ORSANCO

OHIO RIVER VALLEY WATER SANITATION COMMISSION
AN INTERSTATE AGENCY
ESTABLISHED JUNE 30, 1948

1966

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OHIO RIVER VALLEY WATER SANITATION COMMISSION

an interstate compact agency
created jointly in 1948 by the

State of Illinois
State of Indiana
Commonwealth of Kentucky
State of New York
Commonwealth of Pennsylvania
Commonwealth of Virginia
State of West Virginia
State of Ohio

with approval of the
Congress of the United States

respectfully submit their

EIGHTEENTH YEARBOOK 1966

HEADQUARTERS: 414 Walnut St., Cincinnati, Ohio 45202 Telephone: 421-1151

PURSUIT OF A MISSION

IN 1948 WHEN CONTROL of water pollution was a subject of limited social and political concern in the nation, eight states in the Ohio Valley committed themselves to undertake a cooperative program of river cleanup. Under the auspices of an interstate compact they established the Ohio River Valley Water Sanitation Commission (ORSANCO) and gave it this mission: Coordinate and supplement the efforts of the signatory states in abating existing pollution and preventing future pollution of the rivers that flow through, into or border upon any of these states.

Pursuit of this mission is providing a demonstration of the potentialities of regional action — of converting aspirations into realities by uniting the leadership of many and inspiring the participation of all — in restoring the wholesomeness of waters in the Ohio Valley. Not the least measure of progress has been success in motivating communities and industries to invest *local* funds totalling more than a billion dollars for the installation of pollution control facilities. While it is not suggested that the resulting great reduction in gross pollution can be regarded as satisfying the ultimate aims of the compact, it does signify attainment of a fundamental goal in the mission of ORSANCO. Meantime, many other endeavors in advancing this mission are underway. And what is equally important, the obstacles yet to be overcome are being identified, making it possible to plan the strategy for dealing with them.

These and related matters are outlined in this 18th annual report. It has been designed to provide orientation on what has transpired thus far and to highlight aspects of the regional program that now invite attention.

Summarized in a separate section is the annual appraisal of river quality conditions based on data from a network of monitor stations. The assembly and analysis of such information now commands a major part of staff effort. From these findings emanate the facts for making appropriate judgments on what additional controls should be applied and where. In addition, this activity is providing the framework for application of a systems-type quality management program, which could represent the ultimate achievement of the ORSANCO mission.

Also included in this report is a compendium of quality criteria, which was adopted by the Commission on the recommendations developed by its advisory and engineering committees over a period of several years. These criteria define suitability of water for various uses. The importance of these "yardsticks" is self evident; without them the assessment of river conditions becomes a nebulous undertaking.

STATUS OF CONTROL FACILITIES

In starting its regional program the Ohio River Valley Water Sanitation Commission decided that priority should be given to doing the obvious. And that meant halting the indiscriminate discharge of what anyone with eyes and a nose would recognize as pollution. This fundamental aspect of river quality improvement, which called for installation of basic control facilities by thousands of municipalities and industries in the valley, is well along to completion. (See *Tally For The Valley*, page 37) At all major and most minor sources of sewage discharge communities have shouldered the complex task of acquiring treatment-plant locations, installing the interceptor sewers and pumping equipment to bring all wastewaters to these sites, and constructing treatment works and sludge disposal facilities.

Installation of these facilities may be viewed as the culmination of the most costly phase of the municipal program. For example, construction costs for interceptor sewer and pumping components alone have in some cases amounted to four times the cost of the treatment units. Consequently, whatever additional treatment may be required in the immediate future to upgrade quality conditions should constitute only a fraction of capital investments already made.

Meantime, almost 90 percent of the 1,769 industries discharging wastewaters directly into streams are now inventoried as providing control facilities that comply at least with ORSANCO minimum requirements. While this does not mean that nine-tenths of the industrial waste load has been removed, it does represent a substantial reduction in gross pollution. Furthermore, the wastewaters from thousands of industries that go into city sewers are now being treated in municipal plants through arrangements made with local authorities for such service. In Cincinnati, for example, sewage disposal facilities were designed to accommodate the liquid wastes from some 1,800 industrial and commercial establishments.

ADVANCING THE PROGRAM

Although the initial thrust of the Ohio Valley program was directed toward prompt abatement of obvious pollution, the ultimate aim of the regional agreement is to maintain the streams of the district in a condition that will insure their suitability for intended uses. As specified in the compact, the uses to be considered include public and industrial water supply, recreation, maintenance of fish and other aquatic life, and "such other uses as may be legitimate." Simply stated, the guiding principle of the compact is that pollution by sewage or industrial wastes originating in one state shall not injuriously affect the various uses of the interstate waters.

To provide a factual basis to measure progress in attaining this goal the Commission initiated in 1951 a program for monitoring river-quality conditions. From a modest beginning with river sampling conducted manually at a few locations this activity was expanded, and since 1960 has included electronic sentinels called "robot monitors." Development of this unique equipment was pioneered by the ORSANCO staff. It permits continual surveillance of certain river quality indicators at selected sites, and the information is transmitted by telemeter to Commission headquarters every hour night and day. A substantial part of budget resources and staff effort is now devoted to monitor operations, which includes computer processing of data.

Meantime, following several years of study by its advisory committees and the consolidation of viewpoints among its signatory states, the Commission adopted river-quality criteria for evaluating the suitability of water for various uses (see page 10). By matching the criteria against observed river conditions, judgments are facilitated in assessing the adequacy of control measures.

STANDARDS AND REGULATIONS

The following summary of control measures adopted by ORSANCO offers perspective concerning the scope of interstate actions. These measures fall into two categories: Treatment standards that have been promulgated following public hearings; and regulatory policies and procedures. The latter are prescribed in formal resolutions that are adopted by the Commission for application by the signatory states in complying with the compact.

Sewage-treatment standards for the Ohio River were established in the early 1950's. These called for the installation of facilities to produce specified reductions in the settleable-solids, oxygen-demanding and bacterial content of discharges. Seven sets of standards were promulgated, each applying to specific reaches of the river as follows:

Mile 0 to 15, Pittsburgh and vicinity;
Mile 15 to 301, Below Pittsburgh to Huntington;
Mile 301 to 461, Huntington to Cincinnati;
Mile 461 to 483, Cincinnati Pool
Mile 483 to 750, Cincinnati to Owensboro, Ky.
Mile 750 to 803, Owensboro to Henderson, Ky.
Mile 803 to 981, Henderson to Cairo, Ill.

In 1955 the eight states agreed on minimum requirements applicable to all industrial-waste discharges. These requirements, popularly referred to as the "Four Freedoms," stipulate treatment or modification of all wastewater discharges so as to maintain the receiving waters free from: (1) Sludge-forming deposits; (2) debris, scum and other floating substances; (3) materials producing color or odor nuisances; and (4) substances toxic or harmful to human, animal or aquatic life.

The basic requirements are embodied in a detailed statement of regional policy for the abatement of pollution from industrial establishments. In essence, the Commission enunciated a two-step procedure whereby: (1) The states would promptly promote compliance from industries with minimum requirements; and (2) the Commission would complete investigations leading to the imposition of supplementary "tailored" measures to produce quality conditions suited to water uses in defined river stretches.

Effluent from the waste treatment works at Howard Paper Mills is being used for crop irrigation at the company's experimental farm at Urbana, Ohio. This practice serves the dual purpose of improving "white water" waste disposal and increasing crop yields.

Additional resolutions that have been adopted for control of interstate pollution include:

- Specification of measures to be followed at coal mines for minimizing discharges of acid drainage, accompanied with a manual of recommended practices.
- Prohibitions relating to the discharge of oil and oily substances, and the issuance of recommended practices for preventing water pollution from the use, transfer and storage of oil products.
- Requirements for programmed discharge of chloride wastes in accord with variations in river flow.
- Restrictions on discharge of toxic and color-producing materials from municipal sewage disposal plants.
- Elimination of "slug" (abnormal) discharges of phenolic substances.
- Implementation of an embargo on issuance of state permits for expansion of sewer systems in communities where no progress was being made in providing sewage-treatment facilities.
- Imposition of notification responsibilities on industries and municipalities with respect to spills or accidental discharges of substances that might cause river pollution.

The signatory states have relied exclusively on their legal powers for securing compliance with the foregoing resolutions. However, should an occasion arise where the Commission would be called upon to participate by the exercise of its enforcement powers, those resolutions involving treatment requirements must first be presented at public hearings, following which they would be transposed into "standards." Recent discussion of this matter resulted in a decision that the conduct of ORSANCO hearings for this purpose should be held in abeyance pending the outcome of public hearings now being scheduled by the signatory states in order to comply with the Federal Water Quality Act of 1965.

FEDERAL WATER QUALITY ACT

Under the federal act every state is now under compulsion to individually conduct hearings on the basis of which it must submit interstate water-quality standards and a plan for their implementation not later than June 30, 1967. Guidelines were not issued until May 1966 for this purpose. Although certain aspects of these guidelines may require further clarification, it does appear that long-established ORSANCO policies and procedures are compatible with the intentions of the Federal Water Pollution Control Administration.

In support of this view, it may be noted that both the Ohio River Valley compact and the recent federal legislation specify identical objectives with respect to the preservation of water quality for public and industrial supplies, propagation of fish and wildlife, recreational pursuits, and other legitimate uses. The 1966 federal guidelines explain that quality criteria should be developed and "applied to the stream," and they call for identification of water uses to be protected and the establishment of limiting values on the characteristics of wastewater discharges. These provisions reflect the basic philosophy set forth in the 1948 ORSANCO compact, as well as the procedures employed in executing its provisions.

Another declaration in the federal guidelines reflects the aspiration that interstate standards should be designed to "enhance the quality of water." Recognition of this concept has been explicit in past actions of ORSANCO, as well as in the development of additional proposals for upgrading river conditions in the Ohio Valley.

In many other respects ORSANCO practices are in harmony with implementation of procedures outlined in the guidelines. For example, it is specified that quality standards be referenced to a "design" stream flow, which is to be defined in terms of frequency of occurrence and duration. Such determinations have been a fundamental consideration in the drafting of all ORSANCO standards. Further, the guidelines call for the establishment of monitoring and surveillance operations for measuring compliance. ORSANCO has pioneered in such endeavors, the details of which are published anually as a matter of public record (see page 13)

Because of these circumstances there is reason to believe that the states signatory to the Ohio River Valley Water Sanitation Compact are strategically prepared to facilitate their proceedings for compliance with intentions of the federal law. In this connection it can be pointed out that the requirement to establish stream quality criteria should represent no burden. This complex undertaking is one on which the ORSANCO states and advisory committees have been engaged for several years and which was recently completed. Adoption of the criteria by the Commission has made available an authoritative compendium that is not only useful to the Ohio Valley states but is proving helpful to many others now confronted with the pressing task of presenting standards for federal approval. Incidentally, the federal authorities have not yet determined what they will regard as acceptable criteria, and the Federal Water Pollution Control Commission has retained an ORSANCO commissioner, Dr. B. A. Poole of Indiana, for assistance in this matter. The criteria developed by the Ohio Valley states are detailed on pages 10 and 11.

IMPROVING RIVER QUALITY MANAGEMENT

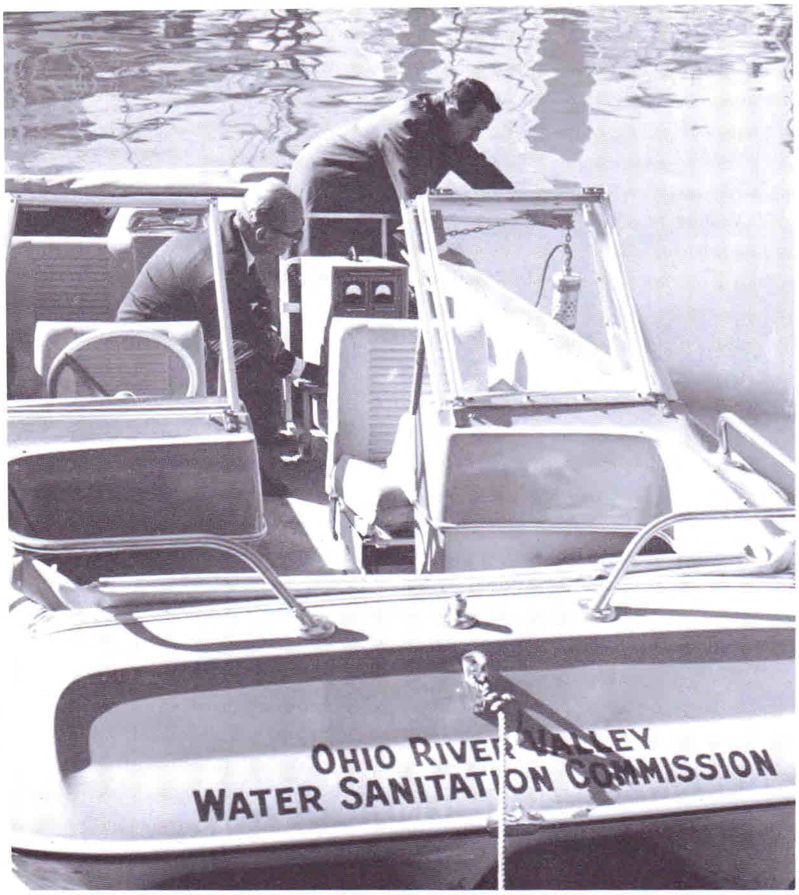
LOOKING TOWARD FUTURE PROSPECTS for advancing the mission of the Ohio Valley compact there are three components of action that now invite attention. These deal with: Upgrading treatment standards for the Ohio River; expanding custodial functions; and correlating reservoir releases and hydropower operations with river quality conditions.

UPGRADING TREATMENT STANDARDS

Some 15 years have elapsed since initial sewage-treatment standards were promulgated throughout the 981 miles of the Ohio River. In the interim certain quality aspects of the river have been continually monitored. Evaluation of this data reveals, among other things, that in some parts of the river there are periods when the dissolved oxygen criterion for aquatic life is not achieved. This condition reflects the need to impose additional controls on discharges of oxygen-demanding substances.

With respect to bacteriological conditions, the data indicates that while conditions at some monitor points are close to meeting the ORSANCO criteria for public water supply and recreational use, more intensive disinfection of sewage discharges is required in all reaches if river quality is to be further enhanced.

The staff has completed a report of its findings along with proposals for remedying these conditions. This matter is now being reviewed by the engineering committee of the Commission, which is composed of the chief sanitary engineers of the signatory states.



River surveillance by boat patrol also provides opportunities to make on-the-spot examination of water-quality characteristics using specially designed portable monitor equipment. The portable model is based on principles employed in the ORSANCO robot monitors, which are permanently installed at locations along the Ohio River and some of its tributaries.

The findings provide a basis for decisions on upgrading interstate standards. Meantime, the report is available to the states for guidance in the conduct of hearings they are currently scheduling for the Ohio River.

EXPANDING CUSTODIAL FUNCTIONS

Guardianship of river quality involves responsibilities that go beyond the promulgation of standards and promoting construction of physical facilities to comply with them. While these are basic to the initiation of a control program, the day-by-day management of the program calls for the conduct of a variety of custodial functions. The latter include inspection of treatment plant operations, river patrol for detection of clean-stream violations and prompt handling of complaints, monitoring and evaluation of stream quality, maintenance of a hazard-and-alert system, and prevention of littering.

Perhaps in no other region of the nation are some of these operations further advanced than in the ORSANCO district. But the importance and the magnitude of this task command far greater support and financial resources than have been marshalled thus far either individually by the signatory states or jointly under auspices of the Commission. Therefore, any consideration of further steps for improving quality management cannot escape reference to expansion of custodial functions.

INSPECTION NECESSITIES — What can be regarded as of major concern is the present limited capability of state regulatory agencies to adapt their activities to an ever increasing burden of plant inspections. Each year a greater number of sewage-treatment and industrial-waste control facilities go into operation and lay claim for "performance auditing." However, budgetary and other constraints have handicapped the states in assigning adequate staff for this task.

Along the Ohio River alone there are now some 335 installations whose operations should be regularly scrutinized. Improper operation of some facilities is revealed from visual observation of river conditions and is suggested by occasional erratic changes in quality indications recorded by robot monitors. There are reasons to believe that carelessness — and sometimes even surreptitious evasion of control responsibilities — may explain why cleanliness in certain stretches of the Ohio River is not now measuring up to expectations.

This situation is not peculiar to the Ohio Valley. Commissioner C. W. Klassen of Illinois confirmed this in a report made earlier this year at the Midwest Governor's Conference. Telling of a canvass that he had made of regulatory-agency practices throughout the nation, Mr. Klassen said: "There are newly constructed municipal and industrial waste-treatment facilities that have never been visited due to sheer lack of states' man power. For the same reason there are numerous treatment plants that have not been inspected for over five years."

With respect to river patrol, there are occasions when the ORSANCO staff undertakes aerial and boat surveillance of streams accompanied by personnel of the signatory states. The results support the view that much is to be gained from visual observations of river conditions. Sources of unrecorded pollution have been discovered, violation of regulations have been uncovered and pictorial evidence has been assembled for use by the states in expediting corrective action.

QUALITY MONITORING — The present monitoring program of the signatory states and ORSANCO provides a comprehensive array of data on quality characteristics of the Ohio River. However, information for evaluating the condition of major tributaries can hardly be considered adequate. And measurement of quality in certain stretches of the main stem leaves something to be desired.

For example, there are only seven places along the Ohio where coliform concentrations in the river are routinely being measured. This cannot be regarded as adequate for determining the extent to which recreational or public water supply criteria are being met. It would appear, therefore, that consideration should be given to a much broader program of coliform monitoring than is now possible with resources available to ORSANCO.

Another monitoring deficiency that poses difficulties is the measurement of threshold-odor conditions. Presently ORSANCO must rely on the voluntary efforts made by its Water Users Committee to provide such data. These measurements are made at only a few places along the 981-mile Ohio River. While they provide important information not otherwise available, the data has limited usefulness in pinpointing where taste and odor troubles originate or may exceed the criterion adopted by the Commission. Taste and odor control is a virtual "no-man's land" from the standpoint of adequate custody.

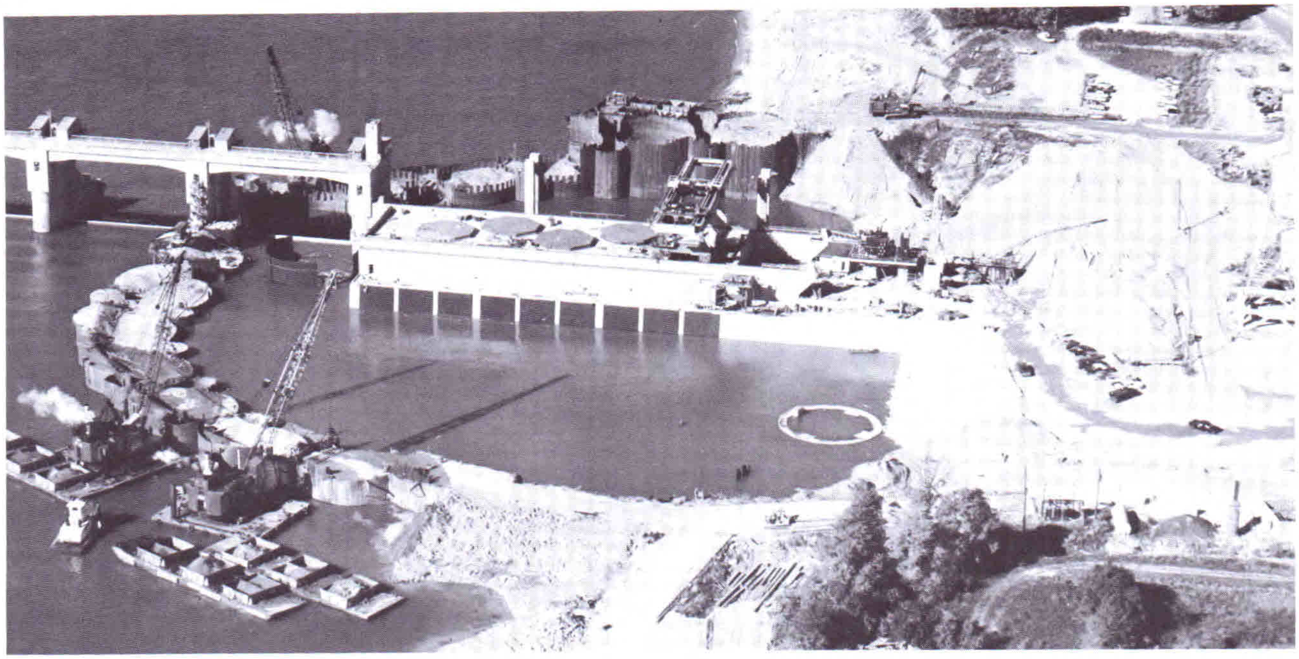
Even more perplexing is the lack of appropriate means for determining compliance with regulations relating to the discharge of substances in such concentrations or combinations that may be toxic or harmful to humans, animals or aquatic life. While the ORSANCO criteria set forth a bioassay procedure for determining toxic risks to fish, no such relatively simple test is available with respect to human or animal toxicity evaluations. And it might be added that even the bioassay test is not yet being widely applied by either those who are expected to comply with such a regulation or by the regulators themselves. This situation is not unique with ORSANCO or its signatory states. Probably no greater challenge presents itself in the administration of water pollution control than determining compliance with toxicity requirements.

