

A STUDY OF THE POLLUTION OF THE BIG MUDDY RIVER SYSTEM

ANSELMO F. DAPPERT

State Department of Health, Springfield.

During the summer of 1928 a detailed study to determine the character, amount, and effect of pollution of the Big Muddy River system was made jointly by the State Departments of Public Health and Conservation. In brief, the investigation was made because of repeated complaints received by both departments relative to the destruction of fish life and the increasing difficulty on the part of several municipalities to obtain a satisfactory and safe water supply from the river. The need for the investigation is reflected by the formal resolution which was passed by the city council of Murphysboro and addressed to the State Department of Public Health, requesting that the necessary studies be made.

During the course of the survey, detailed investigations were made of the pollution tributary to the nine principal tributaries of Big Muddy and the Big Muddy from its source to its mouth. The work comprised an accurate physical survey of all sources of pollution in the entire watershed with reference to the character, amount, and point of entrance of such pollution, routine physical observations of the effect of such pollution along all critical stretches of the tributary streams or river, and repeated chemical and biological studies at numerous convenient and strategical stations established along the various watercourses.

This paper will be restricted to a generalized discussion of only a few representative situations which are typical of the general information acquired for the entire system and which, because of their biological significance, should be of some interest to the members of this section.

SELF PURIFICATION OF REESE CREEK

Reese Creek rises in the vicinity of Tamaroa, flows southerly for a distance of about 7 miles to a point near the northeast corner of DuQuoin and thence easterly and south easterly for about 7 miles to its junction with Little Muddy River.

Above DuQuoin the creek is subjected to only the casual pollution produced by the rural inhabitants of the watershed. Near

the northeast corner of DuQuoin and about seven miles above its mouth Reese Creek receives the combined wastes of the city of DuQuoin and the DuQuoin Packing plant.

The DuQuoin Packing Plant wastes comprise about 5,000 gallons per 8 hours of wash water containing blood, paunch manure and floor washings. The wastes are first treated in two small settling tanks before discharge to the watercourse. The dry weather sewage flow at DuQuoin is about 500,000 g.p.d. which is inadequately treated in a septic tank before discharge. The packing plant wastes enter a small artificial ditch a few feet below the DuQuoin sewage effluent outlet, and the combined wastes which comprise the total flow in this small branch during dry weather, flow north easterly about 1,000 feet to join Reese Creek. At this point the normal flow in Reese Creek is zero and ordinarily only a limited amount of seepage water is available for dilution purposes between this point and Little Muddy River. The stream presents, therefore, an ideal condition for studying the self-purification process. From DuQuoin down stream 3.4 miles, the stream flows in a well defined channel 8 to 12 feet wide and 3 to 4 feet deep. Normally the stream itself flows through a cross section about 3 to 6 feet wide and 0.5 to two feet deep, with a sluggish velocity.

At a point 3.4 miles below DuQuoin, Reese Creek enters what locally is termed "The Scatters", an almost impenetrable swamp overgrown with cattails, pond lilies, marsh grass and other luxuriant aquatic growths. This swamp which normally is fed only by Reese Creek is about $\frac{1}{4}$ mile wide and 1.7 miles long. Reese Creek emerges from this swamp at the hard road crossing just east of old DuQuoin, 5.1 miles below DuQuoin, and flows about $1\frac{1}{2}$ miles to join Little Muddy.

The various observations present such striking evidence of the self-purification process and the beneficial effect of the intervening swamp, that it seems worthwhile to present the essential data.

Although data are available for three separate investigations of Reese Creek and from 11 different stations along its course, it will suffice to present briefly the conditions existing at three points on July 10, 1928, at which time the flow in Reese Creek above the point of pollution was negligible.

