# POLLUTION STUDIES OF ILLINOIS RIVER

BY

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## INTRODUCTION

The State of Illinois has been conducting sanitary chemical and biological studies on Illinois River since 1874, or 26 years prior to the time Chicago started to divert her wastes into its waters. The earlier studies were conducted by the State Natural History Survey and were mainly biological in character. They were, however, supplemented from time to time by chemical studies. The State Water Survey, since its foundation, has been furnishing chemists and bacteriologists for these studies, and has been in full charge of the sanitary chemical and bacteriological studies since 1923. A number of papers and bulletins have been published on the general subject of the pollution of Illinois River. Such publications may be secured for a very nominal sum by consulting the publication indexes of the State Natural History Survey, the State Water Survey, and the U. S. Department of Public Health. These different studies, besides giving routine data as to the rivers' condition, have rendered to sanitary chemistry much fundamental information as to the pollution capacities of streams, their rates of biological oxidation, rates of reaeration, and the like.

The economic history and utility of Illinois River has already been dwelt upon by previous speakers and papers. One's attention should be called to the fact that any large body of water, such as Illinois River, is of vast economic importance as a natural resource which if properly used may safely dispose of a considerable volume of domestic and industrial wastes. The simplest and cheapest method of disposing of sewage is to empty it into some river or lake, and there to allow nature to take care of it without human aid. If, however, this body of water is over-taxed with this pollution load, then numerous other important economic factors come into play. Some of these factors have already been discussed by previous speakers and will be further discussed in forthcoming papers.

## THE POLLUTION LOAD OF ILLINOIS RIVER

The pollution load of Illinois River proper, that is the wastes added directly to Illinois River, as well as the pollution load of the entire Illinois River drainage basin, is summarized in Table I. As the wastes

from the rural districts and from those cities located on tributaries, are largely stabilized by the time they reach the Illinois River proper, those cities which are located in the immediate vicinity of the river are the only ones responsible for the gross pollution of the stream. Table I shows that the total population equivalent of these cities amounts to more than seven million. The Illinois-DesPlaines River at Lockport, which has an average flow of only about 600 cubic feet per second, has, since 1900, received all the sewage and dilution water from the city of Chicago. The pollution load of the city of Chicago is equivalent to a population of 5,602,000 [3]. With the building of treatment plants and the recovery of by-product wastes by the industries, this load has been reduced about 26 per cent (Table I).

The only other cities along Illinois River that add appreciable volumes of wastes are Peoria and Pekin. Peoria furnishes 16 per cent of the total pollution load thrown upon the river, whereas Pekin furnishes only 3 per cent. It is gratifying to note that Peoria has realized its debt to society and has recently built, and is putting into operation this spring, a very modern plant for the treatment of its wastes.

TABLE I.

EQUIVALENT POPULATION OF ILLINOIS RIVER CITIES.*

| Place. | Station (miles from Grafton). | Sewered population (1930) | Population equivalent of industrial wastes. | Total sewered population contributing |
|---|---|---|---|---|
| Chicago | 292 | 3,880,000 | 1,722,000 | †5,602,000 |
| Joliet | 288 | 41,753 | 26,000 | 67,753 |
| Rockdale | 285 | ‡1,477 | ..... | 1,477 |
| Morris | 263 | 5,563 | 30,000 | 35,563 |
| Marseilles | 247 | ‡1,706 | 102,000 | 103,706 |
| Ottawa | 237 | 15,042 | 3,000 | 18,042 |
| LaSalle | 223 | 13,084 | ..... | 13,084 |
| Peru | 222 | 9,121 | 1,000 | 10,121 |
| Spring Valley | 218 | 5,272 | ..... | 5,272 |
| Lacon | 189 | 1,546 | 500 | 2,046 |
| Peoria Heights | 165 | 3,280 | 50,000 | 53,280 |
| Peoria | 162 | 104,788 | 1,000,000 | 1,104,788 |
| Pekin | 152 | 16,096 | 200,000 | 216,096 |
| Havana | 120 | 3,445 | ..... | 3,445 |
| Beardstown | 88 | 6,353 | ..... | 6,353 |
| Total | ..... | 4,108,526 | 3,134,500 | 7,243,026 |

| | |
|---|---|
| Population in drainage area, urban + rural | 5,700,000 |
| Population equivalent of industrial wastes | 3,100,000 |
| Total population equivalent of Illinois River drainage basin. | 8,800,000 |

* Revised Table I, State Water Survey Bulletin No. 28.

† Sewage treated by Chicago Sanitary District:

| | |
|---|---|
| Partial treatment, population equivalent | 2,153,000 |
| Treatment, 100 per cent basis | 1,473,000 |

‡ Population in 1920.