This problem did receive some recognition as far back as 1951 when the Commission approved sponsorship of a research project at The Kettering Laboratory of the College of Medicine, University of Cincinnati. The aim was to generate a better understanding of the physiological aspects of water quality. Over a period of six years investigations were conducted on the potential toxicity of certain chemical substances in water. However, the modest sums available from the ORSANCO budget were not adequate to maintain the research, and the project was terminated in 1957. This experience is cited simply to reflect awareness of the problem and the result of one effort made by ORSANCO to stimulate action for dealing with it.

CORRELATING RESERVOIR RELEASES

Variation in quantity of flow in a river has a major impact on variations in water quality. While the vagaries of rainfall impose the greatest influence on flow, not to be ignored on the Ohio River are the variations introduced by the manipulation of multipurpose storage reservoirs on tributaries. However, the augmentation of flow during dry periods now

An educational campaign to prevent river littering received a big boost from the ORSANCO Petroleum Industry Committee, several of whose member companies have purchased thousands of ORSANCO plastic litter bags and distributed them free to boaters. Here Alex S. Chamberlain, center, chairman of the committee, and J. O. Matlick, chairman of ORSANCO, visit an Ohio River marina to promote anti-litter practices.



Aerial view of construction now underway at Markland Dam on the Ohio River for an 81-megawatt hydroelectric generating plant which will be operated by the Public Service Company of Indiana.

provided from Corps of Engineer reservoirs — and which will be enhanced with the completion of additional headwater reservoirs — is not yet systematically geared to river-quality variations. One reason has been the lack of means for continual measurement of quality changes in various sections of rivers. Equipment for this purpose — the ORSANCO robot monitor — has now been developed.

If releases of stored water can be correlated with quality variations, unusual opportunities are presented for management of quality in the Ohio Valley. In developing these views with the Ohio River Division of the Corps of Engineers the staff conceived possibilities of utilizing the output from the Commission's robot-monitor network to assist in accomplishing this end. The monitors continuously measure variations in quality at several points in the river and this information is relayed every hour by telemeter into Cincinnati, which is also the center for flow-routing operations of the Corps of Engineers. These comments do not imply that flow releases from multiple-purpose reservoirs in the Ohio Valley can be made solely responsive to quality-enhancement desires. However, they do suggest possibilities for accomplishing a more meaningful integration of flow augmentation with quality needs.

Because multiple-purpose reservoirs seek to satisfy several objectives — some of which may be in conflict — their operation must conform to a variety of constraints. For example, a reservoir designed to provide flood control, low-flow augmentation and recreational uses should be drawn down low enough to insure protection from excessive storm run-off, yet it should be full enough to sustain flows during drought periods and, in addition, the pool should be maintained at nearly constant-level to satisfy recreational purposes. Furthermore, consideration must also be extended to timing of releases for downstream navigation needs. When requirements associated with water-quality maintenance are added, the array of objectives to be served is formidable.

In brief, the operation of multiple-purpose reservoirs represents a challenging assignment in devising a systems-type of operation directed toward optimizing benefits. This is a matter receiving much attention from the Corps of Engineers. Since the Corps is represented on ORSANCO, the exchange of views looking toward correlation of flow regulation with river-quality management is facilitated.

HYDROPOWER OPERATIONS

Another aspect of river-flow manipulation that influences quality management is the operation of hydroelectric facilities. At present hydropower is generated at only one location on the Ohio River (80.3 megowatts at the McAlpine navigation dam at Louisville). But the Federal Power Commission has indicated that the navigation improvement program of the Corps of Engineers will create conditions that would support hydroelectric development totalling 900 megawatts capacity. In fact an 81 megawatt project is now under construction (at Markland Dam) and applications have been filed for others.

While it is not possible to predict precisely what effect these hydropower operations may have on water-quality conditions, possibilities of coordinating these operations with quality requirements should not be overlooked. For example, during periods of critically low dissolved oxygen, it might be feasible to vent air or oxygen through the turbines for the purpose of aerating the river.

It is also conceivable that if the power turbines are operated on a peak-load schedule this could disrupt downstream dilution and mixing characteristics. This presumes that normal flow would be greatly restricted for several hours each day while water was being stored in the upper pool of the river.

Other water quality problems may assert themselves due to the diversion of flow to that side of the river where the turbine penstocks are located. Illustrative of a situation that can be created is the problem now being experienced on the Indiana side of the river below the McAlpine Dam. The quantity of flow on the Indiana side has been materially reduced because of the diversion of flow through the turbines close to the Kentucky shorelines. As a result, there is insufficient dilution of effluents from several Indiana sewage and industrial waste-control installations.

The ORSANCO staff has initiated informal discussion on these matters with representatives of the Federal Power Commission.

Experimental unit for the neutralization of acid mine drainage and disposal of precipitated sludge by pipe line transportation to abandoned mine workings several miles away, which has been placed in operation by the Jones and Laughlin Steel Corporation near Beallsville in southwestern Pennsylvania.

Drainage from an active mine (150,000 gallons daily) is pumped to an elevated storage lagoon, from which it flows to the treatment building shown on the left. Here a neutralizing chemical, lime, is added using automatic control equipment. The liquid then flows into the lagoon in the foreground where the iron precipitate settles out. The clear water then flows through a fish pond into nearby Plum Run. ←

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"Operation Yellowboy", a trailer-mounted mobile demonstration plant for the treatment of acid mine drainage, has been designed and operated by Dorr-Oliver, Incorporated, under a research grant from Pennsylvania's Coal Research Board. The purpose of the mobile unit is to evaluate the technical and economic factors involved in treating mine drainage at various test sites. This drainage pollutes streams with sulfuric acid and causes unsightly deposits of iron, popularly called "yellowboy". Treatment processes include lime-neutralization, aeration and sludge-dewatering. Consultants on the project are Gannett, Fleming, Corddry and Carpenter, Inc., of Harrisburg, Pennsylvania.

In the foreground are: Dr. H. Beecher Charmbury, left, secretary of the Pennsylvania Department of Mines and Mineral Industries; Lucien Girard, center, of Dorr-Oliver; and Dr. David R. Maneval, director of research and development for the Department of Mines and Mineral Industries.

ORSANCO QUALITY CRITERIA

ORSANCO RESOLUTION No. 16-66

(Adopted May 12, 1966; Amended September 8, 1966)

WHEREAS: The assessment of scientific knowledge and judgments on water-quality criteria has been a continuing effort over the years by the Commission in consultation with its advisory committees; and

WHEREAS: The Commission now finds it appropriate to consolidate viewpoints and recommendations relating to such criteria;

NOW, THEREFORE, BE IT RESOLVED: That the Ohio River Valley Water Sanitation Commission hereby adopts the following statement and specifications:

Criteria of quality are intended as guides for appraising the suitability of interstate surface waters in the Ohio Valley for various uses, and to aid decision-making in the establishment of waste-control measures for specific streams or portions thereof. Therefore, the criteria are not to be regarded as standards that are universally applicable to all streams. What is applicable to all streams at all places and at all times are certain minimum conditions, which will form part of every ORSANCO standard.

Standards for waters in the Ohio River Valley Water Sanitation District will be promulgated following investigation, due notice and hearing. Such standards will reflect an assessment of the public interest and equities in the use of the waters, as well as consideration of the practicability and physical and economic feasibility of their attainment.

The ORSANCO criteria embrace water-quality characteristics of fundamental significance, and which are routinely monitored and can be referenced to data that is generally available. The characteristics thus chosen may be regarded as primary indicators of water quality, with the understanding that additional criteria may be added as circumstances dictate. Unless otherwise specified, the term average as used herein means an arithmetical average.

MINIMUM CONDITIONS APPLICABLE TO ALL WATERS AT ALL PLACES AND AT ALL TIMES

1. Free from substances attributable to municipal, industrial or other discharges that will settle to form putrescent or otherwise objectionable sludge deposits;

2. Free from floating debris, oil, scum and other floating materials attributable to municipal, industrial or other discharges in amounts sufficient to be unsightly or deleterious;

3. Free from materials attributable to municipal, industrial or other discharges producing color, odor or other conditions in such degree as to create a nuisance;

4. Free from substances attributable to municipal, industrial or other discharges in concentrations or combinations which are toxic or harmful to human, animal, plant or aquatic life.

STREAM-QUALITY CRITERIA

FOR PUBLIC WATER SUPPLY

The following criteria are for evaluation of stream quality at the point at which water is withdrawn for treatment and distribution as a potable supply:

1. **Bacteria:** Coliform group not to exceed 5,000 per 100 ml as a monthly average value (either MPN or MF count); nor exceed this number in more than 20 percent of the samples examined during any month; nor exceed 20,000 per 100 ml in more than five percent of such samples.

2. **Threshold-odor number:** Not to exceed 24 (at 60 deg. C.) as a daily average.

3. **Dissolved solids:** Not to exceed 500 mg/l as a monthly average value, nor exceed 750 mg/l at any time. For Ohio River water, values of specific conductance of 800 and 1,200 micromhos/cm (at 25 deg. C.) may be considered equivalent to dissolved-solids concentrations of 500 and 750 mg/l.

4. **Radioactive substances:** Gross beta activity (in the known absence of Strontium-90 and alpha emitters) not to exceed 1,000 micro-microcuries per liter at any time.

5. **Chemical constituents:** Not to exceed the following specified concentrations at any time:

Constituent	Concentration (mg/l)
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium (hexavalent)	0.05
Cyanide	0.2
Fluoride	2.0
Lead	0.05
Selenium	0.01
Silver	0.05

FOR INDUSTRIAL WATER SUPPLY

The following criteria are applicable to stream water at the point at which the water is withdrawn for use (either with or without treatment) for industrial cooling and processing:

1. **Dissolved oxygen:** Not less than 2.0 mg/l as a daily-average value, nor less than 1.0 mg/l at any time.
2. **pH:** Not less than 5.0 nor greater than 9.0 at any time.
3. **Temperature:** Not to exceed 95 deg. F. at any time.
4. **Dissolved solids:** Not to exceed 750 mg/l as a monthly average value, nor exceed 1,000 mg/l at any time. For Ohio River water, values of specific conductance of 1,200 and 1,600 micromhos/cm (at 25 deg. C.) may be considered equivalent to dissolved-solids concentrations of 750 and 1,000 mg/l.

FOR AQUATIC LIFE

The following criteria are for evaluation of conditions for the maintenance of a well-balanced, warm-water fish population. They are applicable at any point in the stream except for areas immediately adjacent to outfalls. In such areas cognizance will be given to opportunities for the admixture of waste effluents with river water.

1. **Dissolved oxygen:** Not less than 5.0 mg/l during at least 16 hours of any 24-hour period, nor less than 3.0 mg/l at any time;
2. **pH:** No values below 5.0 nor above 9.0, and daily average (or median) values preferably between 6.5 and 8.5.
3. **Temperature:** Not to exceed 93 deg. F. at any time during the months of May through November, and not to exceed 73 deg. F. at any time during the months of December through April.
4. **Toxic substances:** Not to exceed one-tenth of the 48-hour median tolerance limit, except that other limiting concentrations may be used in specific cases when justified on the basis of available evidence and approved by the appropriate regulatory agency.

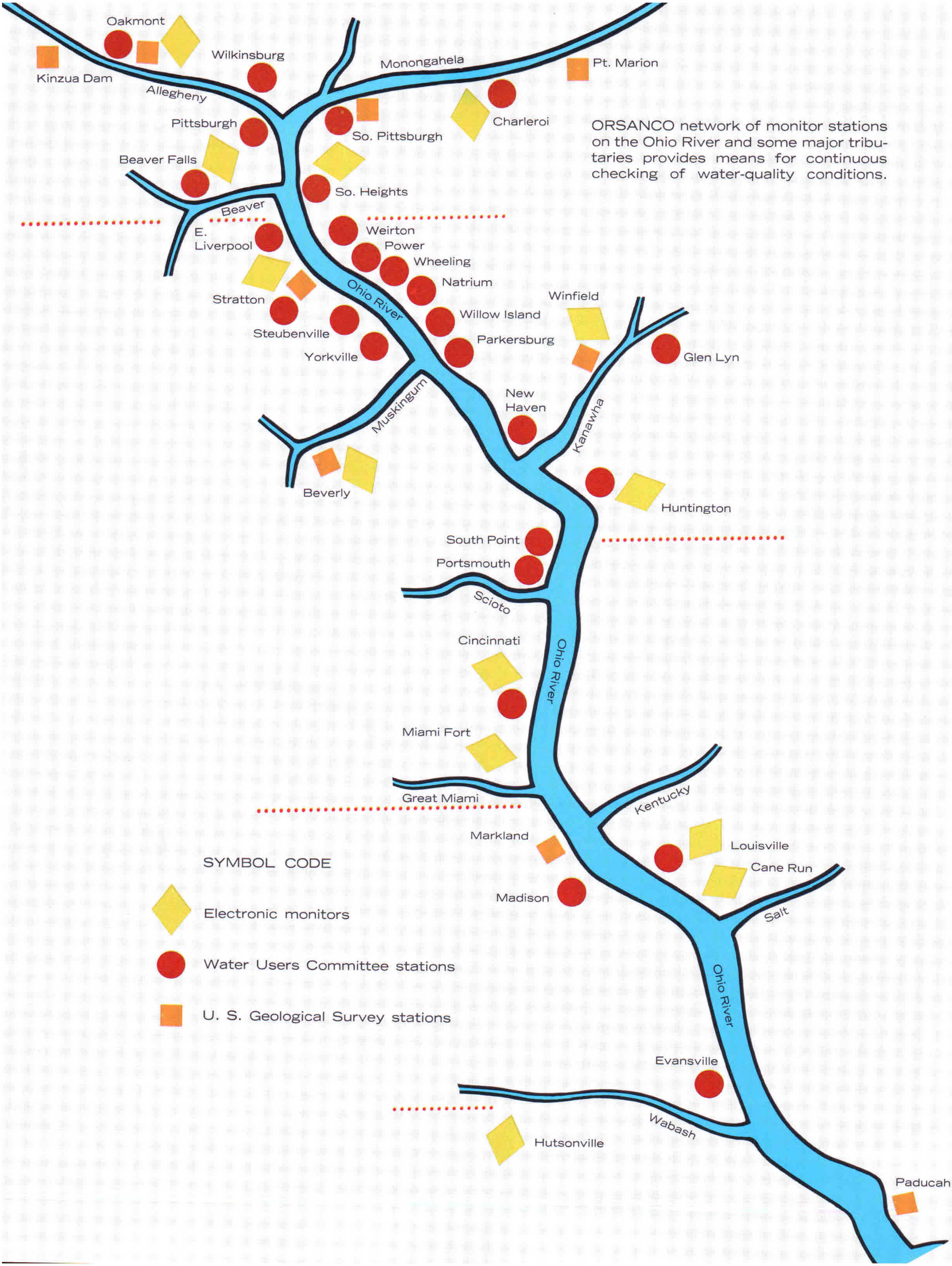
FOR RECREATION

The following criterion is for evaluation of conditions at any point in waters designated to be used for recreational purposes, including such water-contact activities as swimming and water skiing:

Bacteria: Coliform group not to exceed 1,000 per 100 ml as a monthly average value (either MPN or MF count); nor exceed this number in more than 20 percent of the samples examined during any month; nor exceed 2,400 per 100 ml (MPN or MF count) on any day.

FOR AGRICULTURAL OR STOCK WATERING

Criteria are the same as those shown for minimum conditions applicable to all waters at all places and at all times.



ORSANCO network of monitor stations on the Ohio River and some major tributaries provides means for continuous checking of water-quality conditions.

RIVER QUALITY APPRAISAL

FINDINGS WITH RESPECT to quality conditions in the Ohio River are based on an assessment of information derived from three sources: (a) Measurement of chemical, biological and bacteriological characteristics; (b) analysis of the hydrologic variability of the river; (c) conduct of surveillance operations for detection of visual evidence of pollution.

Measurement of chemical, physical and bacteriological characteristics is accomplished primarily by means of an ORSANCO-sponsored monitoring program, which has been in operation since 1951. The monitor network presently (December 1966) includes 35 sampling locations on the Ohio River and its tributaries (see map on page 12). Quality analyses at each location are made through one or more of the following arrangements:

26 locations are monitored by personnel at municipal and private water-supply treatment plants. Twenty are on the Ohio River main stem; there are two each on the Allegheny and Monongahela rivers and one each on the Beaver and New rivers. This is a voluntary service provided through the ORSANCO Water Users Committee.

9 locations are monitored under contract arrangements with the U. S. Geological Survey. Three are on the Ohio River, and six are situated on tributaries. Data assembled by the Geological Survey supplements that from locations monitored by the Water Users Committee and, in addition, includes analyses for certain mineral constituents that are not routinely measured at water-treatment plants.

13 locations are served by ORSANCO robot monitor units. Seven of these electronic sentinels are on the Ohio River and 6 are located on tributaries.

Supplemental data on certain chemical constituents has been obtained from a 1962-63 report issued by the U. S. Public Health Service Water Pollution Surveillance System and from advance information issued by the same agency for the years 1963-65.

Visual surveillance activities are conducted by the ORSANCO staff accompanied on occasion by state-agency personnel. Observations are made through use of a chartered airplane, and these are supplemented by boat patrol. Additional observations are made by monitor-station operators who report unusual incidents, such as accidental spills. River patrol offers an effective means for pinpointing sources of oil and other floating material, foams and wastewater discharges having objectionable color.

FINDINGS IN BRIEF

Conditions in the Ohio River during 1963-65 may be summarized as follows:

Dissolved-oxygen concentrations in some reaches of the river at times were less than levels specified in the ORSANCO criteria for aquatic life. If the criteria are to be attained in all reaches, it appears that additional requirements must be imposed for reduction of the biochemical-oxygen-demand content of certain wastewater discharges into the main stem as well as some tributaries. Recommended remedial measures have been developed by the staff for consideration by the Commission.

Bacterial-quality conditions at several monitor points have improved to the point where they are now close to meeting the ORSANCO criteria for public water supply and recreational use. Staff recommendations have been made for more intensive disinfection of sewage-treatment plant effluents in all reaches.

Dissolved-solids concentrations at monitor stations in reaches where river water is withdrawn for public-water-supply and industrial purposes were within limiting values specified in the ORSANCO criteria for those uses.

Hardness content of the Ohio River varied from 60 to 290 mg/l, a range indicating that river water may be regarded as "moderately hard" to "very hard" in terms of U. S. Geological Survey designations. About half of all the values recorded throughout the river were greater than 120 mg/l. This value of hardness is regarded as the upper desirable limit at Louisville, which is the only municipality on the Ohio River that employs processing facilities for reducing the hardness characteristic of river water.

Values of pH were within the range satisfactory for fish life, 5.0 to 9.0, for 99 percent of the time or better at all stations.

Temperatures at all stations were well below permissible ranges specified in the criteria for aquatic life.

With only a few exceptions of minor significance, levels of the following substances were within limits specified in the criteria for public water supply: Arsenic, barium, cadium, chromium, cyanide, fluoride, lead, selenium, silver and radioactive materials.

Concentrations of chloride and methylene-blue active substances (MBAS) were below limiting concentrations set forth in the U. S. Public Health Service Drinking Water Standards.

Ranges in the concentrations of iron and manganese have remained about the same for each constituent over the past twelve years. Although concentrations at monitor stations exceed limits recommended for drinking water, all water supplied to consumers is first processed in filter plants that have the capability of reducing both iron and manganese content.

These comments summarize major findings. Details on quality conditions in the Ohio River and in some of the tributaries are presented in the following pages.

