REPORT

on the

ILLINOIS RIVER SYSTEM

EFFECTS ON WATER QUALITY OF RECOMMENDED IMPROVEMENT MEASURES

January 1963

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
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INTRODUCTION

A previous report, "Water Quality Conditions,"(1) described the existing condition of the Illinois River System as determined from physical, chemical, biological, and bacteriological determinations. Another report, "Water Quality Goals,"(2) set forth desirable water quality goals for these waters. A third report, "Recommended Measures for Improving Water Quality,"(3) discussed possible improvements and recommended those that were considered reasonable and feasible. The purpose of this report is to discuss the effects which certain recommended measures can be expected to produce. The effects are presented as changes in bacterial or organic loads currently being placed on the river system. The organic pollution loads are stated in terms of Population Equivalent (PE) and in terms of pounds of ultimate BOD per day.

The recommended measures that have been evaluated in this report are the following:

No less than secondary treatment should be provided for all sewage being discharged to the Upper Illinois River System and the main stem below Lockport.

The Metropolitan Sanitary District (MSD) should undertake an extensive study to determine the best plan to attain the recommended goal on stream coliform density. The technical practicability of disinfecting the canal at several locations and/or the disinfecting of treatment plant effluents and storm water overflows should be studied. In this report the technical practicability of disinfecting sewage treatment plant effluents is considered established. Chlorination of treatment plant effluents is evaluated as a possible procedure, and therefore recommended for partial attainment of the stream coliform density goal and the coincident decrease in discharge of BOD.

Industrial pollution should be decreased by treatment at the site if needed or by connection to a municipal sewer system.

The recently enacted industrial waste ordinance should be reviewed for possible revisions that will encourage industrial practices which minimize the quantity and strength of industrial wastes delivered to the MSD sewer system.

The Metropolitan Sanitary District should immediately undertake comprehensive engineering studies to determine the best plan for the separation of storm and sanitary sewers, and the plan should be implemented as it becomes available. Suggested short-term improvements should be made in the meantime.

Other recommendations that have not been evaluated in this report are the following:

The Metropolitan Sanitary District should continue its present experimental program of artificial reaeration of the river system in order to determine whether it is practical to increase oxygen concentrations by this method under the conditions that prevail.

The Metropolitan Sanitary District should continue the program for the detection of unknown submerged outfalls, illegal connections to storm sewers, and other types of illicit connections.

The use of the canals in the Chicago area for cooling water by air conditioning, thermal power, and industrial installations should be regulated and limited.

The MSD and other responsible agencies should increase the emphasis given to research and development programs for improvement of treatment techniques and other measures to protect the quality of receiving waters.

The "water year" for computation of the average allowable diversion should begin on March 1, and should continue for a two-year period if necessary for balancing the water account when circumstances dictate, to foster better utilization of the authorized diversion.

The evaluated improvement measures will not solve the problems related to nutrients and alkyl benzene sulfonate (ABS) (3), and new treatment procedures must be developed to correct the problems resulting from the discharge of these substances.

TREATMENT OF MUNICIPAL WASTES

Secondary Treatment

It was previously reported that the present municipal waste load to the river system is 1,450,000 PE (1)(3). The individual municipalities have been evaluated with regard to the installation of secondary treatment facilities. The estimated discharged PE load from each of the municipalities after the installation of secondary treatment facilities is shown in detail in Table 1. A summary of the municipal loadings by the major subbasin is as follows:

	Present Raw PE	Present Load PE	Load After Improvements PE	Load After Improvements Pounds per Day BOD
Illinois River System - Lake Michigan to Lockport	8,808,400	928,600	889,300	216,000
Illinois River - Lockport to Grafton (Main Stem)	1,752,400	517,400	379,700	92,500

In the area above the confluence of the Des Plaines River and the Sanitary and Ship Canal (Lockport), 16 communities or institutions discharge waste to streams without secondary treatment. The population of the 16 communities totals 61,000, and they discharge 48,000 PE to the streams. After installation of secondary treatment facilities, it is estimated that the waste discharged to the streams from these 16 communities would be approximately 8,700 PE or 2100 pounds per day ultimate BOD. This represents a decrease of about 10,000 pounds or 82 per cent of the municipal waste load from these 16 communities, but only a 5 per cent decrease in the waste load in the entire area when the effluent from the Metropolitan Sanitary District of Greater Chicago (MSD) is considered.

Along the main stem between Lockport and Grafton, 84 of 127 communities or institutions discharge waste with less than secondary treatment. The population of the 84 communities totals 223,000 and they discharge 170,000 PE to the river. After installation of secondary treatment facilities, it is estimated that the waste discharged to the stream from these communities would be approximately 33,000 PE. This is a decrease of 137,000 PE or 33,500 pounds per day of ultimate BOD. This represents an 80 per cent decrease in the municipal waste load from these 84 locations and a 26 per cent reduction in the total municipal waste load discharged to the river from all 127 locations between Lockport and Grafton.

Chlorination

Laboratory studies on the effects of chlorination of sewage treatment plant effluents with respect to reduction in BOD and reduction in coliform density were carried out by the GLIRBP laboratories. Experiments were performed using effluent obtained from each of the three plants of the Metropolitan Sanitary District. The results of these experiments, as well as information available in the literature, are discussed in subsequent paragraphs. From the laboratory findings it was estimated that chlorination of the Metropolitan Sanitary District effluents would result in a 99 per cent reduction in coliform density under the conditions specified, and that a reduction of about 38,000 pounds of ultimate BOD per day could be expected. Chlorination of MSD effluents alone, without elimination of other discharges such as storm water overflows, would not reduce the coliform densities in the Upper Illinois River System to the desired water quality goals.