## Parameters Used in River Studies

Of the various tests that are used in scientific studies of polluted streams and their self-purification, the following are the most important:

1. *Dissolved Oxygen.* The dissolved oxygen test accurately measures the amount of dissolved oxygen gas that is available in any given sample of water for oxidative reactions and for aquatic life.

2. *Biochemical Oxygen Demand.* This test measures the amount of oxygen needed to biologically stabilize any given sample of water or water-borne waste. It is usually expressed in terms of a 5-day demand.

3. *Bacteriological and Biological Counts.* These tests determine the total number and type of organisms found in any given volume of water. Knowing the characteristics and most common habitat of these organisms, the water may be classified accordingly.

The technique of making the above determinations is not so difficult, but factors relative to the manner of sampling, points of sampling, time of day, variations in pollution load, amount and type of dilution, rate of flow, temperature, biological flora found in the water being sampled, and the like, play such an important part in the actual data collected that only those experienced in such work should collect and, above all, interpret such data.

## Pollution Zones

On the basis of data collected, and as an aid in the classification of these data, the writers [1, 2] have divided Illinois River into the following six sections or zones, each of which is briefly characterized:

1. *Zone of Recent Pollution.* That section of the Illinois-Des-Plaines River which extends from the point of confluence of the Des-Plaines River and the diluted wastes from the Chicago Drainage Canal down-stream to about Ottawa, has a very rapid and turbulent flow. As noted in Figure 1, which gives a profile view of the entire Illinois River, there is a fall of some 80 feet in this 50-mile stretch of the river. This upper river constitutes an ideal mechanism to insure maximum biochemical activity. There is relatively little sedimentation. The biochemical oxygen demand of the water in this zone is high, but, as noted in Figure 2, it is also removed very rapidly, due to the high degree of reaeration and active decomposition. The bacteriological counts are of a high order of magnitude (fig. 3) as are also the counts for colonial cileates, tubificid worms, and other forms of biological life common to heavy pollution. The dissolved oxygen of this very turbulent water is always low and in summer the stream is usually completely void of this all important gas.

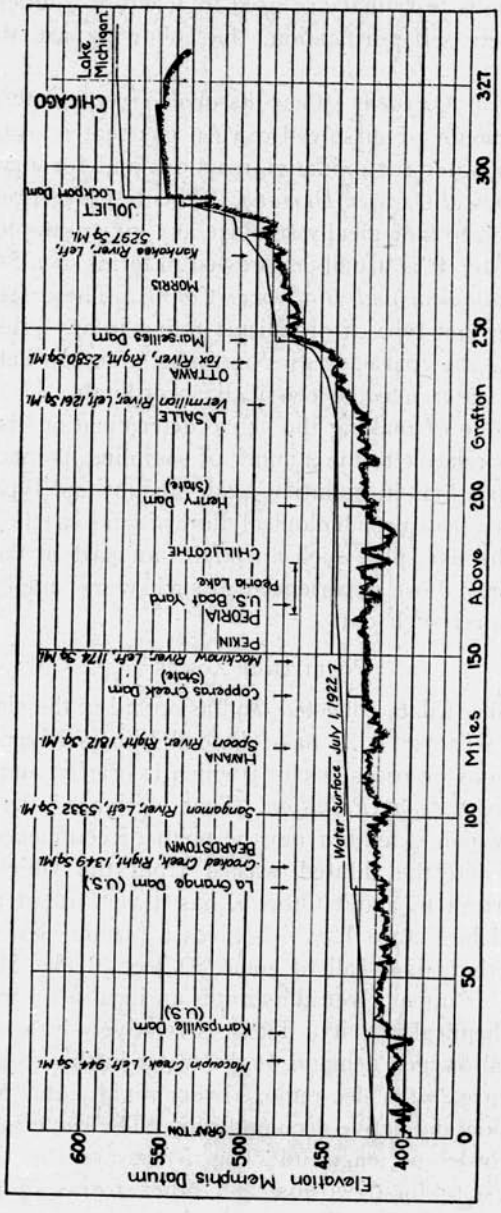


FIG. 1.—Profile of the Illinois River and the Chicago Drainage Canal

(By courtesy of U. S. Public Health Service)

2. *Septic Zone.* Due to the fact that the drop in elevation of the river between Ottawa and Henry is only about 10 feet in 50 miles (fig. 1) as compared with 80 feet in 50 miles in the "Zone of Recent Pollution," the rate of flow found in this second zone is sufficiently low so that much sedimentation takes place. This organic sediment lies practically dormant on the river bottom during the cooler months, but during the summer and fall biological action is accelerated by the increase in temperature to such an extent that an extremely high oxygen demand is thrown upon the river water that flows over this sludge bed. This demand for oxygen is so great that, in spite of reaeration, no free