RIVER FLOW — Basic data on river flow is furnished by the U. S. Geological Survey, which operates a network of stream-gaging stations. Supplementary data is obtained from the Cincinnati River Forecast Center of the U. S. Weather Bureau, which provides daily flow forecasts for twelve locations along the Ohio River and its tributaries. These forecasts include estimates on volume and velocity of flow not only for the current day but for the next three days as well. Availability of this special service makes possible the prompt integration of flow information with quality data from the ORSANCO robot-monitor system.

Flow conditions during the summer and fall seasons of 1963, 1964 and 1965 may be typified as those of a drought character. For example, the lowest monthly-average flow at Sewickley (mile 11.8) during 1963 (which was 3,050 cfs), corresponds to the minimum flow that has a probability of occurrence of about once in sixteen years. At Huntington and Louisville the minimum monthly-average flows in 1963 — 6,600 cfs and 8,200 cfs, respectively — were those that can be expected to occur about once in fourteen years. Low-flow conditions in 1964 and 1965 were not as severe as those in 1963; the minimum monthly-average flows were representative of those whose probability of occurrence ranged from once-in-two-years to once-in-ten-years.

Generally, river quality conditions are poorest during periods of low flow, simply because there is less water available for dilution. Because of this relationship, conditions during 1963-65 could be regarded as among the worst to be expected over the long run. Observations during these years, therefore, provide a critical basis for appraising needs with regard to control measures for wastewater discharges.

The magnitude of flows is profoundly influenced by releases from upstream reservoirs during the dry-weather season. A number of multi-purpose reservoirs on tributaries to the Ohio River have been completed or placed under construction in recent years by the U. S. Corps of Engineers that augment river flow. Among the more important of these additional sources of dilution water are the Allegheny Reservoir, the Shenango and West Branch reservoirs in the Beaver River basin, Sutton and Summersville reservoirs in the Kanawha River basin, Fish Trap and J. W. Flannagan reservoirs in the Big Sandy River basin. Some of these reservoirs are already in operation.

Minimum flows in the Ohio River to be expected once in ten years based on flow augmentation from all reservoirs that will be in operation by 1970 are shown in the following tabulation (which is derived from a 1964 draft of the Corps of Engineers' Ohio River Basin Comprehensive Survey and from flow studies by the ORSANCO staff). The releases from the new reservoirs will provide from 27 to 56 percent increase in minimum flows in the Ohio River, the amount depending upon location.

Station	Min. daily flow (cfs)	Min. 7-day flow (cfs)	Min. 30-day flow (cfs)
Sewickley	4,630	4,910	5,580
Huntington	5,080	8,840	9,640
Cincinnati	6,000	9,000	11,450
Louisville	6,980	9,210	12,450

VISIBLE ASPECTS OF POLLUTION — Incidents of visual pollution recorded from surveillance operations during a three-year period (July 1, 1963, to June 30, 1966), are summarized in the following tabulation. This record should be regarded as only a "sampling" of occurrences, however, because surveillance opportunities are limited.

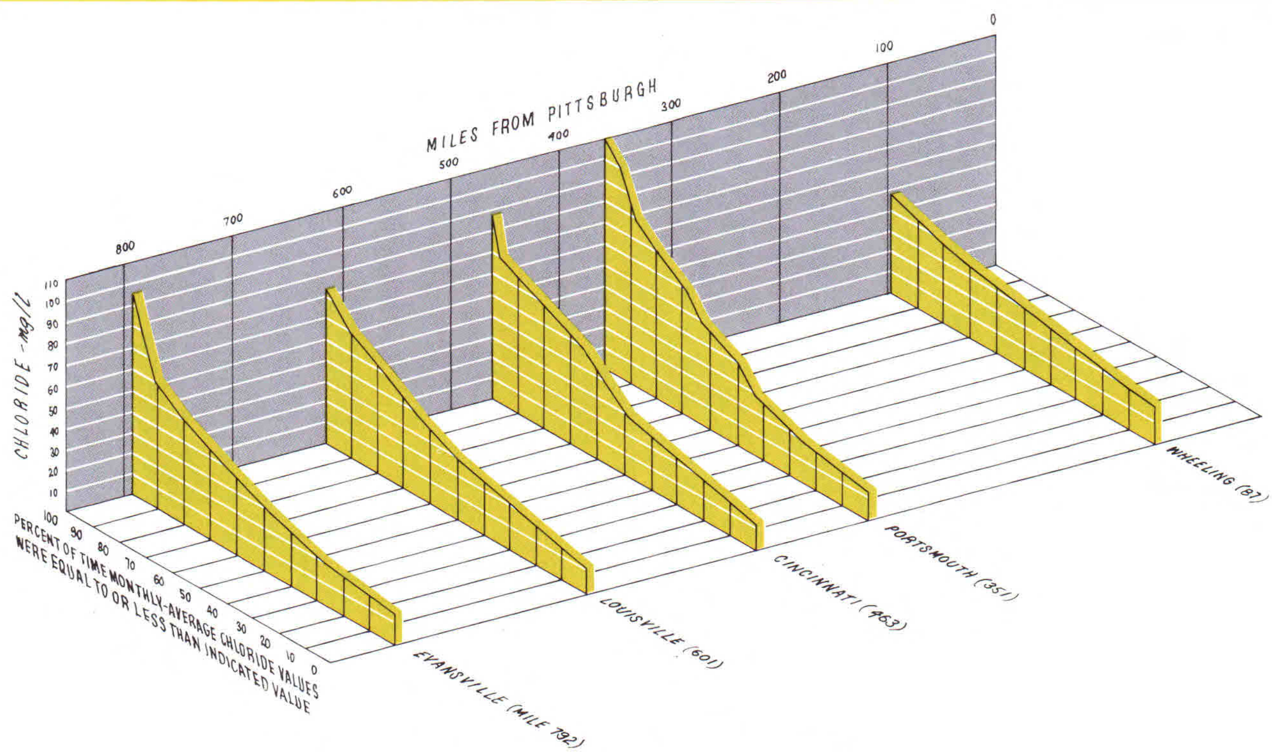
	7/1/63 to 6/30/64	7/1/64 to 6/30/65	7/1/65 to 6/30/66	Total
Fish kills	14	17	34	65
Accidental spills	16	11	16	43
Oil pollution	39	67	49	155
Abnormal color	90	74	66	230
Objectionable appearance (debris, foam, etc.)	35	51	36	122
Total	194	220	201	615

Each of these incidents was investigated by a representative of the state concerned or by the ORSANCO staff. Where responsibility could be fixed the state control agencies took steps toward the application of corrective measures to prevent a recurrence. There are three stretches of the Ohio River in which occurrences of visible pollution have been frequently observed. They are: Pittsburgh to Wheeling, Huntington to Portsmouth, and Louisville to the mouth of the Salt River.

Another form of visible pollution is the occurrence of unsightly conditions resulting from the discharge of garbage and refuse from marinas, pleasure boats and commercial vessels. This situation justifies increasing attention each year because of the vastly expanded use of the river for recreational purposes and the growing volume of commercial traffic.

ORSANCO has been conducting an educational campaign using posters and distribution of litter bags, and this effort has been generously abetted by the U. S. Coast Guard and by several oil companies. The latter purchase and furnish the litter bags to boaters as a public service in behalf of the clean streams program.

CHLORIDE — Chloride conditions in the Ohio River during 1963-65 are revealed by the accompanying qualigrams, which show the frequency of occurrence of monthly-average values at five monitor stations. Concentrations were less than 250 mg/l (the recommended limiting value for drinking water) at all times at all stations. Maximum monthly-average values ranged from 48 mg/l at Wheeling to 110 mg/l at Portsmouth. The increase in chloride levels between Wheeling and Portsmouth reflects the salt load contributed by two tributary streams, the Muskingum and Kanawha rivers.



CHLORIDE QUALIGRAMS
(Period of record — 1963-65)

COLIFORM DENSITY — The density of coliform bacteria provides one measure of the sanitary quality of river water. However, the analytical methods for making this determination are not specific because they measure coliform bacteria common to the soil as well as fecal coliforms associated with sewage discharges.

A more meaningful test for measuring the impact of sewage discharges on bacterial density in rivers is being advocated (see *Reevaluation of the Significance of the Coliform Bacteria* by Harold F. Clark and Paul W. Kabler, *Jour.* AWWA, vol. 56, pp. 931-936, July 1964). The ORSANCO Water Users Committee has been engaged in making comparative examinations of identical samples for determining the ratio of fecal organisms to the total coliform count. The test is specific for identification of fecal organisms. Results during the past year indicate that for the Ohio River the fecal count is one-tenth to one-third of the total coliform count.

Limitations of the conventional coliform-density test should be borne in mind in judging the significance of results shown in the accompanying qualigrams, which are based on monitor records for 1963-65. One set of qualigrams shows the frequency of occurrence of monthly-average coliform values at each station for the full three-year period of record. This information offers a comparison of river conditions with specifications in the ORSANCO criteria for sources of public water supply. For example, the criterion of 5,000 coliforms per 100 ml as a monthly average was met 100 percent of the time at Wheeling. Conditions were almost as good at Huntington and Cincinnati, where the criterion was met more than 90 percent of the time (maximum values at these stations were 6,700 and 5,800, respectively). The 5,000-per-100 ml criterion was met 78 percent of the time at Louisville, 39 percent of the time at Evansville and 3 percent of the time (one month out of 36) at Weirton.

In addition to specifying a limiting value for monthly-average coliform counts, the ORSANCO criteria for public water supply also state that coliform levels should not exceed 5,000 per 100 ml in more than 20 percent of the samples examined during any month, nor exceed 20,000 per 100 ml in more than 5 percent of such samples. As shown by the following tabulation, river conditions matched these latter specifications to about the same degree they met the limitation on monthly-average values.

Station	Percent of months in which 20 percent of daily coliform values did not exceed 5,000 per 100 ml	Percent of months in which 5 percent of daily coliform values did not exceed 20,000 per 100 ml
Weirton	6	11
Wheeling	97	100
Huntington	94	94
Cincinnati	86	100
Louisville	61	83
Evansville	36	56

A second set of qualigrams shows the frequency of occurrence of daily coliform counts during the recreational season of May through September. These qualigrams offer a comparative measure of river conditions with one specification in the ORSANCO criteria for recreational use; namely, coliform densities should not exceed 2,400 per 100 ml on any day. During the recreational seasons of 1963-65, the 2,400-per-100 ml limitation was met 99 percent of the time at Huntington, 97 percent of the time at Wheeling and Cincinnati, 77 percent of the time at Louisville, 63 percent of the time at Evansville and 17 percent of the time at Weirton.

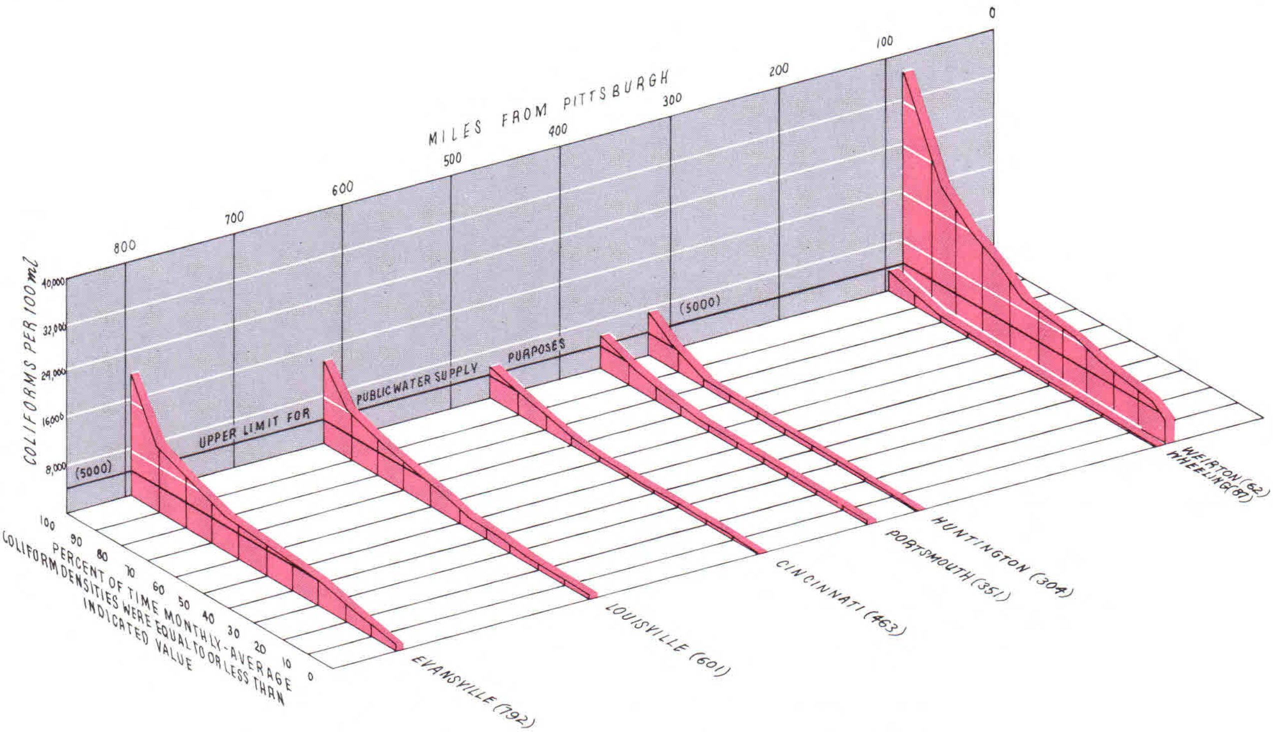
The ORSANCO criteria for recreational use also specify that coliform counts should not exceed 1,000 per 100 ml as a monthly-average value. The degree to which this specification was met in 1963-65 may be expressed in terms of the following frequencies: Huntington and Cincinnati, 87 percent of the time; Wheeling, 80 percent; Louisville, 33 percent; Evansville, 13 percent; Weirton, none of the time.

These findings lead to the conclusion that while bacterial quality conditions at some monitor points are close to meeting the ORSANCO criteria for public water supply and recreational use, more intensive disinfection of sewage discharges in all reaches might enhance river quality.

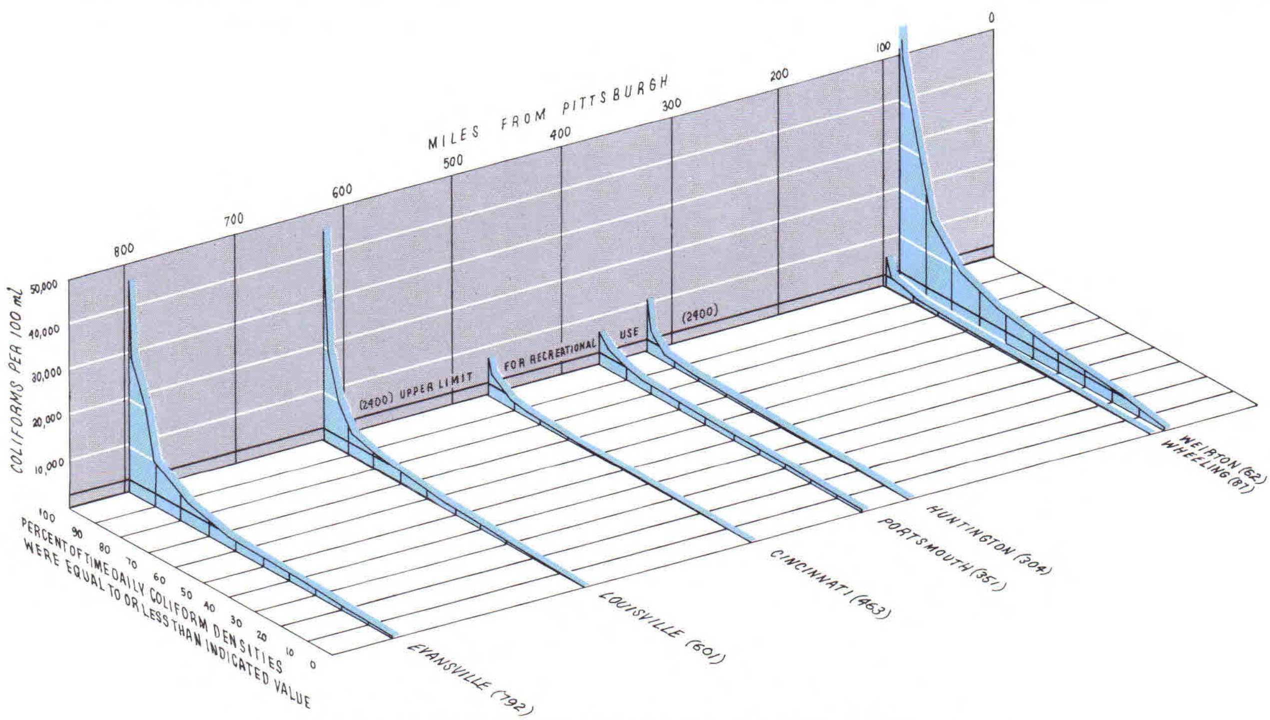
HARDNESS — From the standpoint of hardness, the Ohio River may be characterized as varying from "moderately hard" to "very hard" in terms of U. S. Geological Survey designations (Water Supply Paper No. 1812, 1962), which are based on the following scale:

Soft water	0 to 60 mg/l
Moderately hard	61 to 120 mg/l
Hard	121 to 180 mg/l
Very hard	More than 180 mg/l.

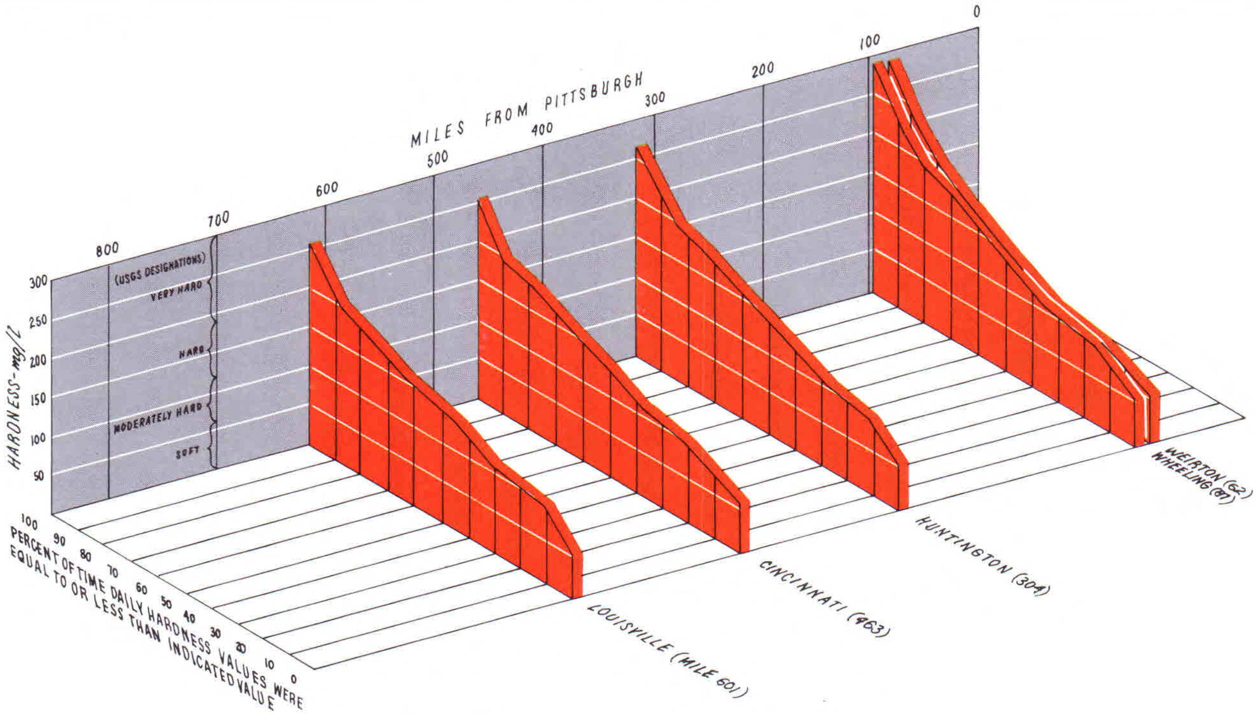
Monitor records show a range in hardness concentrations during 1963-65 of 60 mg/l to 290 mg/l. Yearly average hardness levels at the several stations for the three-year period were: 125 mg/l at Weirton;



COLIFORM-DENSITY QUALIGRAMS
JANUARY THROUGH DECEMBER (Period of record — 1963-65)