Reese Creek just below point of pollution. Flowing liquid was dark greenish brown, of thick sluggish consistency, containing

much suspended material. Very offensive odors prevailed. Gas bubbling was profuse. Sludge deposits were about two feet deep, black, slimy, offensive, and teeming with white tubifex. Significant analytical results were as follows:

(Results in p.p.m.)	
Dissolved oxygen	0
5-day B. O. D.....	550
Turbidity	1100
Total solids	2472
Volatile solids	742
Free Am. plus Organic N.....	18.4
Nitrites	0
Nitrates	0
Oxygen consumed	321

Reese Creek 2.6 miles below point of pollution. This station is situated 0.8 miles above point at which Reese Creek enters "The Scatters". Flowing liquid appeared black due to heavy black, slimy and offensive sludge deposits. Very offensive odors noticeable 500 feet from stream. Significant amounts of oil on surface. Gas bubbling profuse. Tubifex present in mass growth. Top water minnows entering from small ditch connected with small adjoining pond turn back upon reaching the polluted water. Some minnows were observed to become listless upon striking the polluted water, and those which were unable to get back to fresh water perished in 5 to 10 minutes. Blue-green algae pads abundant on water surface. Significant analytical results were as follows:

(Results in p.p.m.)	
Dissolved oxygen	0
5-day B. O. D.....	307
Turbidity	75
Total solids	1344
Volatile solids	378
Free Am. plus organic N.....	4.96
Nitrites	0
Nitrates	0
Oxygen consumed	68

Reese Creek 5.1 miles below point of pollution. This station is located on Reese Creek immediately after emerging from "The Scatters". The stream at this point would never by appearances suggest the offensive conditions which prevail at the point where "The Scatters" begin. There were no odors. The water was clear and contained many minnows of different kinds. Green algae, green aquatic growths, and fresh water forms of life are abundant. Significant analytical results were as follows:

(Results in p.p.m.)

Dissolved oxygen	6.1	=71% of saturation
5-day B. O. D.....	33.5	
Turbidity	0	
Total solids	506	
Volatile solids	180	
Free Am. plus Organic N.....	0.2	
Nitrites	0	
Nitrates	0	
Oxygen consumed	15.2	

It is seen that the intermediate station is situated approximately half way between the point at which the wastes are admitted and the point at which the stream appears to be substantially recovered. The upper 2.6 miles of the stream that we are considering has a well-defined channel. The lower 2.5 miles of stream becomes lost in a swamp 1.7 miles long. The changes occurring in the two sections of the stream are of interest when compared in the following table, because the beneficial effect of the swampy portion of the stream in disposing of the wastes is strikingly presented by the high percentage of change occurring in the lower section.

CHANGES OCCURRING IN REESE CREEK

Determinations	(Results in p.p.m.)			
	Upper section 2.6 miles long fairly uniform channel	% change	Lower section 2.5 miles long 1.7 miles in swamp	% change
Dissolved oxygen.....	0 to 0	0	0 to 71% sat.
5-day B. O. D.....	550 to 307	-44	307 to 33.5	-81
Turbidity.....	1100 to 75	-93	75 to 0	-100
Total solids.....	2472 to 1344	-46	1344 to 506	-62
Volatile solids.....	742 to 378	-49	378 to 180	-52
Free Am. plus Or- ganic N.....	18.4 to 4.96	-73	4.96 to 0.2	-96
Oxygen consumed....	321 to 68	-79	68 to 15.2	-78

ACID CONDITIONS IN BIG MUDDY TRIBUTARIES

Crab Orchard Creek, Hurricane Creek, and Pond Creek enter Big Muddy at points about 10 miles apart, along the most critical stretch of the river. A summary of the most important pollution reaching these tributaries follows:

	Crab Orchard	Hurricane	Pond
Mine wastes.....	400,000 g.p.d.	4,000,000 g.p.d.	10,000,000 g.p.d.
Raw sewage.....	1,200,000 g.p.d.	1,000,000 g.p.d.	
Partially treated sewage..			500,000 g.p.d.
Creosote wastes.....	125,000 g.p.d.		