Bacterial Reduction

Table 2 presents calculated levels of coliform densities at various sampling points in the Upper Illinois River System between Wilmette and the Kankakee River with and without chlorination of sewage plant effluent. In this table, Column 1 identifies the location of the sampling point and the average flow in cubic feet per second (cfs). Column 2 presents the coliform levels as the geometric mean of about 70 individual samples at each station observed during the study period, April through August 1961. Column 3 presents the estimated coliform densities that would be expected to result from the combined flows of tributaries or known inputs with the main stream. Column 4 is an estimate of the coliform densities that would be expected following the chlorination of MSD effluents and assuming no storm water overflow or other sources. The estimated levels in this column are based on assumptions that such chlorination would result in a 99 per cent* reduction in the coliform density of the effluent, and that the mixture of

* This assumption was applied following laboratory studies on the effects of chlorination on the MSD effluents, in which a chlorine residual of up to 0.5 mg/l was observed following 15 minutes contact time, which confirmed the accepted values used in sanitary engineering practice (4).

chlorinated effluent with the stream would result in changes in proportion to those observed in Column 2 between individual stations. By applying the proportionality factor, the estimated levels in Column 4 take into account the changes in the pattern of natural dieoff or multiplication of coliform organisms that might take place under these conditions. Column 5 is an estimate of coliform densities that would be expected following the chlorination of MSD effluents, and includes the effects of other assumed coliform inputs between stations. The levels presented in this column were calculated as follows: The observed densities (Column 2) and calculated densities (Column 3) were scanned for increases or decreases between stations. Wherever an increase occurred that was not due to a known input such as a tributary inflow or treatment plant discharge, this increase was added arithmetically to the estimated density of the upstream station (Column 5) to arrive at an estimate of the density likely to be present at the next station. Where a decrease occurred, a proportionate decrease was applied to the estimated density of the upstream station to arrive at an estimate of the density at the next station. Thus, the densities estimated in Column 5 reflect the effects of other sources including storm water overflow discharges.

In summary, the estimates of coliform density presented in Column 4 represent the idealized conditions wherein all sewage discharged to the Upper Illinois River System would be treated and chlorinated, and those in Column 5 represent the chlorination of sewage plant effluent without the elimination of other discharges including storm water overflows.

The methods of calculation that were used in arriving at the estimates presented in Table 2 are illustrated by the examples that follow:

Because the first three sampling points, NS 340.7, 338.6, and 336.9, would not be affected by chlorination of the treatment plant effluents, no change in coliform density would be expected, therefore, the levels observed during the study period (Column 2) were extended to both Columns 4 and 5.

Below NS 336.9, the North Side Sewage Treatment Plant discharged 391 cfs of treated effluent with an estimated coliform density of 440,000 per 100 ml. Combining the flow at NS 336.9 with the flow from the North Side Plant and the respective coliform densities, resulted in a calculated average coliform density at the next station, NS 334.9, of 160,000.

(Flow times coliform density, Station A, plus flow times coliform density of inflow, divided by combined flow). This number was inserted in Column 3 opposite NS 334.9. Next, a 99 per cent reduction was applied to the coliform density of the North Side Plant effluent, which resulted in an estimated density of 4,400 per 100 ml. This was inserted in Columns 4 and 5 opposite the North Side Plant. Since there was no appreciable difference between the observed and calculated levels in Columns 2 and 3, at NS 334.9, a proportionate change due to chlorination would be expected in the estimated coliform density at this point; therefore, combining the flows as before, the estimated density at NS 334.9 due to chlorination was found to be 6,800 per 100 ml. This value was inserted in both Columns 4 and 5.

Between NS 334.9 and NS 333.4 there was an observed decrease in coliform density of 20,000 per 100 ml. This decrease in density was applied to the estimated density of 6,800 calculated for NS 334.9 as a proportionate decrease, and resulted in an estimate of 6,000 at NS 333.4. This number was inserted in both Columns 4 and 5.

Between NS 333.4 and NB 331.4 is the confluence of the North Branch of the Chicago River with the North Shore Channel. Combining flows of the two streams with the observed coliform densities, the calculated coliform density at the downstream station NB 331.4 was 140,000 (Column 3). Combining flows of the two streams with the calculated coliform density after chlorination at NS 333.4 (6,000) and the observed coliform density of the tributary (71,000) resulted in an estimated density of 8,600. Because the observed value at this station (Column 2) was greater than the calculated value (Column 3), a proportionate increase was first applied to 8600, which resulted in a calculated density of 10,000. This number was entered in Column 4. Since the observed increase of 20,000 at this station could also be due to other discharges, this increase was added to 8600 to give a total of 28,600 (rounded to 29,000). This number was entered in Column 5 opposite NB 331.4.

Between NB 331.4 and 329.0 there was an observed increase in coliform density of 60,000 per 100 ml (Column 2). This increase was applied first to the calculated density of 10,000 (Column 4) for station NB 331.4 as a proportionate increase, which resulted in an estimated level of 14,000 for NB 329.0. This value was entered in Column 4. It was also assumed that because of the observed increase between these stations, other discharges contributed the additional coliform bacteria. Therefore the increase of 60,000 was added to the estimated coliform level (Column 5) for NB 331.4, which resulted in an estimated level of 89,000 for Station NB 329.0. This number was entered in Column 5.

