly arithmetical average "most probable number" of coliform bacteria, not exceeding 1,000 per 100 ml. in any month of the normal bathing

*Water-borne Outbreaks in the United States & Canada 1930-1936. AP.H.A. Annual Year Book, Vol. 20, No. 2.

**Analysis of Water-borne Outbreaks, 1938-45. Jour. Am. W. W. Assoc., May, 1948.

season, nor exceeding this number in more than 20 percent of the samples examined during any such month; nor exceeding 2,400 per 100 ml. on any day.

For general recreational purposes not involving the use of the river waters for bathing or swimming, a monthly average "most probable number" of coliform bacteria not exceeding 5,000 per 100 ml., nor exceeding 5,000 per 100 ml. in more than 20 percent of the samples examined during any month of the recreation season, is recommended as a minimum bacterial-quality requirement.

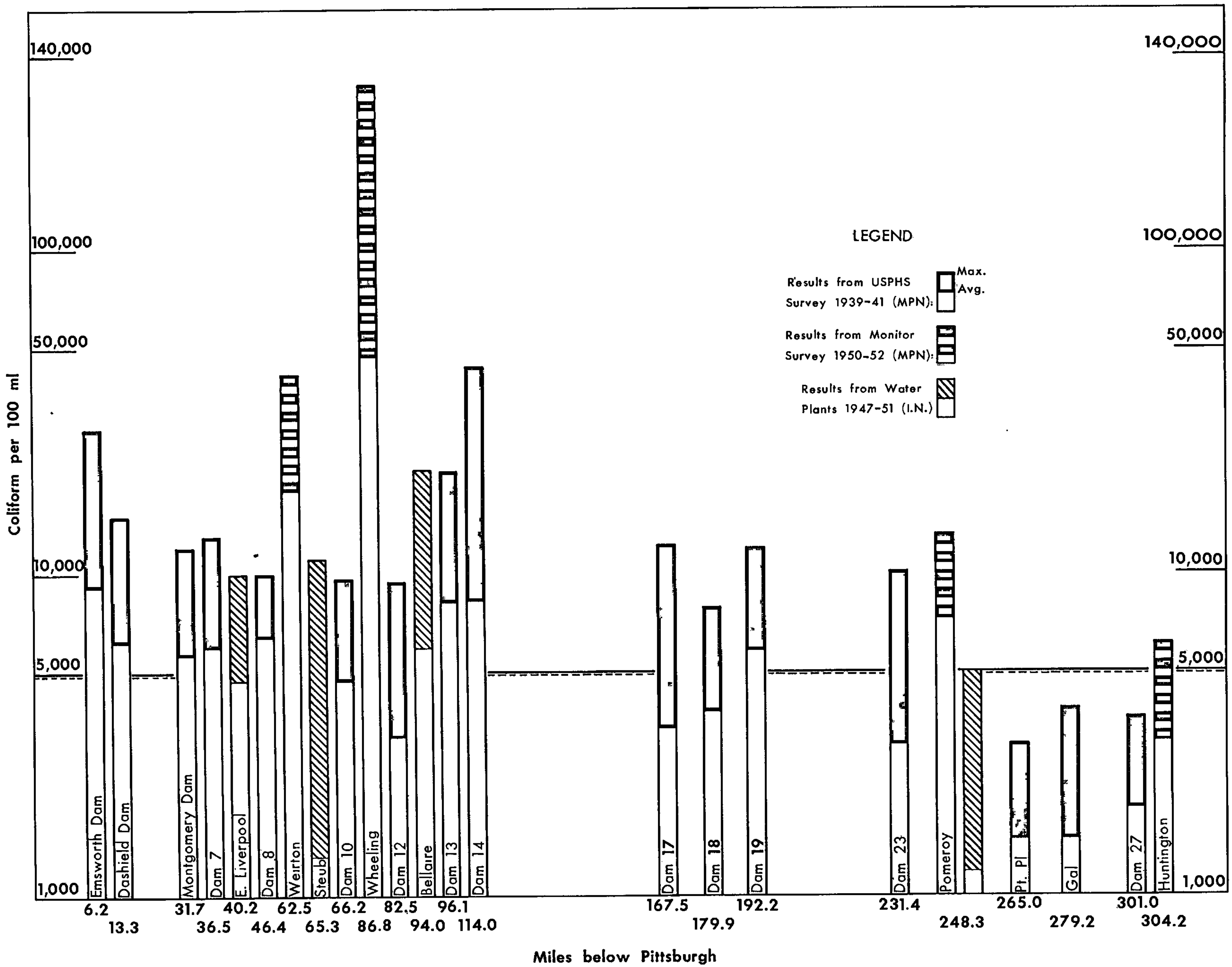
As to the significance of the term "average" as used in this recommendation, it is intended to mean the ordinary arithmetic average. This is done not to exclude, or minimize, the full effects of wide deviations from the average which in the case at hand are believed to be of definite public health significance.