The mine water is that which is pumped from workings and usually is strongly acid. In some mines the water is so strongly acid that pipe lines are renewed weekly.

Determination of hydrogen ion concentration were made at 8 different stations on Crab Orchard on several different days. Values of pH=6.0 to 6.8 were usually recorded for the stretch between Carbondale and Marion, although on July 26 at a point about $\frac{1}{3}$ of the way between Marion and Carbondale a value of less than 4.4 was obtained. The pH readings reflect a water with a normal tendency toward the acid side with an occasional surge toward strongly acid conditions.

The flow of Hurricane Creek normally is about 80 to 90 per cent acid mine water. Readings at 7 stations on three different dates gave pH values ranging from 3.8 to 5.6. On August 3, samples collected from the stream just before junction with Big Muddy, 1.6 miles above its mouth, and Little Hurricane Creek, gave acidities of 276, 320, and 920 p.p.m. respectively. It is thus seen that Hurricane Creek normally is strongly acid.

The flow in Pond Creek is almost altogether comprised of mine water. pH determinations made at 7 stations on 3 different dates gave values uniformly less than 4.4. On August 29, a sample from Pond Creek before junction with Big Muddy gave an acidity of 365 p.p.m. Pond Creek normally is strongly acid.

DESTRUCTION OF FISH IN BIG MUDDY RIVER

The section of the river with which we are now concerned is that stretch between Murphysboro and the mouth of Pond Creek. Acknowledgment is here made to Dr. H. P. K. Agersborg of the Department of Conservation who conducted biological studies of this portion of the river and from whose report certain data have been taken.

During the past several years the dying of thousands of fish in the Big Muddy River has been a periodical occurrence. Usually in September or October of each year the fish become listless.

floundering about near the surface, and succumb within 24 to 48 hours. Sometimes this phenomenon occurs twice a year; sometimes it skips a year; but it always comes with comparatively good regularity. And when it occurs it apparently is no small catastrophe for the bloated remains of countless numbers of fish begin streaming down the river, lodging behind drifts and becoming stranded on sand bars. A description furnished by Mr. Albert Spiller, a commercial fisherman of Carbondale, of the conditions during the past two years will be sufficient. Mr. Spiller, whose word is to be taken at its face value, states:

"In 1927 due to excessive high water, there were more fish in Big Muddy than at any other time since 1899. And when the killing occurred, more fish were destroyed than it is humanly possible to believe could exist in one stream like Big Muddy. The sad thing about it was that about 60 per cent were game fish, mostly black bass, striped bass, and jack salmon or 'wall-eyed pike'. The first three days of October, 1927, Big Muddy was almost white from the dead fish floating down it and it would be hard to estimate how many billions of fish of all sizes were killed. On the sand bars just below Murphysboro, eight or ten wagon loads of dead fish were stranded.

"In October, 1928, thousands of dead fish poured over the Royalton waterworks dam. In many places along the river as many as 50 dead fish (Buffalo, carp, and catfish) weighing between 5 and 50 pounds were floating behind drifts."

On August 13, 1928, conditions at 7 different stations on Big Muddy were no different than on several preceding dates. There were no indications that the waters were approaching a critical condition. The next visit to the routine sampling stations was on August 27 one day after word was received from the Royalton waterworks operator that hundreds of fish were dying in the river. On this date a moderate number of dead fish were observed all the way from Blairsville to Royalton. The Royalton operator stated that conditions had been worse a few days previously. By August 30 the trouble had entirely passed. The analytical results for the period just preceding and following August 27, will be of interest.