The estimates of coliform density at subsequent stations were calculated in this manner. The estimates in Column 4, calculated on the basis of proportional changes as observed during the study, reflect the idealized condition if all sewage would be fully treated and chlorinated. The estimates in Column 5 reflect the effect of chlorination on the sewage now received and treated at the MSD plants, and take into account the effect of existing storm water overflows and other discharges.

In comparing the estimated coliform levels presented in Columns 4 and 5 with the interim water quality goal of 10,000 coliform bacteria per 100 ml for the Upper Illinois River System and the ultimate goal of 5,000 coliform bacteria per 100 ml, it is likely that these goals can be realized through the corrective measures listed below:

1. Chlorination of the effluent of the MSD sewage treatment plants. This measure has been evaluated as a step leading toward attainment of the quality goals.

2. Chlorinating any other sewage before it enters the river system as storm water overflow or otherwise, and possibly

3. Additional direct chlorination of the canal system itself.

Chlorination of the MSD effluents alone, without the additional efforts listed above, would result in a partial reduction of the coliform density of the Upper Illinois River System, but would not bring the water quality within the recommended goals.

These calculations cannot be extended at this time beyond the headwaters of the Illinois River at the Kankakee junction because the data obtained on the lower river were not concurrent with the data used in the upper river calculations. However, it is expected that the effects of chlorination would be extended to the lower river and would be beneficial in reducing the coliform densities found there. These benefits would become less apparent as coliform bacteria are introduced into the main river at downstream points.

BOD Reduction

Available information (5)(6)(7) indicates that in the ordinary practice of sewage disinfection with chlorine, wherein a residual of up to 0.5 mg/l is present after a 15-minute contact time, a reduction in BOD can be expected. The quantity of BOD reduction to be expected has been expressed as follows:

1. A reduction of two mg BOD for each mg of chlorine added.

2. A percentage BOD reduction varying from 10 to 35 per cent.

The experiments performed by the GLIRBP laborabory tended to confirm the first of the two generalizations expressed above more so than the second. These experiments showed that in terms of chlorine dosage, the BOD reduction could vary from less than one to about three milligrams for each mg of chlorine added. In terms of per cent BOD reduction, the variations ranged from near zero to 73 per cent. Further study of the data revealed a relationship between chlorine consumption (dosage minus residual) and per cent BOD reduction, which in effect showed that the percentage of BOD reduction which could be expected through chlorination was dependent on the chlorine consumed by the treated effluent. This implies that effluent from the activated sludge process having a low chlorine consumption will have a lower percentage of BOD reduction than waste water with a higher consumption. In terms of chlorine consumption, one milligram of chlorine consumed could be expected to reduce the BOD by two mg, on the average.

These experiments further indicated an average chlorine consumption of 1.3 mg/l by the effluents from the MSD plants. This indicates that an average reduction of BOD of 2.6 mg/l might be expected.

Based on these experiments, the expected reduction in BOD of the effluents from the three MSD plants were calculated by applying the above relationship to the total daily flow. These calculations, tabulated in Table 3, indicate that a BOD reduction of 38,000 pounds per day (rounded from 37,700) can be achieved with an applied chlorine dosage of 18,340 pounds. These calculations are based on the BOD values of the plant effluents obtained during the April-May, 1961 study of these plants.

INDUSTRIAL WASTES

Treatment

It was previously reported that the present known and evaluated industrial pollution to the river system is 970,000 PE (1)(3). Individual industrial plants have been evaluated based on plant inspections and other available information in order to determine what decrease in the above industrial waste load is feasible. Internal improvements and new and/or improved waste treatment procedures have been estimated for industries where applicable. It has been assumed that some industries will connect to local sewerage systems when they become available. Industrial wastes that will be connected to sewerage systems have been assumed to receive secondary treatment for purposes of this report. Industrial wastes connected to the MSD system have been assumed to receive secondary treatment which currently reduces the BOD 90 per cent, and therefore, only 10 per cent of the connected waste load is assumed to be discharged to the river. Wastes discharged to other sewerage systems have been assumed to receive secondary treatment giving 85 per cent removal of BOD, because this degree of removal is generally accepted as being within the capability of secondary treatment.

Detailed results showing the industrial pollution to the river, taking into account the above estimated improvements, are shown in Table 4. These results are summarized for the three major industrial areas as follows:

	Present Load		Load after Improvements	
Area	PE	Pounds per day BOD	PE	Pounds per day BOD
Chicago-MSD	291,300	71,000	56,190	13,500
Joliet	178,000	43,500	76,000	18,500
Peoria-Pekin	400,000	97,500	90,450	22,000
Total	869,300	212,000	222,640	54,000

These estimates show that the industrial waste load to the river can be reduced by approximately 75 per cent.

Industrial Waste Ordinances

The estimated effect of a program based on an industrial waste ordinance which includes a method of levying sewer service charges based on the quantity and quality of industrial wastes discharged is shown in Table 5. These estimates are based on a five-year study made by the City of Cincinnati (8) which indicated a 13.3 per cent reduction in the BOD load. It is assumed that the industrial waste load in the MSD is equal to 90 per cent of the difference between the influent PE at the MSD plants and the connected population; the other 10 per cent is considered to be contributed by surface runoff and other sources. Based on these values, it is estimated that the total load to the sewer system can be decreased by 390,000 PE. With the current treatment plant efficiencies at approximately 90 per cent, the total load discharged to the streams would then be decreased by 39,000 PE or about 10,000 pounds per day of ultimate BOD.

COMBINED SEWER SPILLAGE

Chicago Metropolitan Area

A complete evaluation of the effects of all of the measures presented for reduction of combined sewer spillage cannot be made at this time. Additional studies would be needed to evaluate several of the methods, as noted below.