COLIFORM-DENSITY QUALIGRAMS
MAY THROUGH SEPTEMBER (Period of record — 1963-65)



HARDNESS QUALIGRAMS
(Period of record — 1963-65)

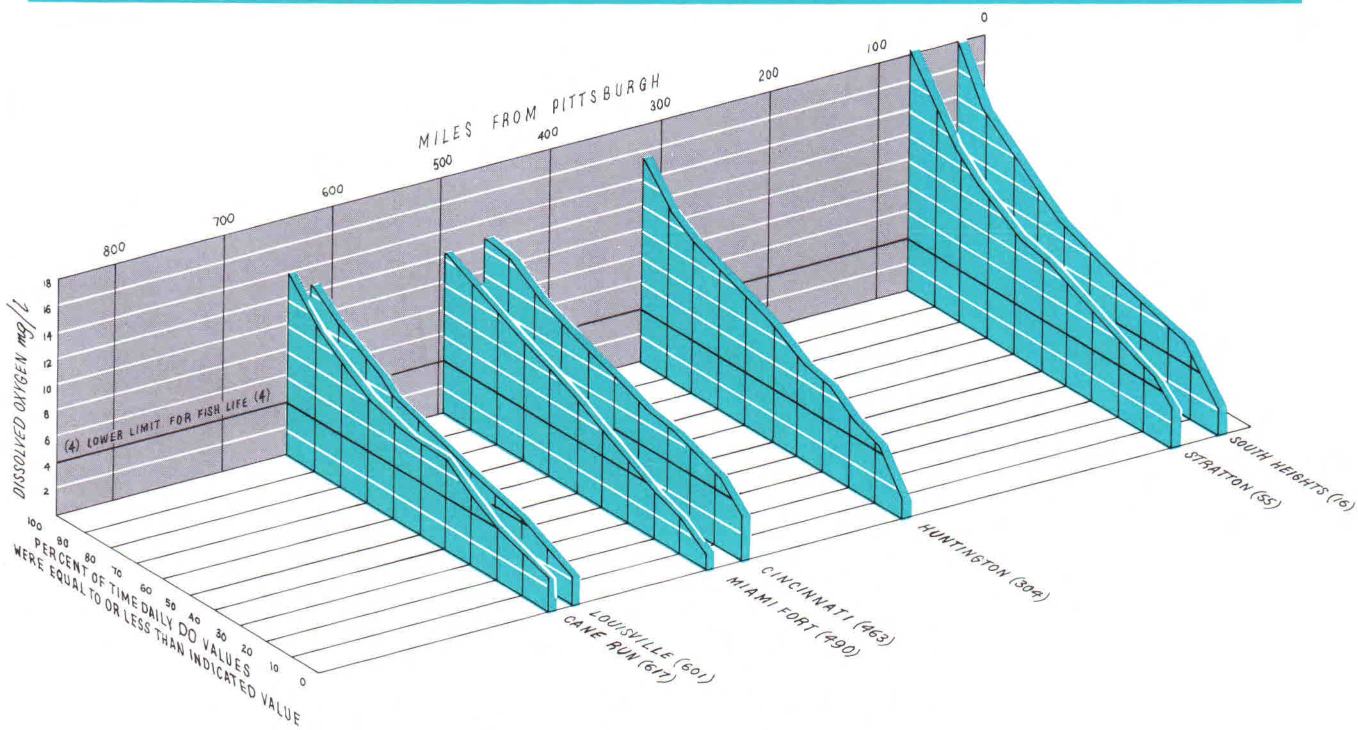
140 mg/l at Wheeling; 154 mg/l at Huntington; 140 mg/l at Cincinnati; 146 mg/l at Louisville; 160 mg/l at Evansville.

The only city on the Ohio River that softens its water supply is Louisville, where the practice is to maintain a hardness level in treated water of 120 mg/l or less (the level varies depending on the hardness of the river water and on the capacity of the water-softening facilities in relation to consumer demand). As shown in the accompanying qualigrams, the hardness of river water at Louisville was greater than 120 mg/l for 54 percent of the time. At other stations, the percent of time that hardness values were greater than 120 mg/l varied from 43 percent (at Weirton) to 67 percent (at Evansville).

About 85 percent of the total hardness in the upper section of the river (Weirton-Wheeling area) may be classified as non-carbonate or "permanent" hardness. This high percentage is attributable, at least in part, to the influence of acid mine-drainage. As alkalinity of the river increases downstream, the ratio of non-carbonate hardness to total hardness decreases, with the result that in the lower part of the river (around Evansville) the non-carbonate fraction is only 50 to 60 percent of the total hardness. Sources of hardness-producing constituents in river water include not only municipal wastewaters, industrial-process wastewaters and mine drainage, but surface runoff and groundwater inflow as well. Potentialities for managing hardness levels in the river will require a detailed study of the relative influence of these man-made and natural sources.

DISSOLVED OXYGEN — The situation with respect to dissolved-oxygen (DO) conditions in the Ohio River is portrayed in the accompanying "qualigrams." The latter are graphical representations that show the frequency of occurrence of specific DO levels at each monitor station. The period of record includes 1964 and 1965 data from all stations except Miami Fort and Cane Run. Miami Fort was not placed in operation until June 1964, and the record extends through May 1966. Records at Cane Run extend from July 1965 through June 1966.

The ORSANCO criteria specify desired DO levels for two uses: (1) Industrial water supply; and (2) maintenance of a well-balanced, warm-water fish population.



DISSOLVED-OXYGEN QUALIGRAMS
(Period of record — 1964-65 except for Miami Fort, June 1964-May 1966, and Cane Run, July 1965-June 1966)

The criterion for industrial water supply (daily average DO not less than 2.0 mg/l) was attained 100 percent of the time at Stratton, Cincinnati and Louisville, and better than 99 percent of the time at South Heights, Huntington and Cane Run. At the Miami Fort station, which is immediately downstream from the Cincinnati metropolitan area, concentrations less than 2.0 mg/l occurred on 51 days, or 7 percent of the time.

With regard to suitability of conditions for aquatic life, a daily average DO content of 4.0 mg/l is regarded — for all practical purposes — as representing conditions compatible with the ORSANCO criterion. The criterion specifies that the DO content should be not less than 5.0 mg/l during at least 16 hours of any 24-hour period, nor less than 3.0 mg/l at any time. From this it may be reasoned that in a river having a DO content of 5.0 mg/l for 16 hours and 3.0 mg/l for 8 hours, the 24-hour average would be 4.3 mg/l. The reasoning is sustained from a statistical study of hourly values recorded by the robot monitors which have repeatedly verified the fact that whenever daily-average values are 4.0 mg/l or greater, the minimum-hourly values have not been less than 3.0 mg/l.

Frequencies-of-occurrence of daily-average DO concentrations less than 4.0 mg/l were as follows: Cincinnati, 1 percent of the time; South Heights and Stratton, 3 percent; Huntington, 4 percent; Louisville, 13 percent; Cane Run, 22 percent; Miami Fort, 26 percent. On the basis of these records, it is concluded that DO conditions are most critical in the reach of the river extending from Cincinnati to Cane Run, which is just below Louisville. One of the factors contributing to critical DO levels in this reach is the low rate of DO recovery through natural processes. Because of the low recovery, DO levels at Cane Run reflect not only the influence of wastes immediately upstream at Louisville and Cincinnati, but the influence of wastes much further upstream — even as far as the Kanawha River — as well.

These findings lead to the conclusion that if the criteria for DO conditions are to be attained in all reaches of the Ohio River, additional requirements should be imposed for reduction of the biochemical-oxygen-denmand content of certain wastewater discharges into the main stem as well as some tributaries. Staff recommendations regarding additional requirements have been developed for consideration by the Commission.

SULFATE — The accompanying sulfate qualigrams show variations in monthly-average concentrations at six Ohio River monitor stations during 1963-65. Sulfate values were highest at the Power and New Haven stations, where maximum monthly averages of 289 and 255 mg/l were recorded. Conditions in the reach between Power and New Haven are attributed to the influence of acid mine-drainage and other industrial operations.

Monthly-average concentrations exceeded the recommended limit of 250 mg/l for drinking water 25 percent of the time at Power and three percent of the time at New Haven. At all other stations monthly values were less than 250 mg/l at all times.

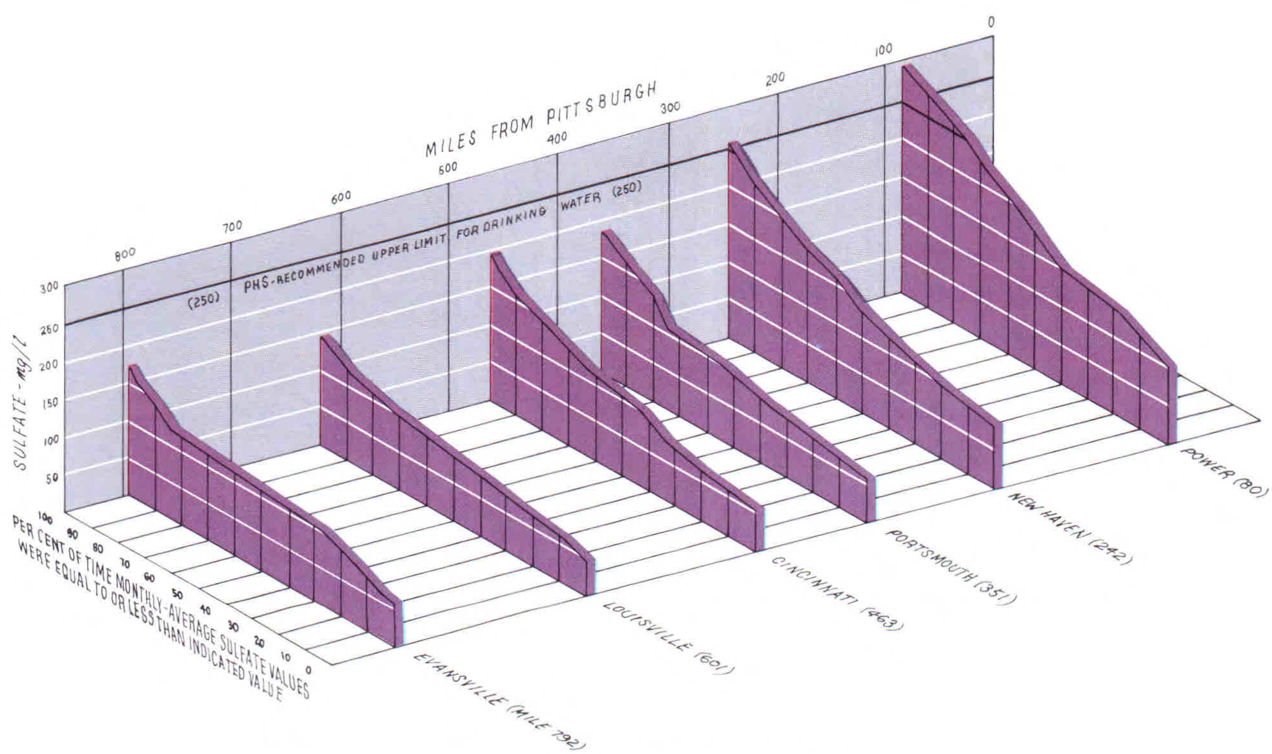
DISSOLVED SOLIDS — The accompanying qualigrams show the frequency of occurrence of daily-average values of specific conductance (micromhos/cm at 25 deg. C.) at six Ohio River robot monitor stations. The period of record is 1964-65 for all stations except Miami Fort, for which the data extends from June 1964 through May 1966.

Relationships developed through statistical analyses show that specific-conductance values can be converted readily to dissolved-solids values (see ORSANCO *Annual Report* for 1965). For example, a conductance value of 800 micromhos/cm is equivalent to a dissolved-solids concentration of 500 mg/l.

The ORSANCO criteria specify that monthly-average values of conductance should not exceed 800 micromhos/cm in water used as a source of public supply. This criterion was met 100 percent of the time at the four monitor stations — Stratton, Huntington, Cincinnati, Louisville — which are located at or near public-water-supply intakes.

The water-supply criterion is not applicable at the South Heights and Miami Fort stations. It might be noted, however, that average conductance values at these latter stations were less than 800 micromhos/cm in all months during 1964-65 except for one (August 1964) at Miami Fort, when a value of 832 micromhos/cm was recorded.

The criteria for public water supply also contain a limiting dissolved-solids concentration of 750 mg/l



SULFATE QUALIGRAMS
(Period of record — 1963-65)

(equivalent to 1,200 micromhos/cm) for any single value. The highest single conductance value observed in 1964-65 was 980 micromhos/cm (which occurred at Cincinnati in November 1964); this is 18 percent less than the specified limit of 1,200 micromhos/cm.

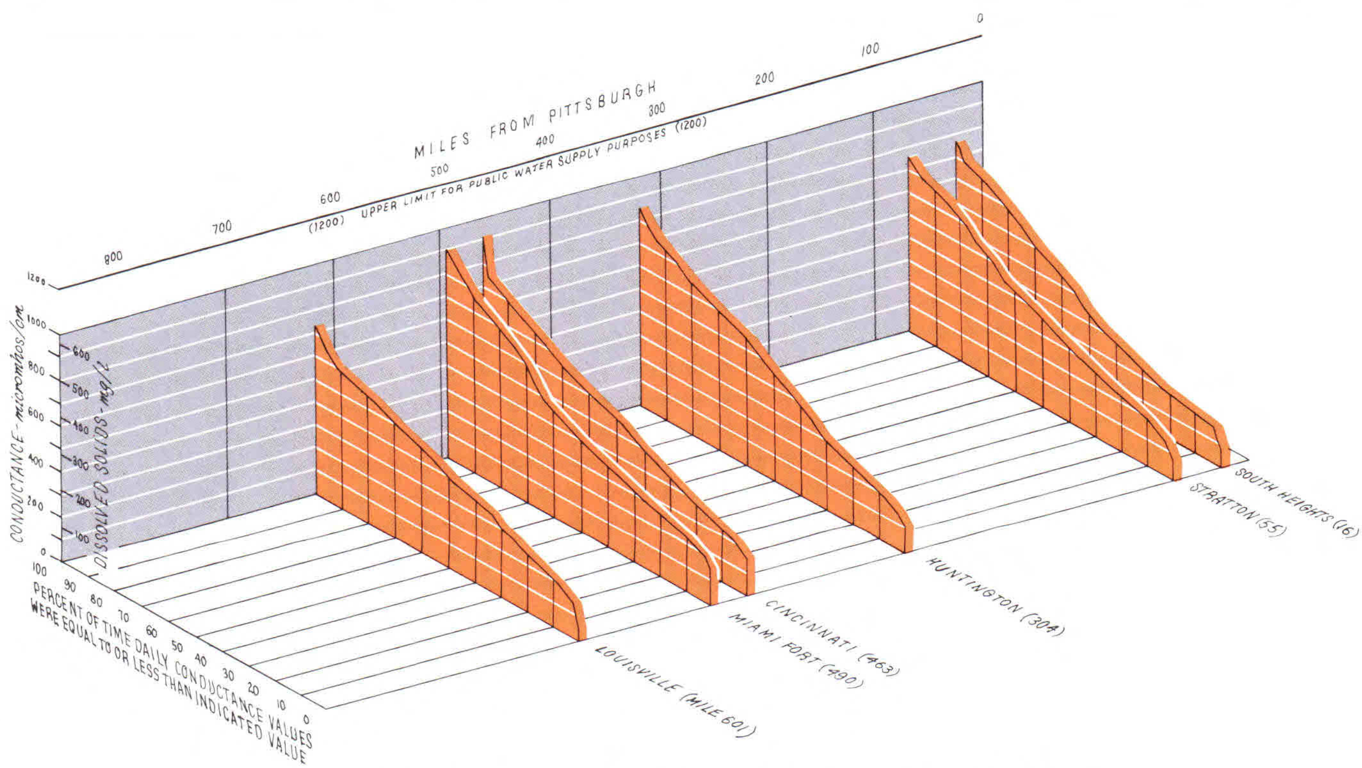
The ORSANCO criteria contain limiting dissolved-solids values for industrial-water use as well as for public water supplies. The values specified for industrial use are 750 mg/l (1,200 micromhos/cm) and 1,000 mg/l (1,600 micromhos/cm) as limiting monthly-average and individual values, respectively. Neither of these limiting values were exceeded at any of the monitor stations during 1964-65.

pH CHARACTERISTICS —The ORSANCO criteria establish limiting values for pH to maintain the suitability of water for aquatic life and for industrial use. For aquatic life, pH values should not be lower than 5.0 nor greater than 9.0 and preferably should be between 6.5 and 8.5. For industrial purposes the specified range is 5.0 to 9.0.

The extent to which these criteria were met in 1963-65 is summarized in the following tabulation (periods of record are 1964-65 for South Heights and Stratton; June 1964 through December 1965 for Miami Fort; June 1965 through December 1965 for Cane Run and 1963-65 at all other stations):

Station	Percent of daily-average values within indicated range: 5.0 to 9.0	6.5 to 8.5
South Heights	99	7
Stratton	99	8
Weirton	100	48
Wheeling	99	56
Huntington	100	82
Cincinnati	100	99
Miami Fort	100	84
Louisville	100	100
Cane Run	100	84
Evansville	100	94

These findings indicate that pH values were within the limiting range for aquatic life and industrial use (5.0 to 9.0) for 100 percent of the time at all stations except South Heights, Stratton and Wheeling. At these latter stations, pH values were outside the range of 5.0 to 9.0 for one percent of the time or less (one to three days per year, depending on the station).



DISSOLVED SOLIDS (CONDUCTANCE) QUALIGRAMS

(Period of record — 1964-65 except for Miami Fort, June 1964-May 1966)

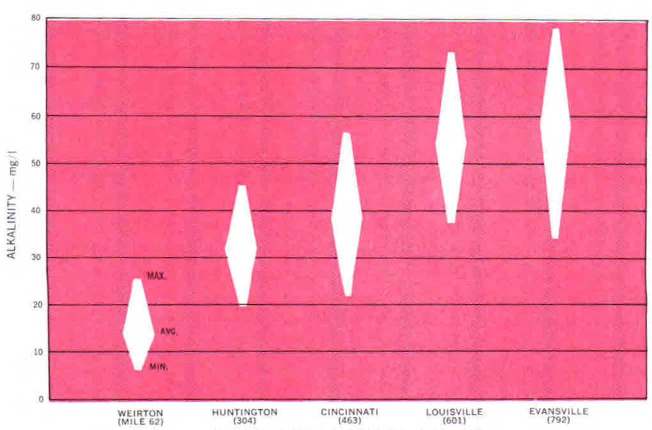
With respect to pH levels within the "preferred" range of 6.5 to 8.5, conditions in that reach of the river extending from Pittsburgh to Huntington are characterized by low pH values (less than 6.5), while the reach between Cane Run and Evansville is characterized by high values (greater than 8.5). For example, pH levels less than 6.5 (but greater than 5.0) occurred 92 percent of the time at South Heights, 52 percent of the time at Weirton and 18 percent of the time at Huntington. This pattern of variation parallels that for alkalinity concentrations, which are low in the upper river with steadily increasing values downstream, and is presumed to reflect the influence of acid mine-drainage.

At Miami Fort, pH values outside the 6.5 to 8.5 range were also on the low side (between 5.0 and 6.5). The situation here is attributed to the local influence of acid wastewater discharges.

The occurrence of relatively high pH values (between 8.5 and 9.0) at Cane Run and Evansville is attributed to alkaline wastewater discharges and the influence of algal growths.

ALKALINITY — Alkalinity concentrations were relatively low in the extreme upper reaches of the river, with steadily increasing values downstream from Weirton. Average values in 1963-65 were: 15 mg/l at Weirton; 33 mg/l at Huntington; 39 mg/l at Cincinnati; 55 mg/l at Louisville, and 59 mg/l at Evansville.

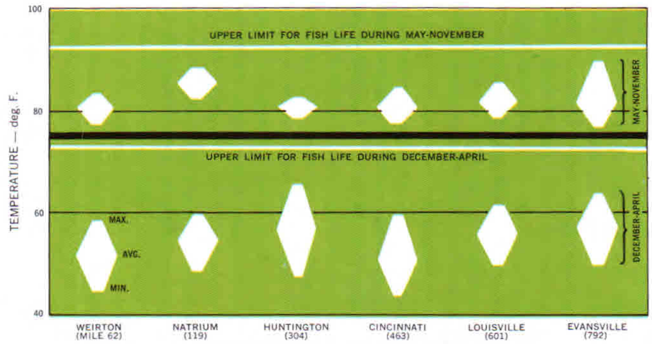
The following chart shows ranges in concentrations at the various monitor stations during 1963-65.