It is to be noted that at all times and even on the date that the dead fish were observed there the waters were well-saturated with dissolved oxygen and had comparatively low bio-chemical oxygen demands. On August 13 the water at all stations was

Location	Date	Dissolved oxygen per cent saturation	5-day B. O. D. p.p.m.	pH	Remarks
Plumfield (above Pond Creek).	Aug. 13	71	8.6	7.6	Turbid.
	Aug. 27	78	5.7	7.8	Turbid.
	Sept. 3	92	4.4	8.0	Turbid.
Royalton (below Pond Creek).	Aug. 13	60	10.1	7.6	Turbid.
	Aug. 27	72	5.2	4.4	Very clear.
	Sept. 3	86	2.0	6.0	Clear.
$\frac{3}{4}$ miles east of Bush below (Pond Creek).	Aug. 13	67	5.7	7.8	Turbid.
	Aug. 27	69	4.9	4.4	Very clear.
	Sept. 3	91	3.3	6.7	Clear.
Blairsville (below Pond Creek).	Aug. 13	64	8.3	7.8	Turbid.
	Aug. 27	78	8.8	6.2	Clear.
	Sept. 3	82	7.5	7.0	Fairly clear.
6 miles north of Carbon-dale.	Aug. 13	54	8.4	7.8	Turbid.
	Aug. 27	76	13.8	6.3	Turbid.
	Sept. 3	75	10.0	6.8	Turbid.
Murphysboro.	Aug. 13	56	9.5	7.8	Turbid.
	Aug. 27	62	21.5	6.6	Turbid.
	Sept. 3	47	7.3	6.8	Turbid.

alkaline as reflected by the uniform pH values of 7.6 to 7.8. On August 27, the day that many dead fish were observed, the water was alkaline above Pond Creek and extremely acid between Blairsville and Royalton. Below Blairsville there was a tendency for the river to recover its alkaline condition although acid conditions prevailed to Murphysboro. On September 3 the pH values had increased considerably although they were still on the acid side. Another striking observation was that when low pH values were obtained there was a striking clarification of the water, which ordinarily is very turbid. At two stations, objects on the river bed could be plainly discerned through a depth of 5 feet. The evidence thus far accumulated would certainly suggest that the phenomenon of fish destruction in Big Muddy is definitely correlated with the acidity of the river waters and occurs when pH values descend to about 4.4. Between October 9 and 13, 1928, the phenomenon was repeated in a more severe manner. Samples collected at the time from Murphysboro and Royalton gave pH values of less than 4.4 at Royalton and 6.0 at Murphysboro.

RIVER SEINING WORK

During the survey under the direction of Dr. H. P. K. Agersborg, river seinings were made at 7 Big Muddy stations and in the principal tributaries. A large 75-foot seine and minnow nets were employed. Not a single fish nor minnow were obtained out of several attempts from Pond, Hurricane, or Crab Orchard Creek. Only slightly better success was obtained for the river stations. The total number of fishes without regard to kind, for each river station examined, is given by the following:

Near Sand Ridge.....	7
Below Murphysboro	6
Above Murphysboro	19
6 Miles North of Carbondale.....	8
Blairsville	0
Royalton	10
Plumfield	6

In 1927 Mr. Spiller at the point 6 miles north of Carbondale obtained as many as 500 small bass with one drag of a seine, while engaged in rescuing fish just prior to the severe slaughter already described by him. The seining work was carried on in September following the period when acid conditions prevailed in the river and this may be an explanation of the indicated low fish population.

CONCLUSIONS

While time has permitted only a general glance at two or three interesting situations uncovered by the investigation, the essential facts have been brought out. Since the investigation two cities tributary to Big Muddy have installed complete sewage treatment works, a third plant is under construction and two other cities have the necessary proceedings underway. It remains now to make some disposition of the more difficult mine wastes problem. Inasmuch as the destruction of fish life in the river seems to occur during periods of low flow, when some mine on Hurricane or Pond Creeks which has been idle for some time is suddenly thrown into operation, the suggestion occurs that the problem may not be so difficult as it first appears and that, with proper cooperation from mine officials, a rather inexpensive plan might be worked out for occasional neutralization of the mine water to prevent the recurrence of the periodical phenomenon that is so distressing to waterworks officials, sportsmen, and residents of the section.