Separation of storm water and sanitary sewage at the source would eliminate untreated sanitary wastes from the storm water spillage. The ultimate BOD load from spillage, as computed in a previous report (1), is about 56,000 pounds per day, about 16 per cent of the total load in the Sanitary and Ship Canal. However, the portions of the spillage load attributable to sanitary sewage and to storm runoff have not been determined. Therefore, the effect of eliminating the sanitary sewage from the total spillage cannot be calculated.

The effect of connecting industrial waste sewers directly to interceptors, in cases where the plant is located near an interceptor, would be small in relation to the overall pollution load.

The construction of additional sewage treatment facilities in outlying areas, or the alternative construction of relief interceptors to serve these areas, would reduce the BOD spilled to the waterways an estimated 10 per cent in the areas served.

The effect of selective interception of wastes would be small in relation to the total pollution load of the streams.

The provision of adequate capacity at each of the three main treatment plants is a primary consideration. The MSD construction program to increase the capacities of these plants is considered to be sufficient for present requirements. It is estimated that the planned treatment plant additions would reduce the BOD spillage about 6000 ultimate pounds per day in an average year.

Primary sedimentation tanks for storm water would provide up to 40 per cent reduction in BOD in the flow through the tanks. The total effect would depend on the size of the tanks provided, which would be determined by an economic study.

Lower Illinois River

Since no studies of sewer systems have been made for cities in the Lower Illinois River Basin, evaluation of the recommendations for reduction of combined sewer spillage has not been attempted.

INTEGRATION OF DECREASED WASTE LOADS

Analysis of the main channel from Wilmette to the junction of the Des Plaines River and the Sanitary and Ship Canal indicates that the total load is 308,000 pounds per day of ultimate BOD. This is based on five 30-day sampling periods in April-May, June, July, and August, 1961, and January, 1962. This load to the main stem is from the following sources:

NS 340.7 (Wilmette Intake)	16,190 pounds per day
North Side Sewage Treatment Plant	24,040
North Branch Chicago River	3,210
Chicago River	10,850
West-Southwest Sewage Treatment Plant	122,210
Calumet-Sag Channel Junction	21,470
Calculated Storm Spillage	56,000
Industrial Waste Load	54,300
Total	308,270 pounds per day

This total load compares favorably with the total load of 353,000 pounds per day of ultimate BOD applied to the main stem and tributaries that was obtained from the inventory of known waste sources plus calculated storm spillage.

Table 6 is a summary of the estimated results of the recommended improvement measures to both the Upper and Lower Illinois River. The improvement measures will reduce the ultimate BOD load to the Upper Illinois River by 122,000 pounds per day, and the load to the Lower Illinois River by 136,500 pounds per day.

SUMMARY

The estimated results of the recommended improvements are summarized in Table 6 and are as follows:

1. Adequate secondary treatment at 16 communities or institutions that are tributary to the river system between Lake Michigan and Lockport would decrease the pollution load by approximately 10,000 pounds of ultimate BOD per day.

2. Chlorination of the MSD sewage treatment plant effluents alone would not attain the recommended goal on stream coliform density, although substantial improvement would result. The MSD should undertake an extensive study to determine the best plan to attain the recommended goal on stream coliform density. The feasibility of disinfecting the canal at several locations and/or disinfecting of treatment plant effluents and storm water overflows should be studied.

3. Chlorination of the MSD sewage treatment plant effluents would be expected to decrease ultimate BOD discharges by 38,000 pounds per day.

4. Between Lake Michigan and Lockport, the connection of known inadequately treated industrial wastes to secondary treatment facilities, or adequate on-site treatment, would decrease the pollution load to the main channel by approximately 58,000 pounds of ultimate BOD per day.

5. Enactment of an ordinance allowing the MSD to assess sewer service charges based on quantity and characteristics of industrial wastes would induce industries to decrease waste

discharges to the sewage treatment plants. It is estimated that this might decrease the discharge of ultimate BOD from the sewage treatment plants by 10,000 pounds per day.

6. The planned additional capacity at the MSD treatment plants will decrease the ultimate BOD of storm spillage by an estimated 6000 pounds per day.

7. The installation of adequate secondary treatment facilities at 84 communities or institutions that are now tributary to the main stem of the Illinois River between Lockport and Grafton would decrease the pollution load by approximately 33,500 pounds of ultimate BOD per day.

8. Below Lockport, the connection of known inadequately treated industrial wastes to secondary treatment facilities or adequate on-site treatment, would decrease the pollution load by approximately 103,000 pounds of ultimate BOD per day.

9. The combined estimated effect of the improvement measures discussed herein would be to reduce the ultimate BOD load to the upper river system from 336,000 pounds to 214,000 pounds per day, and to the lower river from 270,000 to 133,500 pounds per day.