ALKALINITY RANGES 1963-65

Conditions in the upper reaches of the river, where concentrations have remained at consistently low levels for many years, could be attributed to the influence of acid mine-drainage.

TEMPERATURE — Temperature conditions in the Ohio River are depicted in the accompanying chart. To relate these conditions with the criteria for aquatic life, the temperature variations are shown for two periods of the year — May through November and December through April. The chart shows for each



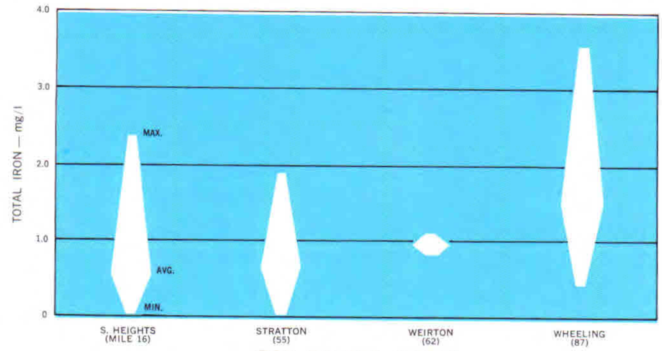
TEMPERATURE RANGES 1963-65

station the maximum and minimum daily temperature values as well as the monthly-average temperature during the most critical — or warmest — month. For purposes of appraisal, the most critical month is regarded as that in which the highest daily-average temperature occurred during the particular season under study.

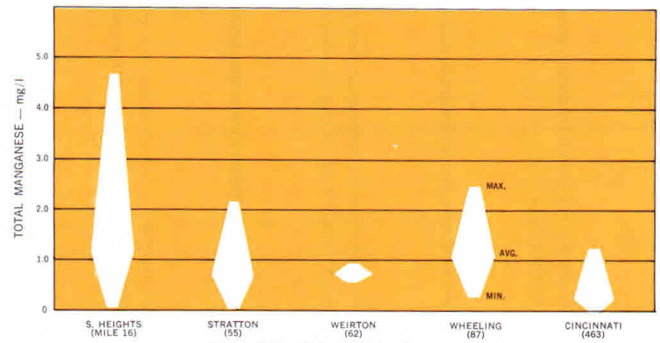
Temperatures recorded at all stations were well below tolerance limits specified in the ORSANCO criteria for the maintenance of aquatic life and for water used as a source of industrial water supply.

IRON — Maximum concentrations of total iron, as shown in the accompanying graph, occur in the Ohio River upstream from Wheeling. Sources of iron include steel-industry operations and mine drainage, as well as stored water released from certain flood-control reservoirs.

During 1963-65, maximum monthly-average concentrations of total iron at the sampling locations from Pittsburgh to Wheeling varied from 1.1 to 3.6 mg/l.



IRON RANGES 1963-65



MANGANESE RANGES 1963-65

Because of increased alkalinity and higher pH values, iron levels downstream from Wheeling are lower. Measurements of iron are not made routinely at water plants downstream from Wheeling.

The U. S. Public Health Service Drinking Water Standards recommend an upper limit of 0.3 mg/l of iron in water after treatment. The question as to what might be an appropriate criterion for river water has not been resolved, and ORSANCO concluded that the evidence was insufficient for justifying establishment of a level at this time. It can be noted that all water supplied to consumers is first processed in filter plants that have the capability of reducing both iron and manganese content.

Insofar as aquatic life is concerned, the ORSANCO Aquatic Life Advisory Committee has concluded that ". . . the setting of allowable levels for iron and manganese in mg/l is unrealistic, of little practical value, and can be very misleading." (*Third Progress Report*, published in the Journal of the Water Pollution Control Federation, vol. 32, pp. 65-67, January 1960).

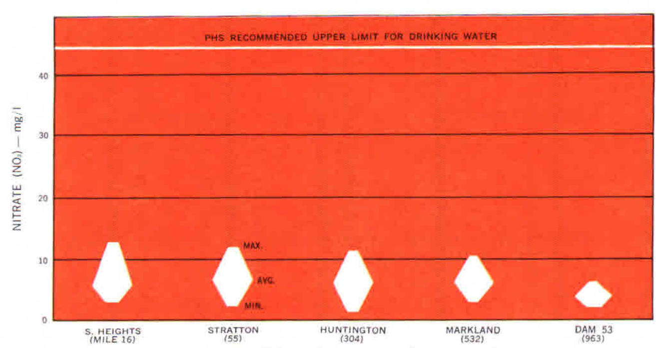
MANGANESE — During 1963-65, maximum monthly-average concentrations of manganese, as indicated in the accompanying graph, ranged from 4.7 mg/l at South Heights to 0.9 mg/l at Weirton. Sources of manganese include ferro-alloy and other steel-industry operations as well as stored water released from flood-control reservoirs.

In its drinking water standards the U. S. Public Health Service recommends a limiting manganese concentration of 0.05 mg/l in water after treatment. Because manganese concentrations can be reduced to and below this level by water-treatment methods, ORSANCO has not yet considered it feasible to adopt a criterion for manganese levels in river water.

As cited in the discussion on iron, the ORSANCO Aquatic Life Advisory Committee did not recommend a limiting value because the effect of manganese on aquatic life was not considered significant.

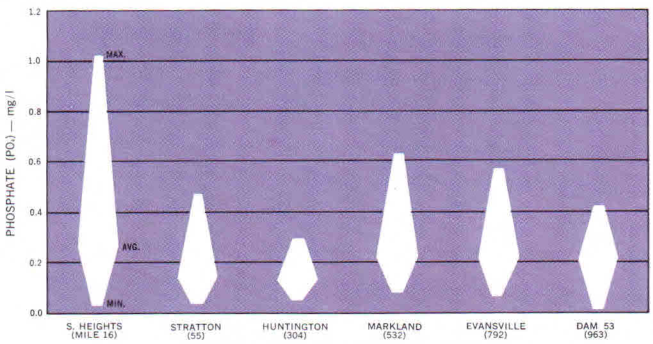
NITRATE — The accompanying chart shows ranges in monthly-average nitrate concentrations during 1963-65. The maximum concentration observed was 13 mg/l, which occurred at South Heights. This value is less than one-third of the limiting value of 45 mg/l recommended in the Public Health Service drinking water standards. There is a small successive decrease in nitrate levels from Pittsburgh to the mouth of the river.

Nitrates, together with phosphates, are recognized as having an influence on the rate of growth of algae and other aquatic plant life. However, no direct correlation between concentrations of these substances and the abundance of aquatic plant life in rivers has been demonstrated.



NITRATE (NO_3) RANGES 1963-65

PHOSPHATE — Ranges in monthly-average phosphate concentrations are shown in the accompanying chart. The two highest values observed were 1.15 and 0.63 mg/l, which were recorded at South Heights and Markland Dam, respectively. It is presumed that the relatively high values at these stations may reflect the influence of wastewater discharges from the metropolitan areas of Pittsburgh and Cincinnati.

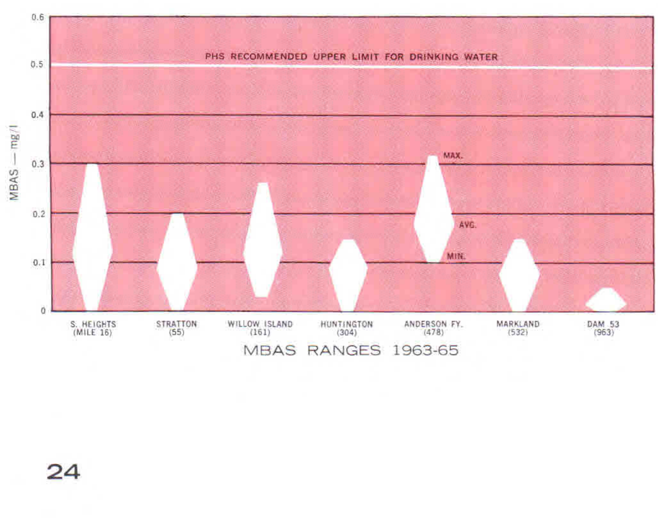


PHOSPHATE (PO_4) RANGES 1963-65

METHYLENE-BLUE ACTIVE SUBSTANCE — The test for methylene-blue active substance (MBAS) is a measure of the apparent concentration of synthetic detergent, including the original alkyl benzene sulfonate (ABS) and the bio-degradable linear alkylate sulfonate (LAS), which has replaced ABS in commercial detergents.

The accompanying chart indicates the range in monthly-average concentrations of MBAS at Ohio River stations during 1963-65. Highest concentrations occurred immediately below the Pittsburgh and Cincinnati metropolitan areas. The range in concentrations in 1963-65 was essentially the same as that in previous years.

All values were below the recommended limiting value of 0.50 mg/l for drinking water, the highest monthly-average concentration being 0.32 mg/l.



MBAS RANGES 1963-65

OTHER CHEMICAL SUBSTANCES — The ORSANCO criteria for public water supply specify limiting values based on the U. S. Public Health Service drinking water standards for nine specific chemical constituents, namely: Arsenic, barium, cadmium, chromium, cyanide, fluoride, lead, selenium and silver. Although monitor data on most of these constituents is meager, findings reveal that — with only a few exceptions of minor significance — concentrations in the river were well within the range considered satisfactory.

Following is a summary of data that is available on each constituent. Information on seven of these constituents (arsenic, barium, cadmium, chromium, lead, selenium and silver), was derived from the U. S. Public Health Service Water Pollution Surveillance System. The data for 1962-63 has been published; that for 1963-65 was provided by USPHS in advance of publication. The reports contain results of analyses made on samples taken from the following Ohio River locations: Toronto, Ohio (mile 50); Addison, Ohio (260); Huntington (304); Cincinnati (463); Louisville (601); Evansville (792); Cairo, Ill. (981). In 1963-65, a total of 51 samples were collected from these stations, including 24 monthly-composite samples, 26 quarterly-composite samples and one daily sample.

Data on fluoride concentrations is available from ORSANCO Water Users Committee stations at Weirton, Wheeling and Huntington, where daily analyses are made, and at Cincinnati where monthly-composite analyses are made.

Arsenic — From a total of 49 analyses in 1963-65, there were five occasions when monthly-composite samples revealed the presence of arsenic in amounts exceeding 0.05 mg/l, which is the limiting value specified in the criteria. Places where these samples were collected, concentration values and months of collection, were: Huntington, 0.06 mg/l in December 1963 and 0.07 mg/l in March 1964; Cairo, 0.06 mg/l in October and November 1964, and 0.13 mg/l in December 1964. In 1965 no values exceeded 0.05 mg/l.

Barium — A total of 51 barium analyses were made in 1963-65. All values were well below the limit of 1.0 mg/l specified in the criteria. The maximum concentration was 0.18 mg/l; ninety percent of the values were less than 0.10 mg/l.

Cadmium — From a total of 48 samples analyzed in 1963-65, two were reported as containing "less than 0.40 mg/l" of cadmium, and twelve as containing "less than 0.02 mg/l." These results are inconclusive with respect to whether concentrations were within the range specified in the criteria, namely, 0.01 mg/l or less. For the remaining 34 samples, however, concentrations were reported in each case to be "less than 0.01 mg/l."

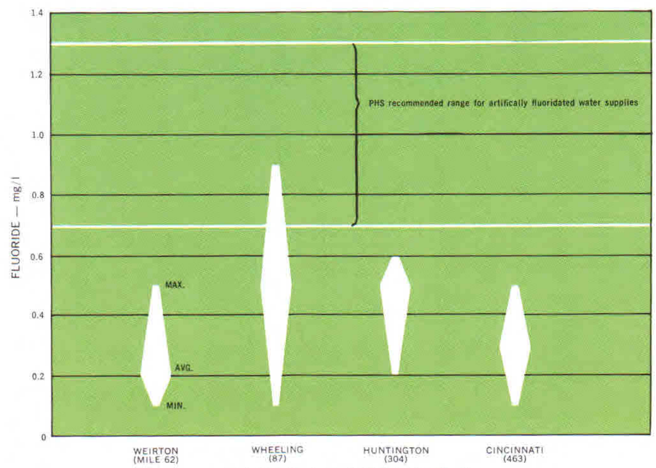
Chromium — The criteria specify a limiting value of 0.05 mg/l for hexavalent chromium. Measurements of *total* chromium in 51 samples from the Ohio River during 1963-65 showed the highest value to be 0.02 mg/l. Since these analyses included the measurement of all ions of chromium (including those in the hexavalent form), it can be concluded that levels of hexavalent chromium in the river were below the criterion.

Cyanide — Surveillance reports of the Public Health Service for 1963-65 do not include data on cyanide levels. The most recent three-year period for which information is available is 1954-57, when measurements were made in connection with USGS-ORSANCO monitor operations at Newell, W. Va. (mile 46), Ravenswood, W. Va. (221) and Florence, Ind. (532). Cyanide analyses were discontinued after 1957 because concentrations were consistently so small as to be of no practical significance. During 1954-57, a total of 78 samples were analyzed, in 74 of which the concentrations were 0.02 mg/l or less. The maximum value recorded during the period was 0.06 mg/l, which is well below the limiting value of 0.2 mg/l.

Selenium — From 1955 to 1961 analyses for selenium were made twice a year at each of six Ohio River stations. All of them indicated concentrations of less than 0.01 mg/l, the limit of sensitivity of the test and also the limiting value specified in the ORSANCO criteria. A report from the Public Health Service for the water year 1962-63 states that selenium determinations were eliminated after 1961 "due to the general absence of this element from the samples examined."

Silver — A total of 50 analyses for silver were made in 1963-65. The highest concentration found in any sample was 0.003 mg/l, which is far below the limiting value of 0.05 mg/l specified in the criteria.

Fluoride — Ranges in monthly-average concentrations of fluoride at four Ohio River stations during 1963-65 are shown in the accompanying chart, which is based on data from 3,002 analyses. The maximum monthly-average value at Wheeling, 0.9 mg/l, was within the recommended range for artificially-fluoridated water supplies (0.8 to 1.3 mg/l for Ohio Valley temperature conditions). All other monthly-average values were below this range. The highest daily value observed was 1.2 mg/l (at Wheeling), which is below the limiting value of 2.0 mg/l specified in the criteria.



FLUORIDE RANGES 1963-65

Lead — A total of 51 samples were collected and analyzed for lead in 1963-65. In all but two the concentrations were less than the limiting value of 0.05 mg/l specified in the criteria. A monthly-composite sample at Huntington in December 1964 contained 0.09 mg/l, and a quarterly-composite sample collected at Evansville during October-December 1965 contained 0.14 mg/l. However, samples collected after those high values were observed (two quarterly and a daily sample at Huntington and a quarterly sample at Evansville) showed lead concentrations to be within the acceptable range.

THRESHOLD-ODOR CONDITIONS — Threshold-odor information is available at six locations on the Ohio River. With the exception of Cincinnati and Louisville, however, the test for threshold odor is varied by water plant operators to fit individual needs in connection with the control of treatment processes and comparison of results is not always meaningful. Therefore, for purposes of comparing river conditions with the ORSANCO criteria, which specify that threshold-odor (TO) numbers should not exceed 24 at 60 deg. C., only data from Cincinnati and Louisville has been employed. The following tabulation shows maximum daily and annual-average values during 1963-65:

	Cincinnati			Louisville		
Year	Max. Daily TO	Yearly Avg. TO	No. values exceeding 24	Max. Daily TO	Yearly Avg. TO	No. values exceeding 24
1963	1,000	142	225	64	6	11
1964	140	24	56	64	6	6
1965	24	7	0	8	3	0

The high values observed at Cincinnati in 1963 were recorded following the impoundment of water by the Markland navigation dam, which was completed that year. Since 1963, conditions have improved at both Cincinnati and Louisville. No threshold-odor value exceeded the criterion of 24 at either place in 1965.

RADIOACTIVE SUBSTANCES — Data on radioactive substances is available from an ORSANCO-sponsored project at the University of Louisville, which was operated throughout 1963 and 1964 and during part of 1965, and from data supplied by the U. S. Public Health Service Water Pollution Surveillance System. The data indicates that from 1963 to 1965 there was a general decrease in all types of radioactivity.

Ranges in radioactivity in the Ohio River during 1963-65 are shown in the following tabulation. The data was obtained from the analysis of over 300 samples collected periodioally at several locations throughout the length of the river. Values are expressed in terms of pico curies per liter, pc/l (equivalent to micro-microcuries per liter).

	1963	1964	1965
Gross beta			
Dissolved	0 to 110	0 to 33	0 to 14
Suspended	0 to 726	0 to 50	0 to 25
Total	14 to 771	6 to 63	5 to 30
Gross alpha			
Dissolved	0 to 3	0 to 2	0 to 1
Suspended	0 to 59	0 to 8	0 to 9
Total	0 to 59	0 to 9	0 to 9
Strontium-90	1.9 to 4.9	1.4 to 3.4	0.8 to 1.8

The quality criteria for public water supply specify that gross beta activity (in the known absence of Strontium-90 and alpha emitters) should not exceed 1,000 pc/l at any time. The "known absence" of alpha emitters and Strontium-90 means a negligibly small fraction of limits specified in the PHS drinking water standards, namely, 3 pc/l and 10 pc/l, respectively.

Since water-purification processes remove substantially all of the suspended matter from the raw water supply, it is the dissolved fractions of the gross beta and gross alpha radioactivity that assume significance in judging the quality of water used as a source of public supply. On the basis of findings with regard to the dissolved fractions of the samples, therefore, the criterion for gross beta activity was met in all cases, the highest value being only about one-tenth of the limiting value.

Gross alpha activity in the dissolved fractions of the samples did not exceed 3 pc/l at any time, although levels up to 3 pc/l were recorded on occasion.

Levels of Strontium-90 ranged between 0.8 and 4.9 pc/l. This range was well below the limiting value of 10 pc/l.

QUALITY CONDITIONS IN TRIBUTARIES

Quality conditions in some of the major streams tributary to the Ohio River are set forth in the following summary.

COLIFORM BACTERIA — Coliform levels are routinely monitored on the Monongahela River at South Pittsburgh and on the Allegheny River at Wilkinsburg. During 1963 and 1964, the most stringent component of the public water supply criterion, monthly-average concentration not to exceed 5,000 per 100 ml, was met for all months except one in each year at each station. In 1965, counts were less than 5,000 per 100 ml for all months except two on the Monongahela and three on the Allegheny.

With regard to the recreational criterion, conditions during the months of May through September in 1963-65 were these: Daily-average counts were less than the specified limit of 2,400 per 100 ml for 40 percent of the time on the Allegheny and 66 percent of the time on the Monongahela; monthly-average counts were less than the specified limit of 1,000 per 100 ml for 33 percent of the time on the Monongahela, but always exceeded 1,000 on the Allegheny.

The following table summarizes conditions at the two stations:

Tributary	Monthly-average coliform levels May through September (coliforms per 100 ml)			Monthly-average coliform levels January through December (coliforms per 100 ml)		
	1963	1964	1965	1963	1964	1965
Monongahela (S. Pittsburgh)	280	5,300	5,200	780	3,200	3,200
Allegheny (Wilkinsburg)	3,100	3,800	4,200	3,000	2,500	3,800

The data shows that coliform densities were generally greater at both stations during 1964 and 1965 than they were during 1963. On the Monongahela, the monthly-average density during the 1964 recreational season (May-September) was about twenty times greater than that during the same season in the previous year.

pH AND ALKALINITY — In all tributaries except the Allegheny and Monongahela rivers, pH values were generally between 5.0 and 9.0 in 1963-65. Ranges in daily-average pH values in the 1963-65 period are shown in the following tabulation.

Tributary	1963		1964		1965	
	Max.	Min.	Max.	Min.	Max.	Min.
Allegheny (Oakmont)	7.9	4.9	9.4	4.8	8.7	4.7
Allegheny (Wilkinsburg)	7.3	4.6	7.3	3.0	7.1	4.5
Monongahela (Charleroi)	6.4	3.1	6.3	3.1	6.1	2.8
Monongahela (S. Pittsburgh)	7.5	3.8	7.0	4.1	7.1	4.4
Beaver (Beaver Falls)	10.4	6.3	8.9	5.9	7.6	6.1
Muskingum (Beverly)	8.5	7.0	9.2	6.4	8.1	5.0
Kanawha (Winfield)	9.0	5.9	8.0	5.4	7.9	5.7
Wabash (Hutsonville)	9.4	7.3	9.0	6.2	8.8	6.9

There were several periods of brief duration in 1963 and 1964 when pH values were greater than 9.0. It is believed that these occurrences reflect the influence of algae blooms.