The above recommendations are a compromise between that which would be desirable and that which is administratively practicable. They represent the best judgment of this reviewer after considering the problem from several different angles.

OHIO RIVER VALLEY WATER SANITATION COMMISSION

AN INTERSTATE AGENCY

ESTABLISHED JUNE 30, 1948



MARCH 1953

ORSANCO

EXHIBIT F - COLIFORM CONCENTRATIONS IN THE OHIO RIVER

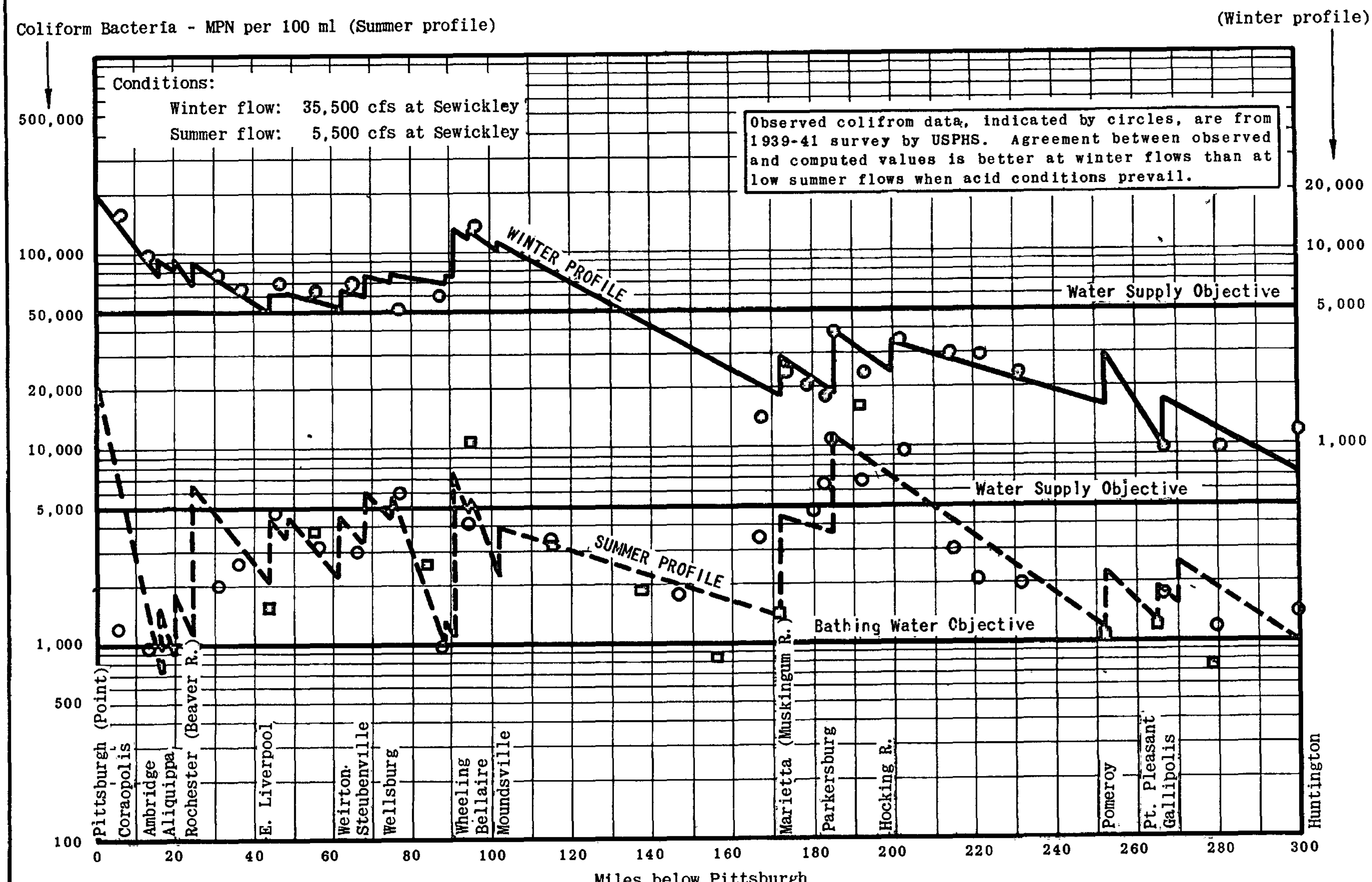


EXHIBIT G - COLIFORM DATA FROM SURVEYS OF WEST VIRGINIA STATE WATER COMMISSION. West Virginia data, shown by squares, were obtained during summers of 1948 and 1949. These data are superimposed on coliform profiles shown in Figure 4 of report titled, "Ohio River Pollution Abatement Needs, Pittsburgh-Huntington Stretch".

March 1953

ORSANCO

EXHIBIT H

STATEMENT BY W. W. TOWNE, U. S. PUBLIC HEALTH SERVICE

To: Mr. E. J. Cleary, Executive Director & Chief Engineer
Ohio River Valley Water Sanitation Commission
414 Walnut Street
Cincinnati 2, Ohio

Subject: Report on the Ohio River Pollution Abatement Needs, Pittsburgh-Huntington Stretch

1. Your report of March 1, 1953, entitled "Ohio River Pollution-Abatement Needs, Pittsburgh-Huntington Stretch," has been reviewed by the Ohio-Tennessee Drainage Basins Office, Division of Water Pollution Control, Public Health Service, Federal Security Agency.

2. The report establishes the following facts concerning the effects of sanitary sewage discharged into that stretch of the Ohio River under consideration.