REFERENCES

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TABLE 1a

REDUCTION IN MUNICIPAL WASTES BY INITIATION OF SECONDARY TREATMENT
ILLINOIS RIVER SYSTEM - LAKE MICHIGAN TO LOCKPORT

Community	Receiving Stream	Existing Raw PE	Existing Discharged PE	Final PE with Secondary Treatment
		Lake County, Ill.		
Waukegan Park City Trailer Park	Skokie Cr.	1,200	800	180
Country Side Manor Subdiv.	Des Plaines R.	200	200	30
Gilmer	Des Plaines R.	100	100	15
		Will County, Ill.		
Lincolnshire C.C.	Cal-Sag Channel	300	300	45
Lockport	Deep Run Creek	5,000	2,600	750
Valleyview	Des Plaines R.	300	100	45
		Cook County, Ill.		
Park Side Subdiv.	Midlothian Creek	2,800	2,800	320
Worth-Ridgeland Plant	Cal-Sag Channel	3,800	3,800	570
Worth-Oketo Plant	Cal-Sag Channel	4,300	2,800	645
		Lake County, Indiana		
Black Oak-Ross	Cady Marsh-Hart	17,000	15,000	2,550
Schererville	Cady Marsh-Hart	1,250	1,000	185
Dyer	Hart Ditch	3,600	3,000	540
Griffith (Part)	Cady Marsh - Hart	7,100	5,700	1,065
Highland (Part)	Little Cal. R.	5,430	4,880	815
Munster (Part)	Little Cal. R.	5,150	4,500	770
Lincoln Gardens		1,000	650	150
		58,530	48,230	8,675

TABLE 1b

REDUCTION IN MUNICIPAL WASTES BY INITIATION OF SECONDARY TREATMENT
MAIN STEM - LOCKPORT TO GRAFTON

Community	Receiving Stream	Existing Raw PE	Existing Discharged PE	Final PE with Secondary Treatment
		Will County, Ill.		
Joliet	Spring & Hickory Cr.	71,600	50,100	10,470
Joliet Fringe-Urban-Unincorp.	I & M Canal, Hickory Creek	6,000	6,100	900
Smaller Sources - Three		1,600	1,300	240
		Bureau County, Ill.		
Spring Valley	Illinois River	5,300	3,710	795
Depue	Lake Depue	1,920	1,536	288
Smaller Sources- Eight		4,438	3,930	665
		Grundy County, Ill.		
Gardner	Trib. to Mazon & Illinois River	1,041	937	156
Coal City	Claypool Cr.	2,852	2,500	428
Morris	Illinois River	7,900	4,500	1,185
Smaller Sources- Seven		2,881	2,570	432
		Kankakee County, Ill.		
Smaller Sources- One		328	290	49
		Kendall County, Ill.		
Smaller Sources- Two		359	320	54

TABLE 1c

REDUCTION IN MUNICIPAL WASTES BY INITIATION OF SECONDARY TREATMENT
MAIN STEM - LOCKPORT TO GRAFTON

Community	Receiving Stream	Existing Raw PE	Existing Discharged PE	Final PE with Secondary Treatment
		Knox County, Ill.		
Smaller Sources-- One		802	700	120
		LaSalle County, Ill.		
Seneca	Rat Run Cr.	1,675	1,257	251
Marseilles	Illinois River	4,347	4,347	652
North Utica	Illinois River	1,014	1,014	152
LaSalle	Illinois River	11,000	7,150	1,650
Peru	Illinois River	10,460	6,800	1,569
Smaller Sources- Six		2,544	2,302	381
		Lee County, Ill.		
Smaller Sources- One		306	250	46
		Livingston County, Ill.		
Smaller Sources- One		936	840	140
		Marshall County, Ill.		
Henry	Illinois River	2,278	2,000	341
Lacon	Illinois River	2,175	1,950	326
Smaller Sources- Two		1,434	1,290	215
		Mason County, Ill.		
Havana	Illinois River	3,400	2,210	510

TABLE 1d

REDUCTION IN MUNICIPAL WASTES BY INITIATION OF SECONDARY TREATMENT
MAIN STEM - LOCKPORT TO GRAFTON

Community	Receiving Stream	Existing Raw PE	Existing Discharged PE	Final PE with Secondary Treatment
		Peoria County, Ill.		
N. Chillicothe	Senachwine Cr.	2,259	2,000	339
Chillicothe	Illinois River	3,054	2,740	458
Rome (U)	Illinois River	1,347	1,010	202
El Vista	Trib. to Kickapoo Cr.	2,000	1,800	300
Bellevue	Illinois River	1,561	1,405	234
Smaller Sources-Ten		3,354	2,980	503
		Putnam County, Ill.		
Granville	Illinois River	1,048	940	157
Smaller Sources-Four		1,227	1,090	184
		Tazewell County, Ill.		
Sunnyland	Farm Cr.	1,000	875	150
E. Peoria	Illinois River	10,000	7,500	1,500
Creve Coeur	Illinois River	6,684	5,900	1,003
North Pekin	Illinois River	2,025	2,025	304
Delavan	Br. of Main Ditch	1,377	1,300	207
Pekin	Illinois River	23,000	16,100	3,450
South Pekin	Lost Cr.	1,007	860	151
Smaller Sources-Four		1,952	1,705	293

TABLE 1e

REDUCTION IN MUNICIPAL WASTES BY INITIATION OF SECONDARY TREATMENT
MAIN STEM - LOCKPORT TO GRAFTON

Community	Receiving Stream	Existing Raw PE	Existing Discharged PE	Final PE with Secondary Treatment
		Woodford County, Ill.		
Washburn	Snag Cr.	1,064	930	160
Smaller Sources-One		237	154	36
		Calhoun County, Ill.		
Hardin	Illinois River	1,000	650	150
		Cass County, Ill.		
Ashland	Indiana Cr.	1,064	930	160
Beardstown	Illinois River	6,294	6,294	944
		Fulton County, Ill.		
Astoria	Ditch to Harris Br.	1,200	780	180
	TOTALS	222,344	169,874	33,080