On both the Allegheny and Monongahela rivers, pH values below 5.0 are attributed for the most part to the influence of acid mine drainage. The presence of acid conditions is also revealed by low levels of alkalinity. During 1965, yearly-average concentrations of alkalinity were 14 mg/l on the Allegheny and 5 mg/l on the Monongahela, which values are substantially the same as those in 1964.

Acid conditions were most evident at Charleroi on the Monongahela, where minimum pH values of 2.8 and 3.1 were recorded during 1963-65. In the stretch of the Monongahela downstream from Charleroi conditions showed improvement. Studies conducted during the steel strike of 1959 indicated that the return to the river of lime treated water withdrawn by steel industries for cooling purposes brought about neutralization of the acid conditions in the river (see ORSANCO report, "River-Quality Conditions During a 16-week Shutdown of Upper Ohio Valley Steel Mills," September 1961). As a result the Monongahela is less acid than what would normally be expected when it enters the Ohio River.

DISSOLVED OXYGEN — At six tributary locations dissolved oxygen is measured hourly by means of robot monitors. Yearly-average and minimum daily-average values (in mg/l) during 1963-65 were:

Tributary	1963		1964		1965	
	Avg.	Min.	Avg.	Min.	Avg.	Min.
Allegheny (Oakmont)	8.2	1.4	9.0	4.8	9.3	3.4
Monongahela (Charleroi)	8.6	2.2	7.7	1.0	9.7	5.0
Beaver (Beaver Falls)	6.2	1.2	7.5	1.8	7.3	0.6
Muskingum (Beverly)	7.7	1.6	8.1	1.7	9.5	3.2
Kanawha (Winfield)	3.9	0.0	5.6	0.0	4.8	0.0
Wabash (Hutsonville)	7.8	3.0	7.2	2.8	9.7	4.0

These results reveal a trend of improvement, notably in 1965, on the Allegheny, Monogahela, Muskingum and Wabash rivers. The improvement is reflected not only by higher minimum values but also in terms of higher average values of dissolved oxygen.

Daily-average DO concentrations of less than 4.0 mg/l, the minimum level for maintenance of a well-balanced warm-water fish population were recorded at times on all tributaries in 1963, on all tributaries except the Allegheny in 1964, and on all tributaries except the Monongahela and Wabash in 1965. The number of days per year in which concentrations in each tributary were less than 4.0 mg/l ranged as follows: 0 to 39 for the Allegheny, 0 to 51 for the Monongahela, 43 to 63 for the Beaver, 13 to 39 for the Muskingum, 177 to 202 for the Kanawha, 0 to 41 for the Wabash.

Daily-average concentrations of less than 2.0 mg/l (the minimum level specified for industrial-water-supply use) were recorded at times on the Beaver and Kanawha rivers in each of the three years, on the Muskingum in 1963 and 1964, on the Allegheny only in 1963, and on the Monongahela only in 1964. The number of days per year in which concentrations in each tributary were less than 2.0 mg/l ranged as follows: 0 to 24 on the Allegheny, 0 to 19 on the Monongahela, 2 to 18 on the Beaver, 0 to 3 on the Muskingum, 140 to 184 on the Kanawha, 0 to 11 on the Wabash.

DISSOLVED SOLIDS — Maximum monthly-average and yearly-average values of specific conductance (in micromhos/cm) at robot monitor stations were:

Tributary	1963 Max.	1963 Avg.	1964 Max.	1964 Avg.	1965 Max.	1965 Avg.
Allegheny (Oakmont)	556	329	594	288	501	248
Monongahela (Charleroi)	631	379	801	411	1,146	637
Beaver (Beaver Falls)	674	540	622	475	570	456
Muskingum (Beverly)	1,448	933	1,495	939	1,379	870
Kanawha (Winfield)	722	322	629	324	770	397
Wabash (Hutsonville)	703	581	664	560	635	545

The relationship between dissolved-solids and specific-conductance measurements previously developed for the Ohio River is also valid for each of the tributaries on which there are monitor stations except the Monongahela, where acid conditions preclude the application of the ORSANCO correlation equation. On the basis of that equation, it may be concluded that monthly-average concentrations of dissolved solids at stations on the Allegheny, Beaver, Kanawha and Wabash rivers did not exceed 500 mg/l (equivalent to 800 micromhos/cm), the limiting value specified in the ORSANCO criteria for public water supply purposes, at any time during 1963-65.

On the Muskingum River, which is not used as a source of public water supply, there were periods in each of the three years during which monthly-average dissolved-solids concentrations exceeded the limiting value of 750 mg/l (equivalent to 1,200 micromhos/cm) specified for industrial-water-supply purposes.

Although a mathematical equation expressing the relationship between dissolved-solids and conductance measurements has not yet been specifically established for the Monongahela River at Charleroi, the evidence suggests that monthly-average concentrations at that station were less than 500 mg/l throughout 1963 and 1964, but were greater than this value at times during 1965. This assumption is supported by supplemental data available from the USGS-Commission cooperative monitor program.

MANGANESE — During 1963-65, concentrations of manganese were routinely measured at two stations on the Allegheny River and at one station each on the Monongahela and Beaver rivers. Monthly-average concentrations on the Allegheny ranged from 0.3 to 4.9 mg/l and from 0.4 to 3.0 mg/l at Oakmont and Wilkinsburg, respectively. On the Monongahela the values at Charleroi varied from 0.4 to 2.4 mg/l. At Beaver Falls on the Beaver River the range was between 0.01 and 1.2 mg/l.

HARDNESS — Hardness was routinely monitored at Wilkinsburg on the Allegheny River and at South Pittsburgh on the Monongahela River. Monthly-average values for 1963-65 ranged from 66 to 192 mg/l at Wilkinsburg, a condition that has shown no significant change from year to year. At South Pittsburgh the maximum monthly-average hardness increased from 176 mg/l in 1963 to 255 mg/l in 1965. This increase corresponded to an increase in conductance of Monongahela River water during the same period.

CHLORIDE — Maximum monthly-average and yearly-average chloride concentrations (in mg/l) are shown in the following table. Data for the Muskingum and Kanawha rivers is based on hourly measurements by robot monitors; data for the other tributaries is derived from analysis of occasional samples by the U. S. Geological Survey.

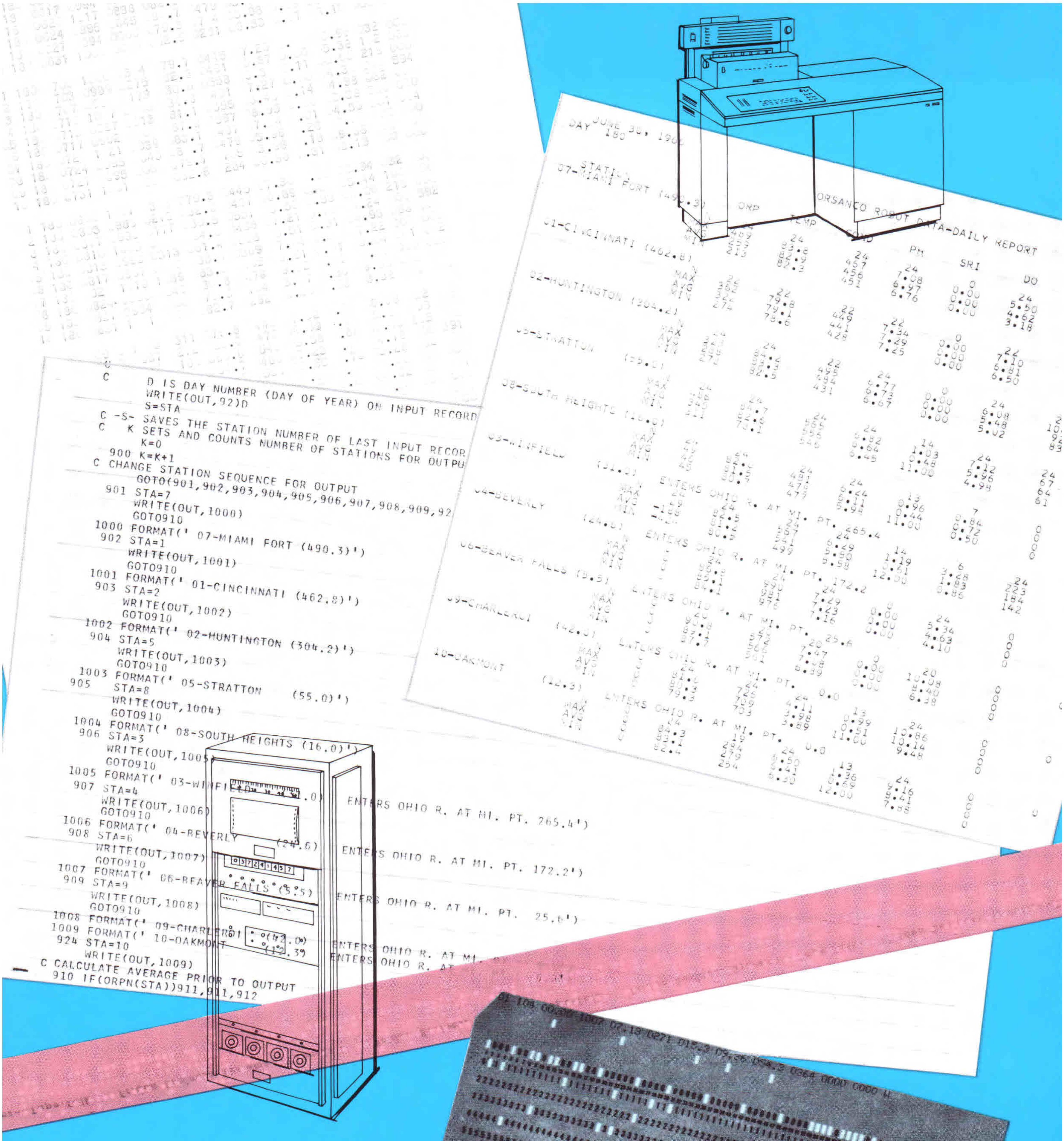
Tributary	1963 Max.	1963 Avg.	1964 Max.	1964 Avg.	1965 Max.	1965 Avg.
Allegheny (Oakmont)	45	26	45	24	40	22
Monongahela (Charleroi)	9	5	15	8	25	14
Beaver (Beaver Falls)	—	—	74	34	50	34
Muskingum (Beverly)	526	277	475	304	380	276
Kanawha (Winfield)	—	—	—	—	186	152
Wabash (Hutsonville)	28	22	32	25	29	21

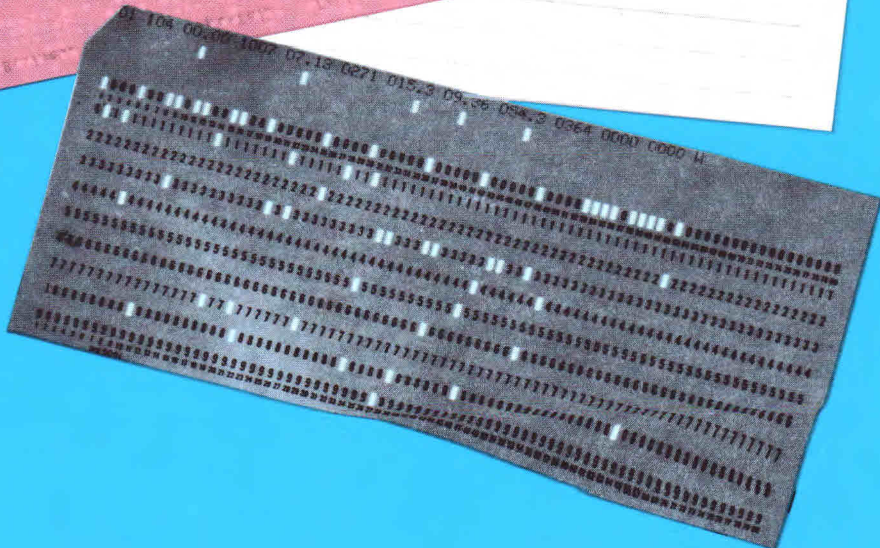
Maximum chloride concentrations did not exceed the recommended upper limit for drinking water (250 mg/l) in any tributary except the Muskingum, which is not used as a source of public water supply.

IRON — Total iron concentrations are routinely monitored in the Allegheny and Monongahela rivers. During 1963-65, monthly-average concentrations varied from 0.26 to 3.2 mg/l at Oakmont and from 0.24 to 4.7 mg/l at Wilkinsburg on the Allegheny River, and from 0.26 to 3.3 mg/l at Charleroi on the Monongahela.

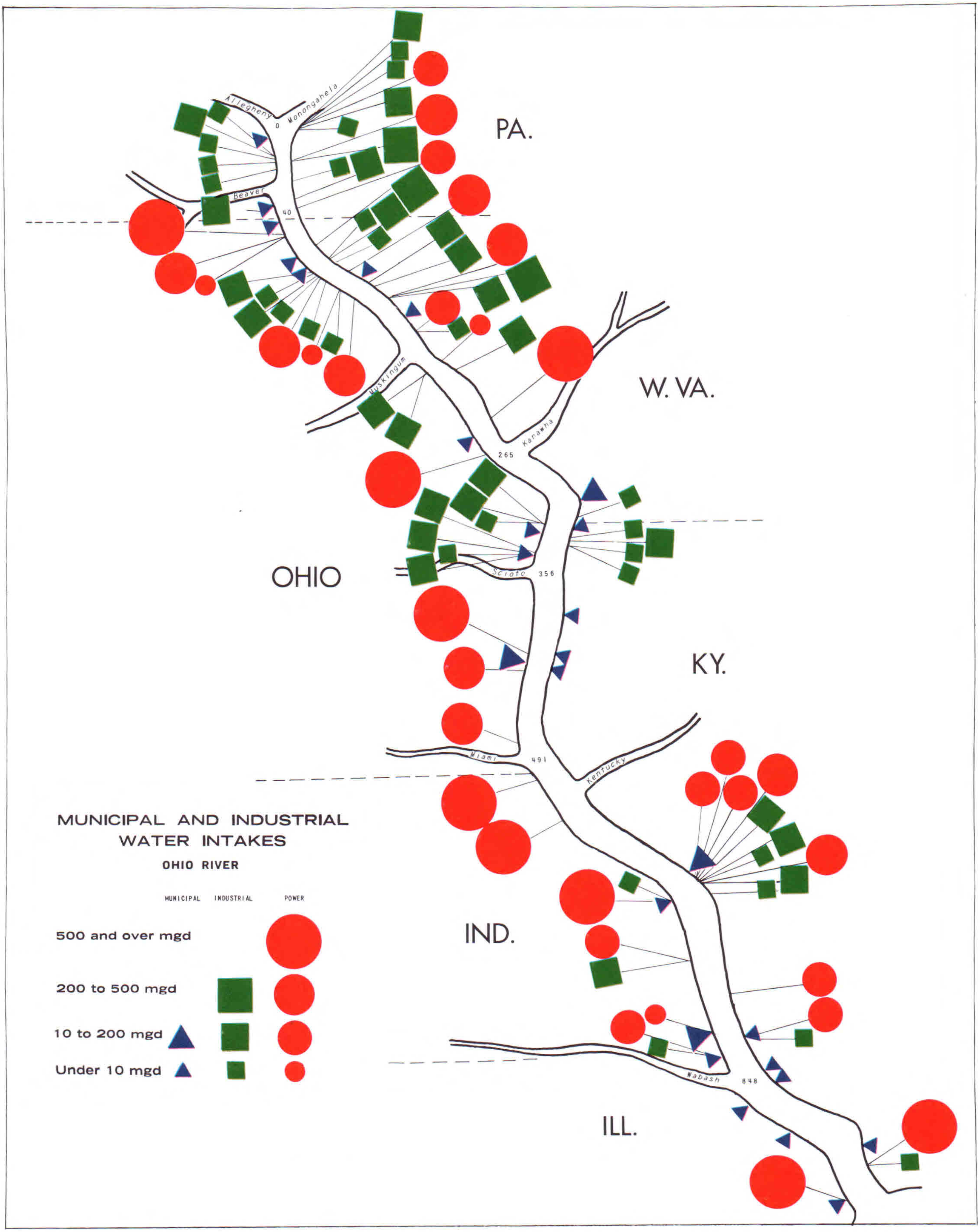
TEMPERATURE — Daily-average temperatures, based on hourly readings at robot-monitor stations, met the criterion for the maintenance of aquatic life at all times during 1963-65. The single highest value during the 1963-65 period — 93 deg. F. — occurred in the Muskingum River in 1965. During the years 1963 and 1964, the highest value, also on the Muskingum, was 91 deg. F.

RADIOACTIVITY — Concentrations of gross beta activity during 1963-65 were far below the limiting value of 1,000 pico curies per liter specified in the public water supply criteria. The maximum value observed in the tributaries was 164 pc/l, which occurred during 1963 on the Kanawha River.





The ORSANCO robot monitor system is geared to measure hourly values of water quality characteristics at many locations and to process this data promptly for assessing river conditions. Shown here are typical print-out and punched-tape recordings from the robot monitor, and the programming components for computer evaluation of data.


MUNICIPAL AND INDUSTRIAL
WATER INTAKES
OHIO RIVER
MUNICIPAL
INDUSTRIAL
POWER
500 and over mgd
200 to 500 mgd
10 to 200 mgd
Under 10 mgd
PA.
W. VA.
OHIO
KY.
IND.
ILL.
Allegheny
Monongahela
Beaver
40
Muskingum
Kanawha
265
Scioto
356
Miami
491
Kentucky
Wabash
848

USES OF THE OHIO RIVER

PREDOMINANT USES of the Ohio River include: Municipal water supply, industrial water supply, navigation, recreational boating, fishing and the carriage of wastewater effluents. Supplementary irrigation of crops and stock watering on farms adjacent to the river is an incidental and minor use. Likewise there is a limited use of the river for generation of hydroelectric power. Following is a summary of facts relating to river use, which has been compiled from data received from federal, state, local and private sources.

MUNICIPAL WATER SUPPLY

Over two million people in 130 communities rely upon the Ohio River as a source of water supply. The total quantity withdrawn for this purpose is 276.4 million gallons daily (mgd), or an average of 128 gallons per capita. The distribution of withdrawals and the population served by states, is:

State	Number of Waterworks	Communities Supplied	Population Served	Avg. Daily Demand (mgd)
Illinois	3	4	12,400	1.9
Indiana	3	5	116,420	26.2
Kentucky	9	76	832,080	108.7
Ohio	7*	34	1,002,800	115.3
Pennsylvania	2	2	8,200	3.3
West Virginia	3	9	184,890	21.0
Total	27	130	2,156,790	276.4

*A river intake for emergency use at Bellaire, Ohio, is not included.

INDUSTRIAL WATER USE

The largest industrial use of water is for cooling purposes at electric power generating stations and manufacturing establishments. This non-consumptive use totals 13,829 mgd — which is 50 times greater than the public-water supply demand. Lesser, but nevertheless substantial, quantities of water are utilized by industries for process and boiler make-up requirements — a total of 185 mgd. Following is a tabulation of the withdrawals of water in each state and the number of industries involved.

This industrial water-use data pertains only to establishments that are self-supplied from the Ohio River. Not included is the quantity used by several thousands of industries who are supplied from municipal systems or local groundwater sources.

State	Number of Industries	Cooling Purposes (mgd)	Process Use & Steam Generation (mgd)	Total Use (mgd)
Illinois	1	990	0	990
Indiana	9	2,512	1	2,513
Kentucky	19	2,481	21	2,502
Ohio	25	4,342	66	4,408
Pennsylvania	17	1,092	91	1,183
West Virginia	16	2,412	6	2,418
Total	87	13,829	185	14,014

RIVER RE-USE

A staff evaluation of wastewater discharges related to total river flow (when drought conditions prevail) reveals that less than one-sixth of the flow in the Ohio River consists of water previously withdrawn for municipal or industrial process use.[1] (References are listed on page ....) Cooling water was excluded in this analysis because it is not regarded as a wastewater in the sense that it requires treatment before re-use. It is concluded, therefore, that total municipal and industrial wastewater discharges would have to increase by 500 per cent before the entire flow of the Ohio River during drought periods would consist of once-used water.

FISHING ACTIVITIES

Findings from a three-year survey of aquatic-life resources sponsored by the Commonwealth of Kentucky and ORSANCO, conducted by the University of Louisville during 1957-60, reveal that the Ohio River supports an abundant and varied fish population.[2] A total of 131 species of fish was catalogued. The estimated standing crop of fish averaged 300 pounds per acre.