a. During critical stream flow periods (minmum weekly - average flow expected once in ten years), present pollution loads from the Pittsburgh district will lower the dissolved oxygen (DO) content of the stream below four parts per million (ppm). Elsewhere, the dissolved oxygen content is not now critical.

b. Bacterial pollution is excessive, resulting in a water quality at public water supply intakes in the upper reaches of the stream which is far inferior to the objectives established by the Commission and accepted by public health authorities as desirable for adequate public health protection.

c. Approximately 200,000 people residing in nine municipalities on the Ohio River between Pittsburgh and Huntington depend upon this stream as a source of public water supply. This is exclusive of Huntington which likewise uses the Ohio.

3. This report makes recommendations for the control of pollution resulting from the discharge of sanitary sewage only. However, it is made clear that industrial wastes now discharged directly to the river are being studied by the Commission and that such sources of pollution will likewise be required to initiate appropriate corrective measures. This report, therefore, may be considered as the first step in comprehensive program for the abatement and control of pollution in this stretch of the Ohio River.

4. The report recognizes the importance of the Ohio River as a source of public water supply and the fact that pollution must be abated to the extent that this most important water use will not be jeopardized. Consideration is also given to recreational uses of the stream, including bathing, and the maintenance of dissolved oxygen suitable for aquatic life and other legitimate uses.