TABLE 2a
ESTIMATED EFFECTS OF CHLORINATION OF SEWAGE EFFLUENTS ON
COLIFORM DENSITIES IN THE UPPER ILLINOIS RIVER SYSTEM

Sampling Point or Tributary Inflow	Avg Flow cfs	Coliform Density per 100 ml		Estimated Coliform Density per 100 ml Assuming Treatment and Chlorination	
		4-month Geometric Mean	Calculated	of All Sewage	of MSD Plant Effluents
(1)		(2)	(3)	(4)	(5)
North Shore Channel and North Branch Chicago River					
NS 340.7*	700	(200)		(200)	(200)
NS 338.6*	706	(3,500)		(3,500)	(3,500)
NS-336.9*	710	(8,200)		(8,200)	(8,200)
MSD-NSSTP[a]	391	440,000		4,400***	4,400***
NS 334.9	1,110	160,000	160,000	6,800	6,800
NS 333.4	1,114	140,000		6,000	6,000
NB 333.4*	48	(71,000)		(71,000)	(71,000)
NB 331.4	1,177	160,000	140,000	10,000	29,000
NB 329.0	1,182	220,000		14,000	89,000
NB 325.8	1,194	390,000		25,000	260,000
South Branch, Chicago River, and Sanitary and Ship Canal					
CH 326.9*	566	(680)		(680)	(680)
CH 325.8*	569	(9,100)		(9,100)	(9,100)
SB 324.3	1,770	200,000	270,000	15,000	130,000
SB 322.8	1,787	280,000		21,000	210,000
SS 320.0	1,832	260,000		20,000	200,000
SS 317.3	1,848	230,000		18,000	180,000
MSD-WSW[b]	1,392	(680,000)		6,800***	6,800***
SS 314.0	3,176	420,000	430,000	13,000	110,000
SS 307.9	3,215	460,000		14,000	150,000
SS 304.1**	3,218	270,000		8,200	88,000
CS 304.1**	641	23,000		5,900	12,000

TABLE 2b

Sampling Point or Tributary Inflow	Avg Flow cfs	Coliform Density per 100 ml 4-Month Geometric Mean	Calculated	Estimated Coliform Density per 100 ml assuming Chlorination	
(1)		(2)	(3)	(4)	(5)
South Branch, Chicago River, and Sanitary and Ship Canal (continued)					
SS 300.5	3,847	200,000	230,000	6,800	67,000
SS 296.2	3,836	110,000		3,700	37,000
SS 292.1	3,819	61,000		2,100	18,000
SS 291.1	3,808	72,000		2,500	29,000
Des Plaines River					
DP 292.7*	290	(4,200)		(4,200)	(4,200)
DP 285.8	4,158	79,000	67,000	3,100	39,000
DP 278.0	4,175	64,000		2,500	32,000
Kankakee River					
KR 277.5*	4,017	(20,000)		(20,000)	(20,000)
Illinois River					
IR 271.5	8,344	17,000	42,000	4,600	11,000
Calumet River and Cal-Sag Channel					
CA 332.7*	275	(2,000)		(2,000)	(2,000)
CA 328.1*	281	(5,400)		(5,400)	(5,400)
CC 325.8*	9	(2,300,000)		(2,300,000)	(2,300,000)
CA 327.0*	282	(4,000)		(4,000)	(4,000)
LC 322.4*	293	(40,000)		(40,000)	(40,000)
LC 320.2*	183	(150,000)		(150,000)	(150,000)
LC 320.1	434	(51,000)		(51,000)	(51,000)
MSD-Cal[c]	227	300,000		3,000***	3,000***
CS 317.9	583	120,000	140,000	30,000	30,000
CS 314.9	603	190,000		48,000	100,000

TABLE 2 c

Sampling Point or Tributary Inflow	Avg Flow cfs	Coliform Density per 100 ml 4-Month Geometric Mean	Calculated	Estimated Coliform Density per 100 ml assuming Chlorination	
(1)		(2)	(3)	(4)	(5)
Calumet River and Cal Sag Channel (continued)					
CS 311.5	618	110,000		28,000	58,000
CS 308.5	623	98,000		25,000	52,000
CS 304.1	641	23,000		5,900	12,000
Illinois River[d]					
IR 271.6	6,620	28,000			
IR 270.6	6,620	27,000			
IR 263.5	6,770	32,000			

* These points, either upstream from MSD discharges or located on tributaries, are not affected by these discharges.

** Indicates junction of Calumet-Sag Channel, and Sanitary and Ship Canal.

*** Present MSD effluent reduced by 99 per cent.

a. MSD Northside Sewage Treatment Plant Effluent.
b. MSD West-Southwest Sewage Treatment Plant Effluent.
c. MSD Calumet Sewage Treatment Plant Effluent.
d. July 1962 data.

( ) indicates no influence expected from chlorination of MSD effluents.

TABLE 3

MSD Treatment Plant Effluents
Estimated BOD Reduction Due to Chlorination

Treatment Plant	Avg+ Flow MGD	Effluent BOD: Without Chlorination: 5 Day BOD+ mg/l	Effluent BOD: Without Chlorination: Ultimate BOD Pounds/Day	Effluent BOD: With Chlorination: Estimated 5 Day BOD* mg/l	Effluent BOD: With Chlorination: Ultimate BOD Pounds/Day	BOD Reduction Pounds/Day	Chlorine Requirement (to 0.5 mg/l residual) Pounds/Day
Northside	231	10.8	23,000	8.2	17,500	5,500	3,460
W-SW	852	16.4	180,000	13.8	152,000	28,000	12,800
Calumet	138	13.5	21,700	10.9	17,500	4,200	2,080
Total			224,700		187,000	37,700	18,340

* Estimated 5 day BOD = 2.6 mg/l reduction by chlorination assuming average chlorine demand of 1.3 mg/l for all plants

\+ Data taken from April-May 1961 study.