Based on a census of catches by fishermen it was found that catfish were more abundant in the upper and middle sections of the river than in the lower section where drum fish was a predominant species. Other fish in order of abundance were carp in all three sections, sunfish in the upper section, white bass, crappies, and black bass in the middle and lower sections.

An analysis of sport fishing activity between Mile 317 and Mile 981 showed 2.3 fishermen per mile of shoreline. Their expenditures per pound of fish caught averaged $1.30, which is about five times the market value when purchased as food.

Commercial fishing is permitted in the Kentucky portion of the Ohio River (mile 317 to mile 981) and to a limited extent in West Virginia, where 120 bait dealers are now licensed to net minnows. Looking to the future, West Virginia has initiated a study to determine the commercial fisheries potential in the 277 miles of the Ohio River over which it exercises control.

In 1958, Kentucky licensed 2,000 commercial fishermen who had a total harvest of 2,000,000 lbs. valued at $410,000. In 1964, although 2,600 fishermen were licensed, the income from a reported catch of 479,800 lbs., was only $67,800. According to the Division of Fisheries of the Kentucky Department of Natural Resources, this decrease was not due to an absence of fish but to a declining market that has discouraged intensive fishing efforts.

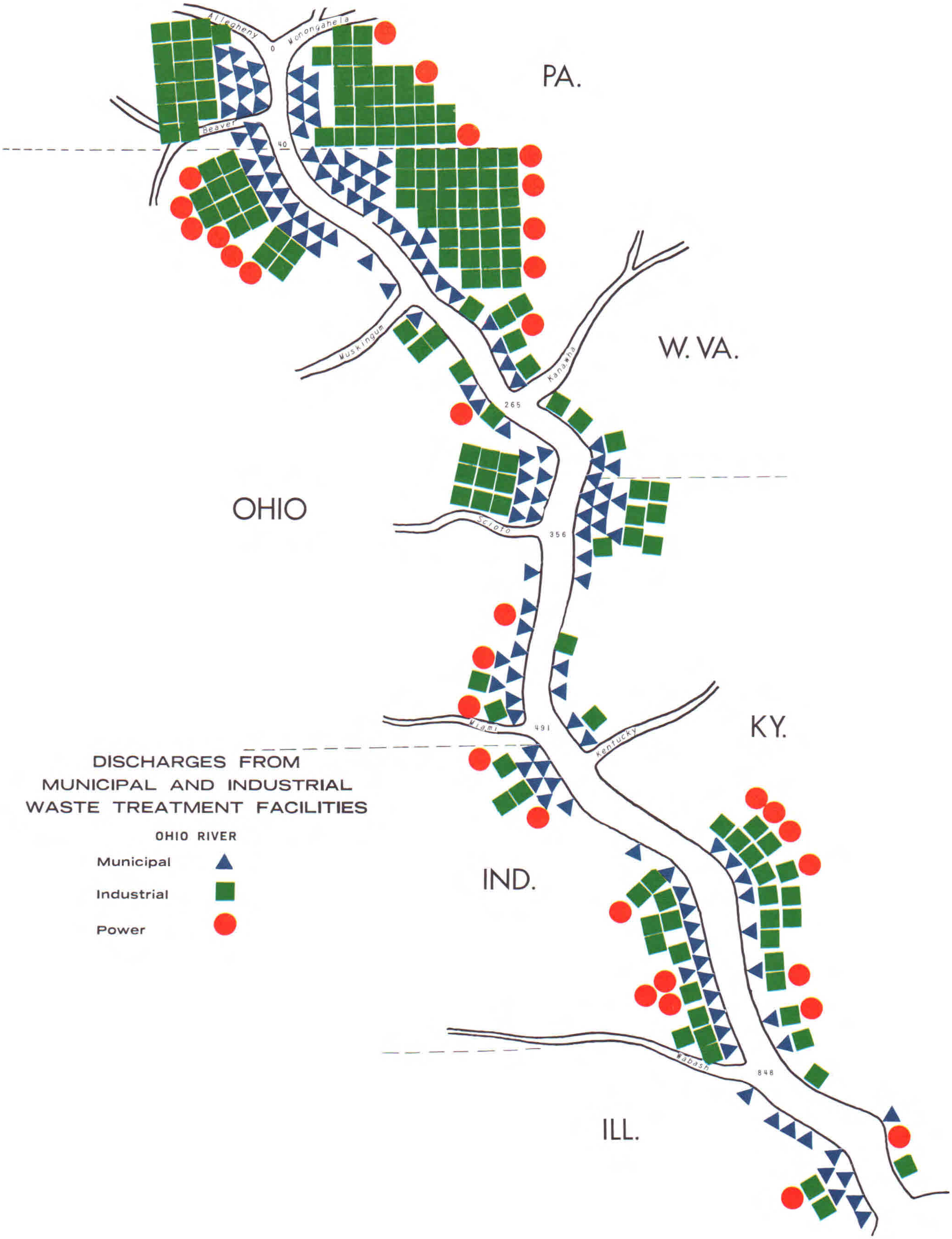
During the past few years the Asiatic clam has invaded the Ohio River and has been slowly migrating upstream. Latest evidence indicates that it has reached as far as Marietta, Ohio (mile 172). The clam has been regarded as a nuisance mollusk because its presence in river water used for industrial cooling causes clogging of heat exchanger and condenser tubes. However, commercial fishermen are now finding use for the clams as a source of bait and animal food.

In 1963 the U. S. Public Health Service conducted fish population sampling studies[3], which included four places in the Ohio River — Huntington, Cincinnati, Louisville and Evansville. These findings add support to certain conclusions of the earlier investigation made by the University of Louisville. For example, it was noted that at all the places sampled there was a diverse population of fish species typical of a large warm water river. From the standpoint of desirable food and game fish (such as large and small mouth bass, spotted bass and channel catfish), it was said that the Cincinnati station had an excellent fish population typical of a relatively unpolluted warm water river. However, it was noted that the sampling station at Cincinnati was upstream from the effects of pollution from the Little Miami River and the City of Cincinnati.

The station at Louisville had the largest population of a large sport fish of any Ohio River station. At Huntington there was a paucity of adult fish and an unusual high incidence of disease and parasitism. Lesions on large-mouth bass were found to be typical of a virus-caused disease which is reportedly common on the walleye from some northern waters. At Evansville there were difficulties in obtaining a satisfactory sample of the fish population.

The Public Health Service investigation concluded that: "With the exception of some unusual circumstances at Huntington and reported problems in relation to palatability at both Huntington and Cincinnati, the fish populations at the Ohio River stations sampled do not appear to be seriously affected by pollution. All stations sampled had an excellent population of desirable game and food species and a diverse population of forage species composed of both plankton and insect feeders. The population at Louisville is particularly excellent with an abundance of large black bass and channel catfish. However, according to local residents and fishermen, the fish at Huntington and Cincinnati are not palatable and, therefore, worthless from a commercial standpoint. Palatability would certainly also reduce their value from the standpoint of the sport fisherman . . ."

Experiences of those who fish the river, as reported in newspaper accounts, appear to support these scientific assessments. In a feature story in the August 21, 1966, issue of the Cincinnati *Enquirer*, it was stated that the Ohio is developing into a "fisherman's paradise." Included was this comment credited to a long-time river fisherman: "Anywhere you used to catch a fish within the limits of the Ohio, even in some of its tributaries, they weren't fit to eat. But now, there's some mighty good fish coming out of the river." Two weeks earlier the paper reported that a local resident "caught about the biggest fish of all times to enter in the *Enquirer's* fish-of-the-month contest." It was a 62 lb. paddlefish; the runner-up was a 50 lb. flathead catfish.


Allegheny
0
Monongahela
PA.
Beaver
40
Muskingum
W. VA.
Kanawha
265
OHIO
Scioto
356
Miami
491
Kentucky
KY.
DISCHARGES FROM
MUNICIPAL AND INDUSTRIAL
WASTE TREATMENT FACILITIES
OHIO RIVER
Municipal
Industrial
Power
IND.
Wabash
848
ILL.

NAVIGATION ACTIVITIES

Barge transport on the Ohio River during 1965 is estimated by the U. S. Corps of Engineers to be in excess of 100,000,000 tons, a threefold increase since 1945. From a comparative standpoint, the Ohio carries more commercial traffic than either the Panama Canal (76,500,000 tons) or the St. Lawrence Seaway (45,000,000 tons).

Improvement of navigation facilities, which includes replacement of 43 low-level wicket-type dams with 16 fixed high level dams over the next two decades, is already underway. Seven of the new dams are already in place. The slackwater pools created by these dams in some cases are as much as 100 miles in length — as contrasted with the former low-level pools, which averaged about 22 miles. The deeper, longer pools along with larger lock facilities result in faster movement of river traffic. Lockage statistics compiled by the Corps of Engineers at three locations in 1965 illustrates the nature and scope of river traffic.

		Traffic through Locks			
Location	Mile Point	Tons (Millions)	Tow Boats	Barges	Pleasure Craft
Emsworth Dam	6.2	22.9	8,737	48,068	2,075
McAlpine Dam	604.4	26.2	5,109	30,744	1,545
Dam 52	950	32.6	6,888	37,600	469

Coal, oil and gasoline continue to make up the major portion of the products transported. The following tabulation lists the type of commodities and quantities during the three-year period of 1962-64.

Commodity Transported	Quantity (in millions of tons) 1962	1963	1964
Stone, sand and gravel	11.72	12.64	14.36
Coal and coke	41.93	42.62	46.67
Oil and gasoline	17.61	18.55	19.14
Sulphur	0.51	0.58	0.65
Chemicals	3.92	4.41	5.08
Iron and steel	2.83	2.85	2.87
All others	6.79	7.18	7.60
Total	85.31	88.83	96.37

It will be noted that shipment of chemical products, some of which may be classified as toxic substances, constituted about 5 per cent of the tonnage transported on the river. This is more than double what it was in 1959 when an ORSANCO staff report focussed attention on the potential pollution hazards associated with barge transport of chemicals. Findings and recommendations in the report[4] pointed, among other things, to the desirability of the U. S. Coast Guard promulgating additional rules, regulations and instructions for safeguarding waterways from accidental contamination.

Many of these recommendations are already being carried out and the Coast Guard is sponsoring a continuing study of this matter by the National Academy of Science, and has promulgated new regulations governing the transport of hazardous materials and the reporting of spills and accidental discharges. In addition, the Corps of Engineers is now designating all public water supply intakes on navigation charts. The American Waterways Association has also been devoting increased attention to the responsibilities of their membership in handling of hazardous products through the use of posters and newsletters.

RECREATIONAL ACTIVITIES

There are more than 240 small-craft harbors and launching ramps along the Ohio River. This is double the number in 1956. The new facilities are not only larger, to accommodate a substantial increase in boat ownership, but in some places they are being supplemented with year-round restaurant facilities as well as swimming pools and playgrounds. One of the most elaborate of the new marinas, with docking space for 300 boats, is at Cincinnati, Ohio. Another of comparable capacity is being constructed at Evansville, Indiana. The largest concentration of marinas and boating clubs is in the Louisville, Kentucky, area.

The U. S. Corps of Engineers is constructing launching ramps, which will be available to the public, in each of the new pools created by the higher navigation dams. Twenty-seven ramps have already been completed and two are under construction. Another 64 sites are under study for possible inclusion in the program. After completion these facilities are leased to the states in which they are located for public use.

The number of pleasure craft using the Ohio River is estimated to be over 80,000 — more than ten per cent of the 730,000 boats licensed by the states in the Ohio Valley district. Larger pleasure boats, which are eligible for federal licensing, number 3,850 according to the U. S. Bureau of Customs list of "documented" vessels. The Port of Cincinnati has 1,450 documented boats and is rated as the thirteenth largest of the 139 ports in the United States.

Boating regattas have also increased in popularity with some 31 being held in 1965. These affairs not only attract boaters but also land observers numbered by the thousands. The "River Days" celebrations at Madison, Indiana, and Portsmouth, Ohio, are rated as major summer attractions in these areas. Water-skiing is one of the most popular river sports, and now scuba diving is winning an increasing number of devotees with active clubs in Pittsburgh, Huntington, Ironton, Cincinnati and Louisville.

Recreational use of the Ohio River, which has been enhanced by reduction of sewage and industrial-waste pollution, has brought with it another kind of pollution — littering of the waterway with discarded cans, bottles, and other debris. To counteract such carelessness, ORSANCO has been conducting a public-education campaign under the slogan "Litter-ly Speaking — Don't Go Overboard." This campaign is being advanced with the production of plastic litter bags imprinted with a message about river cleanliness and made available for distribution at marinas and launching ramps. Major producers of marine fuel have been enlisted in this campaign and for the privilege of adding their names on the bags they have purchased thousands of them, which are then made available to fueling stations along the river. Several boat accessory dealers are also participating in the distribution of ORSANCO litter bags.

HYDROELECTRIC POWER

On the main stem of the Ohio River hydroelectric power is generated at only one location — at the McAlpine navigation dam, Louisville, Kentucky. Here where the "Falls of the Ohio" once existed there is about 35 ft. of head and facilities operated by the Louisville Gas and Electric Company now have a capacity of some 80 megawatts of power. This capacity represents less than one per cent of the total power generated by steam plants along the river. However, federal navigation improvements involving the installation of so-called high dams have created more favorable conditions for hydropower installations. Installation of turbines, with a generating capacity of 81 megawatts, at Markland Dam will be completed during 1966. Applications have been received by the Federal Power Commission for permits to install hydroelectric generating facilities at the Racine, Greenup, Cannelton and Newburgh dams. The proposed capacity of these four locations totals 235 megawatts. The Federal Power Commission (Appendix I — Ohio River Basin Comprehensive Project — review draft) estimates indicate a 600 megawatt potential production of hydroelectric power at 12 of the 13 other high dams authorized, under construction or completed.

What effect the operation of these hydroelectric projects will have on water quality is uncertain. Conceivably they could alter river flow to the extent that during times of low summer flow there would be periods during the day when stretches of the river were stagnated.

IRRIGATION

Ohio River water is used for supplementary irrigation purposes during the ninety-day average growing season in the Ohio Valley. The Ohio Division of Water estimates that farmers irrigate only about 20 days during this period. The amount of Ohio River water used for agricultural irrigation constitutes only 0.03 per cent of the total river water used for all purposes. Most farm irrigators consider the greatest single benefit derived from irrigation to be crop stabilization and not increased yield. Utilizing irrigation, farmers achieve greater independence from seasonal rainfall fluctuations. Generally, the method of application is by sprinkler-type systems using lightweight portable pipe and pumps installed along the river bank.

(1) Cleary, Edward J., Robert K. Horton and Robert J. Boes, "Reuse of Ohio River Water," *Jour. American Water Works Association,* Vol. 55, No. 6, p. 683-686 (June, 1963).

(2) ORSANCO-University of Louisville Report, "Aquatic-Life Resources of the Ohio River," January, 1962.

(3) Tebo, L. B., Jr., "Fish Population Sampling Studies at Water Pollution Surveillance System Stations on the Ohio, Tennessee, Clinch and Cumberland Rivers," Public Health Service, Cincinnati, Ohio, April, 1965.

(4) See Twelfth Annual Report of the Ohio River Valley Water Sanitation Commission, 1960, pages 4 to 6.

TALLY FOR THE VALLEY

THE ANNUAL INVENTORY of municipal and industrial wastewater control facilities is compiled from information supplied by each of the states in the Ohio Valley Compact. Summaries of the status of sewered communities and industries, as of July 1, 1966, are presented in the accompanying tabulations. Following is an appraisal of the current situation.

Municipal Status — On the Ohio River main stem, treatment facilities in operation service 99 percent of the 3,700,000 sewered population, and those currently under construction will provide treatment for another 0.3 percent. Classified according to degree of purification provided, 41 percent of the sewage receives primary (mechanical) treatment; 56 percent is designed for intermediate (chemical) treatment; and 3 percent is designed for secondary (biological) treatment (see map, page 33).

For the entire drainage district which includes 19 major tributaries, treatment facilities now in operation serve 94 percent of the 11,400,000 sewered population, 1 percent more than last year. Facilities under construction will service an additional 1 percent. Degree of treatment provided is 25 percent primary, 25 percent intermediate, 48 percent secondary and the remaining 2 percent is unclassified.

Construction of sewage-treatment plants was started this year at 17 communities with a combined population of 36,000. In addition, improvement to existing facilities were initiated at 20 communities with a population serving 700,000.

During the year new works were placed in operation at 52 communities with a combined population of 92,000. Improvements to 16 existing plants serving 121,000 were completed.

Industrial Status — There are 1,769 industrial establishments in the district whose effluents are discharged directly to streams. Of these 89 percent (1,569) have installed facilities that are reported to comply at least with minimum control requirements established by ORSANCO. The states report that 1,459 industries (83 percent) are meeting all requirements prescribed by them for the local protection of the receiving stream.

Basin Status — Of the 324 sewered communities that have not installed treatment facilities, one-half have a population of 1,000 or less and only 22 have populations greater than 5,000. The following tabulation provides a basin-by-basin summary of the number of these communities, sewered population without treatment facilities, median community population and the population of the largest of these communities in each basin.

SEWERED COMMUNITIES WITHOUT TREATMENT FACILITIES

		Population		
Basin	Number	Total	Median Community	Largest Community
Ohio River	11	21,378	1,458	5,514
Allegheny	50	119,959	1,388	13,005
Monongahela	85	229,096	891	28,112
Beaver	2	2,132	—	1,255
Muskingum	10	12,429	982	2,958
Little Kanawha	3	2,011	727	1,660
Hocking	1	2,255	—	2,255
Kanawha	30	34,014	921	6,370
Guyandot	0	—	—	—
Big Sandy	16	21,363	1,062	5,313
Scioto	6	5,654	617	1,984
Little Miami	1	913	—	913
Licking	2	2,061	—	1,611
Miami	7	5,669	701	1,678
Kentucky	1	766	—	766
Salt	1	916	—	916
Green	1	817	—	817
Wabash	69	75,549	962	4,341
Cumberland*	0	—	—	—
Tennessee*	13	21,645	745	5,872

*Drainage area in compact states only (Kentucky, Virginia, West Virginia)

Federal Aid Program — Since July, 1956, grants-in-aid for construction of sewage-disposal facilities have been available to municipalities under provisions of the Federal Water Pollution Control Act. Between September 1962 and July 1964, additional grants were available under the Federal Public Works Acceleration Act.

For the fiscal year 1965-66 construction grants of $8,712,000 were allocated to 55 communities in the Ohio Valley compact district to aid financing of projects whose total estimated cost is $31,153,300. The total for the previous nine years was $82,786,500; these grants assisted in the financing of 638 sewer and treatment plant projects with an estimated cost of $282,966,600.

MUNICIPAL AND INSTITUTIONAL SEWAGE-TREATMENT FACILITIES — July 1, 1966

Number of communities (top number) and population served (bottom number)

STATUS	ILL.	IND.	KY.	N. Y.	OHIO	PA.	VA.	W. VA.	TOTAL	% of TOTAL
Control currently acceptable	**65** 287,005	**164** 1,063,899	**244** 1,321,036	**5** 47,572	**304** 3,467,103	**289** 2,558,299	**46** 153,513	**79** 388,254	**1,196** 9,286,681	**70.0** 81.6
Treatment provided (improvements under construction)	**2** 51,679	**6** 544,547	**1** 2,523	**0** 0	**7** 46,977	**0** 0	**0** 0	**3** 109,678	**19** 755,404	**1.1** 6.6
Treatment provided (improvements needed)	**2** 12,353	**28** 203,255	**8** 18,568	**9** 50,487	**29** 169,731	**15** 82,708	**20** 16,723	**17** 104,331	**128** 658,156	**7.5** 5.8
New treatment works under construction	**0** 0	**8** 14,227	**0** 0	**0** 0	**3** 10,712	**10** 25,813	**1** 4,678	**19** 51,622	**41** 107,052	**2.4** 1.0
No treatment; construction not started	**2** 2,680	**68** 72,617	**11** 12,120	**4** 11,493	**32** 40,388	**109** 259,565	**19** 18,970	**79** 156,201	**324** 574,034	**19.0** 5.0
Total	**71** 353,717	**274** 1,898,545	**264** 1,354,247	**18** 109,552	**375** 3,734,911	**423** 2,926,385	**86** 193,884	**197** 810,086	**1,708** 11,381,327	**100.0** 100.0

STATUS OF INDUSTRIAL WASTE-CONTROL FACILITIES — July 1, 1966

STATUS	ILL.	IND.	KY.	N. Y.	OHIO	PA.	VA.	W. VA.	TOTAL	% of TOTAL
Control currently acceptable	15	219	153	18	298	501	45	210	1,459	82.5
Control facilities inadequate, improvements in progress	5	0	3	0	10	6	0	3	27	1.5
Control provided, but not adequate	9	28	13	7	51	32	2	28	170	9.6
New control facilities under construction	0	10	1	0	3	15	0	3	32	1.8
Planning treatment facilities or preparing to connect to municipal sewers	2	5	0	6	2	23	0	8	46	2.6
No action by company	2	0	1	5	5	17	1	4	35	2.0
Total number of industries	33	262	171	36	369	594	48	256	1,769	**100.0**
Complying with ORSANCO *minimum requirements*	20	250	160	20	354	502	46	217	1,569	88.7

ADMINSTRATIVE AFFAIRS

POLICIES AND DECISIONS for managing the mission of the Ohio River Valley Water Sanitation Commission are the responsibility of 27 commissioners. Each of the signatory states is represented by three commissioners appointed by the Governor of the state, and federal interests are represented by three commissioners appointed by the President of the United States. Administration of Commission affairs is conducted by a staff of eleven persons headquartered in Cincinnati.