5. In order to maintain satisfactory water quality conditions for dissolved oxygen and coliform bacteria, the treatment of sanitary sewage in excess of the minimum Compact requirements is necessary.

a. The removal of not less than 50 per cent of the biochemical oxygen demand (B.O.D.) from the sewage and waste load to be treated by the Allegheny County Sanitary Authority will assure desirable dissolved oxygen conditions in the Ohio River at the Pennsylvania-Ohio-West Virginia State line. This degree of treatment is now planned by the Authority and has been previously approved by your Commission.

b. Treatment to reduce bacterial pollution caused by discharge of sanitary sewage is necessary to maintain bacterial objectives at the several water supply intakes between Pittsburgh and Huntington.

6. Under Section 2(a) Public Law 845, 80th Congress, 2nd Session, the Surgeon General, Public Health Service, in cooperation with other Federal agencies, State water pollution control agencies, and interstate agencies and with municipalities and industries involved, is charged with the responsibility of preparing or adopting comprehensive programs for eliminating or reducing pollution of interstate waters. The Act further stipulates that in the development of such comprehensive programs due regard shall be given to the conservation of such waters for public water supplies, propagation of fish and aquatic life, recreational purposes, and agricultural, industrial and other legitimate uses. This report has been reviewed, therefore, with the thought that the recommendations contained therein might be adopted by the Surgeon General as a part of a comprehensive program for eliminating or reducing pollution in this section of an interstate stream.

7. Following this review, we find that the program recommended by the Commission will maintain dissolved oxygen levels and bacterial quality objectives that are reasonable and likewise that the treatment of sanitary sewage recommended to accomplish these objectives is also reasonable. It is further concluded that the proposed program for controlling pollution due to sanitary sewage constitutes a part of an acceptable comprehensive pollution control plan for the Pittsburgh-Huntington stretch of the Ohio River.

/s/ W. W. Towne
Officer in Charge

2 cc: Div. of WPC
April 2, 1953

EXHIBIT I

STATEMENT BY A. R. TODD, SUPERINTENDENT TREATMENT PLANT, WHEELING, WEST VIRGINIA

MEMBERS OF THE OHIO RIVER VALLEY WATER SANITATION COMMISSION

Gentlemen:

I have been connected with the Wheeling Water Works since 1932. My job is and has been chemist, bacteriologist and superintendent of purification and filtration.

During this period of twenty one years, it has been my experience that the Ohio River water at Wheeling becomes increasingly more difficult to treat each succeeding year, and that we must change or modify our method of treatment on an average of about every five years.

Our costs for purification chemicals which amounted to $2.43 per million gallons in 1933, rose to $8.00 per million gallons in 1952.

Our purification process using Chlorine Dioxide and Breakpoint Chlorination plus five pounds gave excellent results in 1949, 1950 and 1951. The results were not so good in 1952 and laboratory experiments indicate that we will need to supplement the process by using 40 pounds of carbon per million gallons part time in 1953. The use of this amount of carbon will add $3.00 to the cost of each million gallons of water purified.

Permit me to call the Commission's attention to the fact, that a stage of pollution can be reached and the Ohio River water is rapidly reaching that stage where so much and so many chemicals for purification will be required, that the resulting product will be more like chemical soup than drinking water.

There were several times during the year 1952, when we found it utterly impossible to produce an acceptable water because of the pollution load of phenols and sewage.

EXHIBIT J

STATEMENT BY RAYMON T. ALLISON AND J. R. BARTLETT

Mr. Edward J. Cleary
Executive Director and Chief Engineer
Ohio River Valley Water Sanitation Commission
414 Walnut Street
Cincinnati 2, Ohio

Dear Sir:

We, of Gallipolis, Ohio, have a critical water work's problem in that for the past ten years we have been unable to use our river wells for domestic water consumption, except during the rainy winter season, due to the large amount of chemical pollution in the river.

Our City is located on alluvial formations varying from sixty to eighty feet in depth, and we have been using wells for most of our production. However, at this time the area immediately adjacent to the water work's plant has been drawn on so heavily that the wells have become silted and no longer produce sufficient water to supply the demand.