TABLE 4a

EFFECTS OF IMPROVEMENTS ON WASTE LOADS TO THE ILLINOIS RIVER SYSTEM FROM INDUSTRIES

Map Location Code	PHS Industrial Code	River Mileage	Effluent MGD	Present PE (5-Day BOD)	Present Treatment	Future Treatment	Future PE (5-Day BOD)	Increased PE from Sewage Treatment Plants
				NORTH BRANCH CHICAGO RIVER				
N-1	39	I-325.6-3.0	0.42	11,500(2)	None	Divert Wastes to MSD	0	1150
N-2	28C,20Q	I-325.6-2.0	17.50	1,200	Grease Sep.	None	1200	0
N-3	31A	I-325.6-1.4	0.07	2,100(2)	None	Divert Wastes to MSD	0	210
	39,34C,34B, 26I,28A		0.72	1,500		Divert Conc.Wastes to MSD	600	90
			18.75	16,300			1800	1450
				ILLINOIS RIVER SYSTEM AND MINOR TRIBUTARIES - LAKE MICHIGAN TO KANKAKEE RIVER				
I-1	20A	I-327.0	9.0	3,600(2)		Divert Conc. Wastes to MSD	1000	260
I-2	22E	I-321.6	0.18	7,000	None	Divert Wastes to MSD	0	700
I-3	20A	I-320.6	0.40	20,000(2)		Divert Wastes to MSD	0	2000
I-4	29E	I-317.4	0.17	1,600(2)	Oil Sep.	Improved Oil Sep.	1000	0
I-5		I-314.8	21.0	144,000		Divert Wastes to MSD	0	14400

TABLE 4b

Map Location Code	PHS Industrial Code	River Mileage	Effluent MGD	Present PE (5-Day BOD)	Present Treatment	Future Treatment	Future PE (5-Day BOD)	Increased PE from Sewage Treatment Plants
		ILLINOIS RIVER SYSTEM AND MINOR TRIBUTARIES - LAKE MICHIGAN TO KANKAKEE RIVER (Cont'd)						
I-6	39,34I,33E,33B 29E,28B,20P	I-313.3	4.95	29,000(4)	Oil and Grease Sep. sed.	Divert Wastes to MSD	0	2,900
I-7	29A	I-290.7-2.4	50.0	40,000	Oil Sep. and Lagooning	Improve Oil Sep.	30,000	0
I-8	26H	I-289.8	3.0	16,000	Screening	Internal Improv. & Sed.	8,000	0
I-9	29A	I-288.9-7.8	68.0	25,000	Oil Sep.	Improve Existing Treatment Facilities	19,000	0
I-10	34H	I-288.9-0.2	21.0	1,000	Sed. and By-Product Recovery	Install Oil Separators	500	0
I-11	39	I-286.5-1.0	0.12	2,000	Sedimentation	Divert Wastes to Joliet Disposal Plant	0	1,400
I-12	34I	I-284.5	0.80	1,000	Oil Separation	Internal Improv.	500	0
I-13	28B	I-280.0	0.65	92,500	Oil Separation	Secondary Treatment	14,000	0
	39,34I,34C,33E 28A,28C,20R		11.38	4,400		Internal Improvements	2,200	0
			190.65	387,100			76,200	21,660

TABLE 4c.

Map Location Code	PHS Industrial Code	River Mileage	Effluent MGD	Present PE (5-Day BOD)	Present Treatment	Future Treatment	Future PE (5-Day BOD)	Increased PE from Sewage Treatment Plants
				CALUMET SAG CHANNEL AND TRIBUTARIES				
C-1	33C,29B	I-303.4-26.6	37.0	19,200(2)	Sed.and Oil Separation	Divert Conc. Wastes to MSD	5,200	1,400
C-2	33E,33C,29B	I-303.4-26.2	85.0	10,000(2)	Sed.and Oil Separation	Divert Conc. Wastes to MSD	2,500	750
C-3	28C,20Q	I-303.4-25.2-3.7	10.0	18,000	Grease Sep.	Internal Improvements	9,000	0
C-4	28A	I-303.4-25.2	4.0	3,200(2)	None	Internal Improvements	1,600	0
C-5	20Q	I-303.4-25.1	0.40	4,400	None	Divert Conc. Wastes to MSD	500	399
C-6	34I	I-303.4-24.1	0.50	3,000	Filtration	Divert Conc.Wastes to MSD and Internal Improv.	500	200
C-7	28B	I-303.4-21.9	1.50	1,800	None	Divert Wastes to MSD	0	180
C-8	33C,33E	I-303.4-18.0	48.0	1,500	Sedimentation and Oil Sep.	Improve Existing Treatment Fac.	700	0
C-9	20F,24,28A 28B,29E,33A 34A,34B,34H	I-303.4-16.3-8.9-11.2	8.0	4,700(3)		Divert Conc.Wastes to Bloom Township Sanitary District	750	320
C-10	29A	I-303.4-13.3	27.0	21,000	Oil Separation	Improved Oil Sep.	14,000	0
	39,33C,33E 24C,29B,28A		94.08	900		Internal Improve and Divert Conc. Wastes to MSD	500	40
			316.08	87,700			35,250	3,280