Chairmanship of the Commission is rotated annually among the states. During the year covered by this report, July 1, 1965, through June 30, 1966, Andrew C. Offutt, M.D., one of the three commissioners representing Indiana, served as chairman. Dr. Offutt was appointed to ORSANCO in 1954 and is health commissioner for the State of Indiana.

J. O. Matlick, commissioner of the Kentucky Department of Natural Resources, was elected to serve as chairman for the year beginning July 1, 1966. Mr. Matlick, who has been a commissioner of ORSANCO since 1960, brings to the interstate agency the viewpoints of a specialist in agricultural land use and water conservation practices. Last year he guided the drafting and passage of legislation in Kentucky for more effective regulation of strip mining, and he also authored measures for the establishment of a state water-resources authority. His avocation is boating, and this activity contributes to his special interest in promoting the Ohio Valley campaign to reduce stream littering.

Franklin D. Yoder, M.D., director of the Illinois Department of Public Health is vice-chairman for the current year. Dr. Yoder is a diplomate of the American Board of Preventive Medicine, a member of the executive staff of the American Medical Association and a past-president of the Association of State and Territorial Health Officers.

Other officers of the Commission are: Edward J. Cleary, executive director and chief engineer; F. H. Waring, secretary; Verna B. Ballman, treasurer; Robert K. Horton, assistant treasurer and Leonard A. Weakley, legal counsel.

Vice-chairman Yoder, left, and Chairman Matlick on the right.

IN MEMORIAM

With profound sorrow the Ohio River Valley Water Sanitation Commission records the death on April 11, 1966, of Commissioner Karl M. Mason of Pennsylvania.

Mr. Mason was appointed to the Commission on January 7, 1958, and was a member of the Engineering Committee, serving as its chairman from 1959-60. His professional competence and his diversified knowledge and experience in the field of water pollution control were of inestimable value in the deliberations of the Commission.

Karl Mason commanded the esteem and warm personal regard of his associates on the Commission. He will be sorely missed. With the sense of our loss is mingled deep sympathy for the members of his family.

(This resolution was passed by the Commission on May 12, 1966.)

Membership Changes — This year a greater number of changes have occurred in membership of ORSANCO than in any comparable period in the past. On September 8, 1966, members of the Commission were saddened by the resignation of Commissioner Hudson Biery of Ohio. Mr. Biery, who has been affectionately regarded as the "father" of the Ohio River Valley compact was the first chairman of ORSANCO. This honor gave recognition to his 13 years of unflagging effort in promoting negotiations that culminated in the adoption of the regional agreement by eight state legislatures and its approval by the Congress of the United States. Mr. Biery resigned because of a decision to establish residence in Indiana. However, Mr. Biery's colleagues were unwilling to be deprived of his counsel and have named Mr. Biery to serve as Advisor to the Chairman.

Raymond Fuller of Burgess and Niple, consulting engineers of Columbus, Ohio, was appointed to fill the vacancy from Ohio.

After seventeen years of continuous service, including a term as chairman in 1954, Commissioner W. W. Jennings of West Virginia resigned on September 30, 1965, because of ill health. Mr. Jennings was one of the signers of the compact for his state when the Commission was activated in 1948. Appointed to succeed Mr. Jennings was Luther N. Dickinson of the Union Carbide Corporation, Charleston, West Virginia.

Maurice E. Gosnell, who was chairman in the year 1959-60, completed eleven years of service as a Commissioner representing the State of Illinois on January 24, 1966. He was succeeded by Kenneth E. Damann, head of the Botany Department of Eastern Illinois University. Dr. Damann found it necessary to resign his appointment on September 1, 1966, when he moved from Illinois to accept employment in another state. A successor has not yet been appointed.

On June 1, 1966, Commissioner Bern Wright of West Virginia resigned when he changed his residence to another state. Mr. Wright served the Commission for nine years, and in 1962-63 he was chairman. Appointed to succeed Mr. Wright was Edgar N. Henry of the West Virginia Department of Natural Resources.

When Surgeon-General Luther L. Terry resigned from the Public Health Service on September 30, 1965, he automatically terminated his affiliation with ORSANCO. The same situation prevailed when Commissioner Edwin E. Abbott retired from the Corps of Engineers on December 31, 1965. These two representatives of the Federal government were succeeded by Frank C. DiLuzio, assistant secretary of the Department of the Interior, Washington, D. C., and by Louis G. Feil, Chief, Engineering Division, Ohio River Division, U. S. Corps of Engineers, Cincinnati, Ohio.

Financial — Operations of the Commission are funded by appropriations from the eight signatory states and by annual grants from the Federal government. Total state appropriations in the period from 1949 to 1953 were $100,000 yearly. Since 1954 the total has been $130,000. Because of the increasing difficulties during the past 12 years to match this fixed state appropriation with budget requirements, the commissioners have requested the governors to approve an annual appropriation of $182,000 effective July 1, 1967.

A detailed financial report for the year ending June 30, 1966, will be found on page 42.

State appropriations are proportioned according to the weighted average of population and area in the drainage district. Under this allocation the respective percentages are: New York 1.10; Virginia 3.50; Illinois 5.10; West Virginia 11.35; Pennsylvania 15.20; Indiana 18.10; Kentucky 20.75 and Ohio 24.90.

Under provisions of the Federal Water Pollution Control Act, administrative grants-in-aid to state and interstate agencies became regularly available in 1956. For fiscal 1965-66 the grant to ORSANCO was $104,530, and the average during the past decade has been $110,000 annually. During the years of 1949 to 1952, ORSANCO received three federal grants averaging $26,000 annually.

Advisory Committees — Since 1950 the Commission has received invaluable aid in its work from the services performed by advisory committees, which currently include a membership of some 242 specialists. These committees represent water users, aquatic-life resouce interests and industrial enterprises. In May, 1966, the electric power industry advisory committee was established by Commission Resolution No. 15-66.

In January 1961, under the sponsorship of the ORSANCO Coal Industry Advisory Committee, a reference library on Acid Mine Drainage was established at Bituminous Coal Research, Inc., Monroeville, Pennsylvania. Its materials are now available to any interested parties. The collection includes more than a thousand published and unpublished works on such topics as: principles and practices for the operation of coal mines consistent with the preservation and improvement of land and water resources; water pollution problems of the coal mining industry; and fundamental chemistry and biology of acid mine drainage formation. Abstracts and photocopy service are offered at nominal cost. Inquiries may be directed to Dr. Richard A. Glenn, 350 Hochberg Road, Monroeville, Pennsylvania, 15146.

Although Chairman Offutt is outside the range of the camera, this picture of a meeting of the ORSANCO commissioners makes it apparent that his views are the primary focus of attention and he is in command of the situation.

COMMISSION COMMITTEE ASSIGNMENTS

(for year ending June 30, 1967)

Executive Committee

Chairman	J. O. Matlick
Vice-chairman	F. D. Yoder, M.D.
Past-chairman	A. C. Offutt, M.D.
Illinois	Clarence W. Klassen
Indiana	Blucher A. Poole
Kentucky	Minor Clark
New York	Joseph R. Shaw
Ohio	Emmett W. Arnold, M.D.
Pennsylvania	M. K. McKay
Virginia	Ross H. Walker
West Virginia	N. H. Dyer, M.D.
Federal	Raymond E. Johnson

Audit

Minor Clark, *Chairman*
Ross H. Walker
Barton Holl

Bylaws

M. K. McKay, *Chairman*
Blucher A. Poole
Lyle W. Hornbeck

Pension Trust

Barton Holl
Robert K. Horton
Clarence W. Klassen

Salaries and Personnel

J. O. Matlick
F. D. Yoder, M.D.
A. C. Offutt, M.D.

Finance

Joseph R. Shaw, *Chairman*
Barton Holl
Blucher A. Poole
J. O. Matlick
F. D. Yoder, M.D.

Engineering Committee

Illinois	Clarence W. Klassen, *Chairman*
Indiana	Blucher A. Poole
Kentucky	Ralph C. Pickard
New York	Dwight Metzler
Ohio	George Eagle
Pennsylvania	Walter Lyon
Virginia	A. H. Paessler
West Virginia	Edgar N. Henry
Corps of Engineers	Lawrence A. Farrer
Dept. of Interior	Raymond E. Johnson
FWPCA	R. A. Vanderhoof
Secretary	F. H. Waring
Staff	Robert K. Horton

CHAIRMEN OF ORSANCO ADVISORY COMMITTEES

(as of December 1, 1966)

Aquatic-Life Advisory Committee — Lloyd L. Smith, Jr., University of Minnesota, St. Paul, Minnesota

Chemical Industry Committee — Jack T. Garrett, Monsanto Chemical Co., St. Louis, Missouri

Coal Industry Advisory Committee — Larry Cook, Ohio Reclamation Association, Columbus, Ohio

Metal-Finishing Industry Action Committee — W. H. Toller, Jr., Houdaille Industries, Huntington, West Virginia

Petroleum Industry Committee — Alex S. Chamberlain, Louisville Refining Company, Louisville, Kentucky

Power Industry Advisory Committee — Edward E. Galloway, Cincinnati Gas and Electric Co., Cincinnati, Ohio

Pulp and Paper Industry Action Committee — W. C. Mathews, Mead Corporation, Chillicothe, Ohio

Steel Industry Action Committee — D. J. Motz, Shenango, Inc., Pittsburgh, Pennsylvania

Water Users Committee — Lawrence J. Killian, Filtration Plant, Evansville, Indiana

FINANCIAL REPORT

The following information relative to revenues collected and expenses paid, and statement of resources, was taken from the Audit Report of Wm. H. Mers and Company, Certified Public Accountants, for the year ended June 30, 1966.

OHIO RIVER VALLEY WATER SANITATION COMMISSION

STATEMENT OF REVENUES COLLECTED AND EXPENSES PAID
YEAR ENDED JUNE 30, 1966

Revenues collected:			
From signatory states:			
State of Illinois			$ 6,630.00
State of Indiana			23,530.00
Commonwealth of Kentucky			26,975.00
State of New York			1,430.00
State of Ohio			32,370.00
Commonwealth of Pennsylvania			19,760.00
Commonwealth of Virginia			4,550.00
State of West Virginia			14,755.00
			130,000.00
From U. S. Department of Health, Education and Welfare (Grant by authority of Federal Water Pollution Control Act)			104,530.00
Sale of publications			635.83
Interest earned on bank deposit			3,299.68
Total revenues collected			238,465.51
Expenses paid:			
From state funds:			
From authorized budget of $140,000.00	$131,882.85		
From $2,495.00 encumbered at June 30, 1965 for boat for visual river surveillance	2,495,00		
From $6,000.00 encumbered after June 30, 1965 for renovation of robot monitor receiving station	2,600.00		
		$136,977.85	
From federal funds:			
From authorized budget of $104,530.00	103,554.83		
From $1,800.00 encumbered at June 30, 1965 for telemeter transmitter	1,800.00		
		105,354.83	
Total expenses paid			242,332.68
Excess of expenses paid over revenues collected			$ 3,867.17

STATEMENT OF RESOURCES JUNE 30, 1966

	State Funds	Federal Funds	Total
Available resources for period to June 30, 1965	$ 51,242.63	$ 6,297.86	$ 57,540.49
Add: Revenues collected:			
Annual budget — July 1, 1965 to June 30, 1966	130,000.00		130,000.00
U. S. Department of Health, Education and Welfare		104,530.00	104,530.00
Sale of publications	635.83		635.83
Interest earned on bank deposit	3,299.68		3,299.68
	185,178.14	110,827.86	296,006.00
Less: Expenses paid:			
July 1, 1965 to June 30, 1966	136,977.85	105,354.83	242,332.68
Available resources for period June 30, 1966 before encumbrances	* 48,200.29	5,473.03	* 53,673.32
Balance of encumbered funds at June 30, 1966:			
Renovation of robot monitor receiving station	3,400.00		3,400.00
Available resources at June 30, 1966 after encumbrances	*$ 44,800.29	$ 5,473.03	*$ 50,273.32

The above amount of $53,673.32 is comprised as follows:		
Cash on deposit with The Central Trust Company		$ 51,375.88
Cash on deposit with American Airlines, Inc.		425.00
Cash on deposit with Ohio Bureau of Workmen's Compensation		120.00
Petty cash on hand		200.00
Accounts receivable:		
Advances for employees:		
Employees' pension trust	$ 1,326.94	
Hospitalization	225.50	1,552.44
Total		$ 53,673.32

*As of June 30, 1966 in addition to resources shown above there was an amount of $4,000.00 due from Schneider Instrument Co. on a credit memorandum for advance payment to them on a cancelled radioactivity monitor contract.

ORSANCO DOCUMENTARY FILMS

Following is a list of ORSANCO films produced to illustrate various aspects of pollution abatement in the Ohio Valley. These 16 mm movies, in color and with sound, may be borrowed for group showings by addressing the state agencies listed on the inside back cover, or by request to Commission headquarters.

GOOD RIDDANCE This fast-moving, omnibus film depicts the progress made and the tasks that still remain in curbing water pollution in the Ohio Valley. This offers a general introduction on the regional crusade for clean streams undertaken by eight states. (29½ minutes)

BEARGRASS CREEK The story of what can happen to a stream when people along its banks disregard their obligation to prevent pollution. Of particular interest is the work being done by the University of Louisville in conducting the ORSANCO-sponsored study of aquatic-life resources. (19½ minutes)

OIL ON THE RIVER Beginning with the story of the discovery of oil in the Ohio Valley, this film shows the unhappy consequence of carelessness in handling, transportation, storage and use of oil products and then depicts preventive measures. (20½ minutes)

CRISIS ON THE KANAWHA A portrayal of industrial growth and the failure to keep pace with it in terms of river protection is the opening theme of this film. Then follows a detailed description of the remedial steps that are being taken to deal with the situation. (22 minutes)

RIVER WATCHERS Safeguarding streams from pollution hazards calls for constant vigilance. This is the story of the sentinels in the eight states who are engaged in checking sewage plant operations, aerial surveillance, virus identification, sampling of streams, forecasting river flow and evaluating the results from robot monitors. (18½ minutes)

THE FIRST FIFTEEN YEARS ORSANCO commissioners describe progress in the fifteen-year crusade for clean streams in the Ohio Valley. A highlight of the film is a visit to The Kettering Laboratory where toxicity studies are documented. (26 minutes)

COAL AND WATER A penetrating look at pollution problems created by the coal industry and the steps being taken to solve those problems. Included is a description of sealing operations in an underground mine to curb acid mine-drainage. (23 minutes)

"OOPS!" An educational film which demonstrates how careless actions within a plant may result in river pollution and steps to take to guard against such situations. Designed as an in-plant training aid to solicit employee and supervisor alertness in preventing accidental spills. (22 minutes)

WHY WAS ORSANCO ESTABLISHED? — Prior to 1948 there was no federal legislation for dealing with pollution of interstate waters. Many streams in the Ohio Valley are interstate; they either pass through or serve as the political boundary for two or more states. Since no state has jurisdiction over practices in another state the increasing pollution of interstate streams became a problem of mutual concern.

The Ohio Valley states, looking upon the job of river clean-up as a matter of local responsibility exercised within the framework of regional interests, decided to attack the problem through an interstate treaty. With the approval of the Congress of the United States these eight states — Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Virginia and West Virginia — entered into a compact to cooperate in the control of future pollution and the abatement of existing pollution. In so doing they established the Ohio River Valley Water Sanitation Commission.

WHAT IS THE COMMISSION'S TASK? — The role of ORSANCO is to coordinate and supplement efforts of the eight states in their regional pollution control program. In performing these functions the Commission is guided by the principle that no discharges of sewage or industrial residues originating within one state shall injuriously affect the interest of another state.

Coordination activities include assistance in enactment of legislation, conduct of technical investigations and public hearings on control requirements, promulgation of river quality standards and improvement of administrative practices.

Supplementation of state activities includes development of public support for pollution abatement, establishment of river-quality monitor and surveillance activities, sponsorship of research (notably in development of electronic detection devices) and application of legal measures when a signatory state believes it has exhausted its own remedies for securing compliance.

DOES THE COMMISSION HAVE ENFORCEMENT POWERS? — Yes, in limited form. ORSANCO is authorized to promulgate rules and regulations for the control of municipal and industrial-waste discharges. Securing compliance with these interstate regulations is a pledged responsibility of the state agencies. If a state has difficulties in securing compliance it can request the Commission to institute legal action in a United States District Court. Since 1948 the Commission has been requested to intervene in only five situations. Meantime, the states had secured compliance from hundreds of municipalities and industries through persuasion rather than compulsion.

DISTRIBUTION OF ANNUAL SHARES OF BUDGET BY STATES

1960 Census Figures Used As Basis for Determining Annual Shares for Operating Budget of $130,000 Established in 1955; also Included Are Shares Based on Proposed $182,000 Budget.

State	Area within Ohio River Drainage Basin		Population (1960) within Ohio River Drainage Basin		Weighted Average of Percentages of Area and Population	Annual Share of Budget (for total budget of $130,000)	Annual share for proposed budget of $182,000
	Square Miles	Percent of Total	Population	Percent of Total			
Illinois	10,745	7.0%	591,109	3.2%	5.10%	$ 6,630	$ 9,282
Indiana	29,135	18.9	3,227,072	17.3	18.10	23,530	32,942
Kentucky	39,375	25.5	2,981,670	16.0	20.75	26,975	37,765
New York	1,955	1.3	168,365	0.9	1.10	1,430	2,002
Ohio	29,570	19.2	5,702,592	30.6	24.90	32,370	45,318
Pennsylvania	15,620	10.1	3,783,796	20.3	15.20	19,760	27,664
Virginia	7,175	4.6	457,312	2.4	3.50	4,550	6,370
West Virginia	20,610	13.4	1,738,006	9.3	11.35	14,755	20,657
TOTALS	154,185	100.0%	18,649,922	100.0%	100.0%	$130,000	$182,000

REGULATORY AGENCIES
OF THE
SIGNATORY STATES

ILLINOIS	**Technical Secretary** **State Sanitary Water Board** **Springfield, Illinois 62706** **Phone: 525-6580**
INDIANA	**Technical Secretary** **Indiana Stream Pollution Control Board** **1330 West Michigan Street** **Indianapolis, Indiana 46207** **Phone: 633-4420**
KENTUCKY	**Executive Director and Chief Engineer** **Kentucky Water Pollution Control Commission** **275 East Main Street** **Frankfort, Kentucky 40601** **Phone: 564-3410**
NEW YORK	**Deputy Commissioner** **Environmental Health Services** **New York State Department of Health** **84 Holland Avenue** **Albany, New York 12208** **Phone: 474-2933**
OHIO	**Chief Engineer** **Division of Engineering** **Ohio Department of Health** **P. O. Box 118** **Columbus, Ohio 43216** **Phone: 469-4470**
PENNSYLVANIA	**Sanitary Water Board** **Box No. 90** **Harrisburg, Pennsylvania 17120** **Phone: 787-4190**
VIRGINIA	**Executive Secretary** **State Water Control Board** **P. O. Box 11143** **Richmond, Virginia 23230** **Phone: 644-4111 — Ext. 6411**
WEST VIRGINIA	**Chief** **Division of Water Resources** **Department of Natural Resources** **1201 Greenbrier Street** **Charleston, West Virginia 25311** **Phone: 348-2107**