The water work's system of necessity will have to be completely redesigned in the not too distant future.

If we could have some assurance that the chemical pollution would be removed from the river, particularly phenol (phenol is displeasing to the taste and cannot be successfully removed or treated), we could use our existing plant with certain modifications and treat river water. If the chemical is not removed we will be forced to abandon the present site and move to a new location which would involve great expense.

We believe that the greater amount of chemical water pollution comes from the Charleston, West Virginia, area.

We would appreciate it very much if you could incorporate this letter as a permanent record in the forthcoming hearing to be held at Pittsburgh, Pennsylvania.

Very truly yours,

/s/ Raymon T. Allison,
President of the City Commision
and Ex-officio Mayor.

/s/ J. R. Bartlett
City Manager

March 23, 1953

STATEMENT BY DANIEL M. HEEKIN, CINCINNATI, OHIO

Ohio River Valley Water Sanitation Commission

Gentlemen:

The usual thing to do, I believe, when called upon in such a meeting, is to introduce yourself. I am Daniel Heekin, a business man from Cincinnati, and a graduate of Purdue University, a mechanical engineer, in the Class of 1910. I have lived in Cincinnati all my life and early in my mature days I began to be impressed by the horrible condition of the Ohio River, the Great Miami and the Little Miami, and smaller creeks in the immediate vicinity, both in Ohio and in Kentucky. My first technical information on the way to reduce this shameful pollution was while I was a junior at Purdue when it was my good fortune to be able to take an elective subject in biology. It is not my purpose to give a technical talk, but rather one emanating from a taxpayer interested in five or six enterprises in Cincinnati which are paying their respective shares for our preventive measures. I am happy to recommend making these payments to my associates and in this I have their entire support.

My first trip on the Ohio River was in a rowboat when I was aged 7, and since that time I have spent many pleasureable hours and some profitable ones, on the Ohio River. My memory being reasonably good and my powers of observation normal, I recall that as a boy we swam in and drank out of the streams in the vicinity of which I spoke before. It is my contention and, of course, which hasn't actually been put to proof by tests, that if one drank out of most of these streams today, he probably wouldn't live long enough to arrive at a hospital in time to be saved.

The solution to the safe disposal of ordinary city sewage was developed a long time ago - perhaps as long as 100 years - and several methods have been perfected, namely, settling, chemical and activated sludge. In a city the size of Cincinnati, this, of course, requires a tremendous initial expenditure if you count the money spent over the years to bring about a concentration of the city sewage so that it is possible to handle it in one or more sewage disposal plants. Fortunately, the city fathers started as far back as 50 years building intercepter sewers. I recall one such construction effort which I observed as a child, and while it meant little to me at the time, I have learned later that this was one of our first intercepters and is about to be put to its ultimate usage when our first sewage disposal plant is open in Cincinnati next fall. Further, I recall a matter of perhaps 40 years ago, when a huge intercepter was put in Millcreek Valley, a water-shed which practically bisects the downtown area of Cincinnati. At this point another sewage disposal plant will be built and I believe the plans call for an additional two smaller ones, at which time Cincinnati will be a city its inhabitants can be proud of.

Across the River from Cincinnati, the two Northern Kentucky Counties have combined in their efforts and are now constructing a large sewage disposal plant which will take care of the sewage originated by the great majority of the people in those two counties. I mention these matters to let you know what we, living practically in the middle of the length of the Ohio River, have done to help this great problem of stream pollution on to its final successful accomplishment. We hope in our actions that we have encouraged others to step in and do likewise. All of this costs money, to be sure. At the present time residents in Cincinnati are paying a 60% tax on their household water bills and industries are paying 6¢ extra on the first 60,000 cubic feet used and 5.4¢ thereafter.

We, in industry, are now in the process of analyzing our sewage discharge, first, because it is necessary for everyone to find out what he is putting in the river that might be detrimental, and, second, I believe that there is a provision for a lower rate for those who have less harmful ingredients in their sewage. Very briefly, this takes care of the subject of what might be called ordinary city discharge into the Ohio River, and, of course, this is only a part of the problem.