TABLE 4d

PHS Industrial Code	River Mileage	Effluent MGD	Present PE (5-Day BOD)	Present Treatment	Future Treatment	Future PE (5-Day BOD)	Increased PE from Sewage Treatment Plants
			DES PLAINES RIVER				
39,34B,34C 34I,28A,20R		1.15	4,000		Divert Wastes to MSD and Internal Improvements	1,000	200
		1.15	4,000			1,000	200
			ILLINOIS RIVER SYSTEM AND MINOR TRIBUTARIES - KANKAKEE RIVER TO SPOON RIVER				
26H	I-264.2	3.0	10,200	Screening	Sed. and Internal Improvements	5,100	0
26H	I-264.6	1.0	9,000	Sedimentation	Internal Improv.	4,500	0
26E	I-165.5	0.60	3,000	Divert Wastes to PSD	Divert to PSD	0	450
34I	I-162.0	9.0	1,500	Oil Separation	Internal Improv.	750	0
20-0	I-161.3	12.0	50,000	By-Products Recovery	Divert Conc.Wastes to PSD	25,000	2,500
20F	I-161.0	1.80	12,500	Divert Wastes to PSD	Divert to PSD	0	1,800
20H	I-160.2	1.50	4,000	Divert Wastes to PSD	Divert to PSD	0	600
28A,20-0	I-160.1	4.70	30,000	None	Divert Conc.Wastes to PSD and Internal Improv.	7,500	1,500
34H	I-157.8	70.0	1,500	Sedimentation	Oil Separation	750	0

TABLE 4e.

PHS Industrial Code	River Mileage	Effluent MGD	Present PE (5-Day BOD)	Present Treatment	Future Treatment	Future PE (5-Day BOD)	Increased PE from Sewage Treatment Plants
			ILLINOIS RIVER SYSTEM AND MINOR TRIBUTARIES - KANKAKEE RIVER TO SPOON RIVER (Cont'd)				
20R	I-151.7	17.0	86,000	None	Secondary Treatment	13,000	0
20-0	I-151.5	8.50	31,500	By-products Recovery	Secondary Treatment	5,000	0
26H	I-151.3	1.20	5,000	Screening	Sed. and Internal Improv.	2,000	0
20R	I-151.0	5.50	175,000	Secondary Treatment for Conc. Wastes	Secondary Treatment for all Wastes	26,000	0
28C, 28B	I-148.1	2.30	6,500	Primary Treatment	Internal Improv.	3,300	0
39, 34I, 28A 28B, 28C		3.60	1,200		Internal Improv.	600	0
		141.70	426,900			93,500	5,950

(1) Garbage incinerator.
(2) 24 Hour PE value estimated from eight-hour observations.
(3) Total PE value of industries drained by the State Street Ditch.
(4) Total PE value of industries drained by the Summit-Lyons Conduit.
(5) Adjusted PE value from seasonal industries.

TABLE 4f

P. H. S. INDUSTRY CODE

11	Coal Mining and Processing	28B	Intermediate Chemicals
14	Quarrying	28C	Finished Chemicals
20A	Sugar Refining	29A	Petroleum Refining
20C	Canning-Vegetables	29B	By-Product Coke Plant
20F	Meat Packing	29E	Petroleum-Miscellaneous
20G	Poultry Processing	30A	Rubber Products
20H	Milk Receiving	31A	Tanning
20-0	Distillery	33A	Ferrous Metal Manufacture
20P	Rendering	33B	Non-Ferrous Metal Manufacture
20Q	Vegetable Oil Manufacture	33C	Blast Furnace
20R	Food - Miscellaneous	33E	Ferrous Rolling Mills
22E	Fur and Hair	34A	Ferrous Metal Fabrication
24	Wood Products	34B	Non-Ferrous Metal Fabrication
26E	Jute or Hemp Paper Mill	34C	Metal Plating
26H	Paper Board Mill	34H	Fabricated Metal-Rolling Mills
26I	Paper Mill - Miscellaneous	34I	Metal Fabricating - Miscell-aneous
28A	Basic Chemicals	39	Miscellaneous Manufacturing

TABLE 5

Estimated Industrial Waste Loads Before and After the Adoption of a Comprehensive Industrial Waste Ordinance by the Metropolitan Sanitary District.

	PE Load to MSD Plants		PE Load to River System	
	Before	After	Before	After
Population Connected	4,750,000	4,750,000	475,000	475,000
Industrial	2,950,000	2,560,000	295,000	256,000
Others	330,000	330,000	33,000	33,000
Total	8,030,000	7,640,000	803,000	764,000

TABLE 6

SUMMARY OF ESTIMATED RESULTS OF IMPROVEMENTS

Upper Illinois River System - Lake Michigan to Lockport

Present Total BOD Load			
a. Municipal	226,000		
b. Industrial	71,000		
c. Calculated Storm Spillage	56,000		
Total Load			353,000
BOD Reduction by Improvements			
a. Secondary Treatment of Municipal Waste		10,000	
b. Industrial Waste Reduction		58,000	
c. Industrial Waste Ordinance-MSD		10,000	
d. Chlorination of MSD Effluents		38,000	
e. Stormwater Overflow Control Through Short-Term Improvements		6,000	
Total Pounds of BOD Reduction by Improvements			122,000
Total BOD Load After Improvements			231,000

Lower Illinois River System - Lockport to Grafton (Main Stem)

Present Total BOD Load			
a. Municipal	126,000		
b. Industrial	144,000		
Total Load			270,000
BOD Reduction by Improvements			
a. Secondary Treatment of Municipal Waste		33,500	
b. Industrial Waste Reduction		103,000	
Total Pounds of BOD Reduction by Improvements			136,500
Total BOD Load After Improvements			133,500

All values are ultimate BOD, pounds per day.