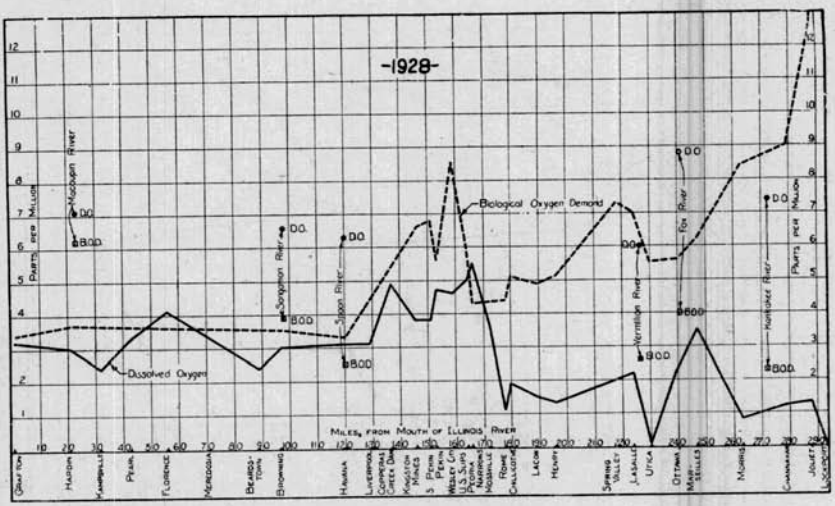


FIG. 2.—Summer averages of biochemical oxygen demand and dissolved oxygen data for 1928

oxygen is found present. Following the removal of all of this gas from the water, anaerobic decomposition sets in and the offensive odors common to this type of degradation are then liberated. It is a regretable fact that one of the State's most historic, most beautiful and most visited parks, namely Starved Rock Park, should be located on the banks of such a stream.

With the completion of the numerous dams that are now being built along the upper Illinois River in connection with the Great Lakes to Gulf Waterway System, there seems little doubt but what the flow between these dams will be sufficiently slow so that the organic matter, which now settles out on the river bottom between Ottawa and Chillicothe, will settle out between these dams which in summer will then virtually become large septic tanks. This septic condition could, of