Next we come to industrial waste and this covers a multitude of ingredients, some of them which are exceedingly harmful and toxic. Colonel Strong, of the U.S. Engineers, whose offices are in the City of Cincinnati, referred to the Ohio River Valley in a recent talk as the "Ruhr Valley of the United States of America" and indeed it is. I recall very distinctly years back when this statement could not be made, because in the last 50 years, particularly since World War I, the Ohio Valley has become a teeming giant and what with our ordinary expansion, growing as usual, and the building of plants in the valley due to the brand new movement in Atomic Energy Research, we are growing at the rate of ten times what we did 50 years ago. All of this brings terrific problems and very dangerous ones.

What I am coming to is just this, that while a natural waste from cities seems to be under reasonable control, the study of our industrial waste has only begun. I recall very well, during the War, when the Government synthetic rubber plants were operating on the Great Kanawha at Charleston, West Virginia, we, Cincinnatians, were both very loyal and very polite, because if any one had cause to raise the roof, we did. When these synthetic rubber plants began to make styrene and butadiene, actually, our Cincinnati public water was so bad, that when one would take a drink of hot water early in the morning, as is my custom, this habit would cause one to burp about 11 o'clock and the result was the creation of an atmosphere around one that would remind you of the odor emanating from an overheated, worm-out, truck tire.

I would like to say to you, gentlemen, that this whole matter of pollution isn't one of whether we are going to get together and clean up our streams, or one of what it is going to cost, but when are we going to clean them up. Rest assured, that the longer this polluting condition exists and grows just so long will we be working in this Ohio Valley in a manner calculated to run all the people out of it. I, therefore, beg of you to get together with your neighbors up here at the beginning of the Ohio Valley, and begin to work on how to treat us Cincinnatians as we are about to begin treating our friends down in Louisville. This is our first job and we should drive hard to finish this portion of our good work, having in mind all the time that some industrial wastes present even a greater problem.

STATEMENT BY DOUGLAS K. FULLER, CINCINNATI CHAMBER OF COMMERCE

Ohio River Valley Water Sanitation Commission
Mercantile Library Building
Cincinnati 2, Ohio

Gentlemen:

Your Commission is holding a public hearing in Pittsburgh, Pa., commencing at 10:00 o'clock March 31, 1953, for the purpose of establishing the degree of treatment to be given sewage discharged into the Ohio River between Pittsburgh, Pa. and Huntington, W. Va. It will be appreciated if you will incorporate this communication in the record of the above hearing.

For more than twenty years the Cincinnati Chamber of Commerce has continuously and assiduously promoted the cause of stream sanitation in the Ohio Valley Watershed. This long continued effort culminated in the signing of the Ohio River Valley Water Sanitation Compact on June 30, 1948, when the Governors, Secretaries of State and Compact Commissioners from the signatory states met in Cincinnati for the ceremonial signing of this historic document.

Subsequent to the signing of the Compact, the Cincinnati Chamber of Commerce has continued to support the cause of stream sanitation. We worked actively for the passage of Senate Bill 62 in the 99th General Assembly of Ohio. This Act established the Ohio Water Pollution Control Board which, since its inception, has done much to strengthen Ohio's control of pollution and has advanced the planning and construction of Treatment Works in this state. We have also continued to be active in our own community. Substantial progress in this community has been made toward providing facilities for the treatment of wastes, both residential and industrial, to meet the standards established by your Commission.

On May 12, 1948, City Council of the City of Cincinnati passed an Ordinance, No. 195 - 1948, fixing rates to be charged for the use of its Sewerage System and Treatment Works and providing funds for the construction, management, operation and maintenance of the Sewerage System Treatment & Disposal Works.

Twenty-two political subdivisions in Hamilton County have agreed to cooperate by discharging their wastes through the facilities of the Cincinnati System, so that a substantial majority of the communities in Hamilton County are thus meeting their obligation to cease pollution of the streams. The charges imposed by Ordinance No. 195 - 1948, above referred to, first were imposed beginning July 1, 1948 and from that date to June 30, 1952, the collections under that Ordinance had amounted to more than Seven and a half million dollars.

On January 21, 1953, the City Council of the City of Cincinnati passed Ordinance No. 24 - 1953, modifying the previous Rate Ordinance by increasing the charges in an amount estimated to meet the increased cost of constructing the necessary facilities.

Exhibit L
Sheet 2 of 2

On the same date the Council of the City of Cincinnati passed an Ordinance, No. 25 - 1953, authorizing and directing the City Manager to make and enforce rules and regulations governing the discharge of sewage, industrial wastes and other matter, establishing surcharges, etc. Under this Ordinance, rules and regulations for the handling of industrial wastes and the charges therefor have been established.

The first of the Disposal Works in the Cincinnati area, The Little Miami Sewage Treatment Plant, with a capacity of 29,000,000 gallons daily, is practically complete - at a cost in excess of $5,000,000. It is expected that this plant will be placed in operation within the next few months. A second plant, known as the Mill Creek Sewage Treatment Plant, is in the final stages of design. A site for this facility has been acquired and the contract for grading of the site is to be let within the next few weeks.

The engineering estimate for the cost of this second Treatment Plant is approximately $22,000,000. The Division of Engineering in the Department of Public Works of the City of Cincinnati estimates that the cost of the complete sewage disposal program for this community will be approximately $47,000,000.

It may be seen from this recital of facts that the Cincinnati area is making substantial, rapid and continuing progress toward abating its pollution of the Ohio River and its tributaries. While these local works in this community are of some direct benefit to this community, their major benefit is to the communities lying to the West, down stream from us. We, in turn, will receive maximum benefits from the Pollution Control Program only when our friends and neighbors to the East - up stream, do their part toward controlling the pollution generated in their local communities. It is our sincere hope that these friends and neighbors up stream will come to grips with their own local problems promptly, will firmy resolve to do their share toward the common ofjective of providing an uncontaminated and useable water supply for all the inhabitants and for all the industry in the Ohio Valley.

Sincerely yours,

/s/ Douglas K. Fuller
Executive Vice President

STATEMENT BY HON. GERALD E. BROUGHTON, MAYOR OF MARIETTA, OHIO

To: Ohio River Valley Water Sanitation Commission, Cincinnati, Ohio

A prepared statement showing the progress that has been made in Marietta, Ohio in regard to the elimination of the discharge of raw sewage into the Ohio River water shed.

A permit from the Ohio Water Pollution Control Board to discharge raw sewage into the Ohio River was renewed March 15th. This permit will expire August 15, 1953 with the proviso that the contract for the construction of the interceptor lines and the treatment plant be let prior to August 15, 1953.

Contract Plans and Specifications have been completed for a Sewage Treatment Plant and the necessary interceptor lines to effectively collect and treat with primary treatment, the sewage from the City of Marietta, Ohio. These plans have been approved by the State of Ohio Department of Health and are ready to be advertised as soon as the necessary enabling legislation has been passed by the Marietta City Council.

I am anticipating that no difficulties will be experienced in meeting this required date.

The land necessary for the erection of the treatment plant has been purchased.

Tentative rates necessary to liquidate the revenue bonds and maintain the plant have been drawn and at the present time are in the final stages of refinement. It is anticipated that these final rates will become effective in the near future thus assuring adequate financing of this project.

The anticipated sewage charge will be approximately 100% or perhaps a little more of our present water rates and will be collected in conjunction with the present water system. The total estimated cost of One Million Nine Hundred Sixty Thousand Dollars, will require, a bonded indebtedness averaging a little more than $100 per person for the 16,000 people living in Marietta. These revenue producing bonds will mature over a thirty year period.

CITY OF MARIETTA, OHIO

/s/ Gerald E. Broughton
Gerald E. Broughton
Mayor

April 3, 1953

(Statement submitted to Hearing Board after close of Hearing)