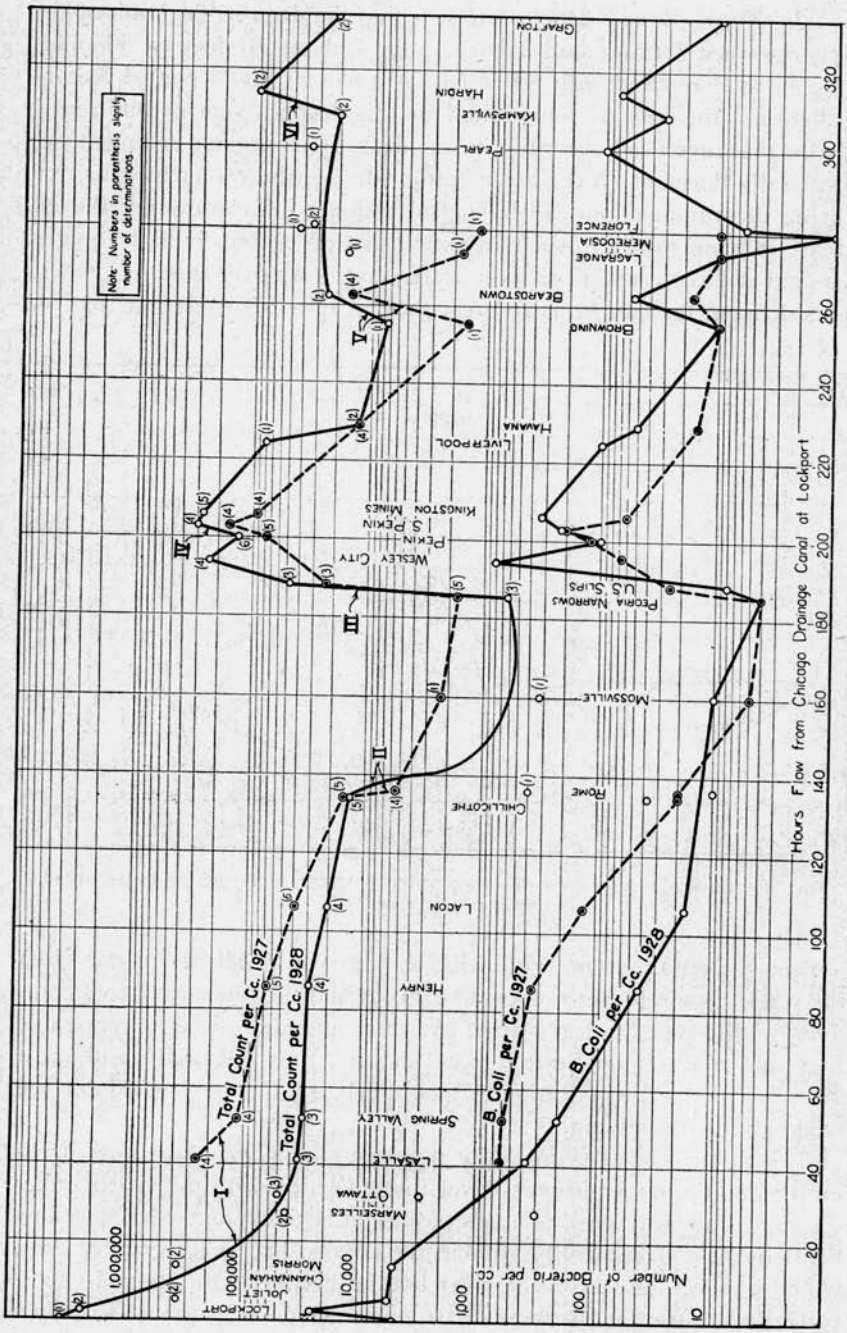


Fig. 3—Graph of bacteriological data for 1927 and 1928

course, be overcome by frequent dredging. With the advent of complete sewage treatment by the city of Chicago this problem would be eliminated.

3. *Polluted Zone.* That section of the river immediately following the septic zone is in many respects very much like its immediate predecessor. The river bottom carries a heavy blanket of sludge, but, as it is more nearly stabilized, the load on the stream is not as heavy. Chemical and bacteriological data bear out this fact.

4. *Zone of Marked Recovery.* That reach of the river between Chillicothe and Peoria is one of the most interesting of the entire river. The river widens in this section and forms the Upper, Middle, and Lower Peoria Lakes, which in all are about 18 miles long and from one-half to one mile wide. The average rate of flow in this reach ranges from 0.3 to 0.6 miles per hour, depending on the stage of water. This slow moving, wide expanse of water makes conditions ideal for the completion of the stabilization and purification of the wastes added to the river at its headwaters. Sedimentation, photosynthesis, reaeration, and the abundant growth of pure water organisms found in these lakes all play an important part. Chemically and bacteriologically (figs. 2 and 3) the river is sufficiently pure at Peoria Narrows so that with mere filtration and chlorination it could be safely used by the city of Peoria as its public water supply.

During hot summer seasons of low stage of water the pollution zones move further downstream, and if it were not for the Peoria Lakes, the Illinois River at Peoria, during such seasons, would be very foul. During the low water season of 1930, the anaerobic zone at times moved as far down stream as South Rome which is located four miles below the head waters of Upper Peoria Lake.

5. *Zone of Repollution.* The Illinois River no sooner gets rid of its one pollution load than it is again polluted. The cities of Peoria and Pekin are at present adding untreated domestic and industrial wastes equivalent to a population of about 1,400,000. The chemical and bacteriological data shown in figures 2 and 3 pictorialize the effect of these wastes. The flow of the river in this zone (Peoria to Kingston Mines) is such that no very definite sludge bed is formed in either this or the following reach of the river.

6. *Zone of Slow Recovery.* The river from Kingston Mines to its confluence with the Mississippi at Grafton has an average flow at medium stage of from 1.2 to 1.5 miles per hour. The soil in the lower Illinois River Valley is such that the river is turbid practically all the time. This turbidity inhibits the growth of algae which play such an important part in the reaeration of a stream. As a result of this, and

other factors which need not be mentioned here, and the heavy load added by Peoria and Pekin, the lower river always possesses a moderate biochemical oxygen demand, a moderate bacteriological count, and only a fairly high dissolved oxygen content. This lower-most reach of the river with its odorless water, harbors but few tubificid worms and practically no colonial ciliates both of which are so abundant in the upper river. However, a variety of gill-breathing insect larvae and other forms common to slightly polluted and unpolluted waters are relatively abundant.

It has been the purpose of this paper to show in a general way how river studies are made and to point out the inter-dependency of the various physical, biological, and chemical factors involved in the self-purification of a polluted stream. With the complete treatment of Chicago's wastes and the wastes of Peoria, Illinois River should again become the stream described by scenic beauty admirers and sportsmen of the "nineties" as the most picturesque river and the best fishing and hunting grounds in the State. This may all be possible even though the river is called upon to take care of the treated effluent from the Chicago and Peoria waste treatment plants.

LITERATURE CITED

[1] Boruff, Ind. Eng. Chem. 22, 1252 (1930).
[2] Boruff and Buswell, State Water Survey Bulletin No. 28, 1929.
[3] Chicago Sanitary District Report to U. S. Supreme Court (1931).