

Compliments of
GEN. JOHN C. SMITH,
65 Sibley St. Chicago.



A DISCUSSION
OF THE
DRAINAGE AND WATER SUPPLY
OF CHICAGO.

BY D. W. JACKSON.



CHICAGO :
RAND, McNALLY & COMPANY, PRINTERS.
1892.

DEACCESSIONED BY
CHICAGO HISTORICAL SOCIETY,
PRINTED COLLECTIONS

F38 LI,
J13

COPYRIGHT, 1892, BY RAND, McNALLY & Co.

CHICAGO
JACOBSON
VT 1892
John C. Smith

20793

Introductory.

The writer confesses to having been one of those who voted for the adoption of the Drainage Act. He understood that it was approved by the Citizens' Association, who claimed to have investigated the subject—something must be done—the method formulated by the Drainage Act was declared to be the best, and, indeed, the only attainable solution of the drainage question, and there seemed virtually no alternative. Vague suspicions arose in the minds of many, after the adoption of the act, and the election of drainage trustees, that the proceeding was ill-advised, and it was hoped that the Supreme Court would declare the act invalid. In this, they were disappointed.

The attention of the writer was first drawn to the matter, by the suggestion as to the vast amount of damages which the city would have to pay annually, for flooding the bottom lands of the Illinois River Valley. It requires no very great experience as a lawyer to understand the danger, not only of having to pay large amounts for damages actually sustained, but of a larger amount, which would be recovered on trumped-up claims, but which local juries would most assuredly find against the city, and it was this apprehension, that led to this investigation. If the city could have settled the entire matter, once for all, by building the channel at an expenditure of the fifteen million of dollars (\$15,000,000) provided for in the Drainage Act, while there would have been the conviction that there might be a cheaper way, it is hardly probable that this attempt to investigate the subject would have been made. Without any previous study of the drainage question, or of the various methods by which sewage may be disposed of, and with only the vague reports made by the engineers as a basis, the outlook for a comprehensive survey of the matter was rather formidable, but no one else seemed disposed to do it, and as it was something which ought to be done, the following attempt was made—with what success the reader must judge. The work was entered upon without any prepossession for or against any man, and if any disapprobation appears in these pages toward any person or persons, such disapprobation arose from the facts. It is not permissible to compare the men, who by their scheming, their suppression of the

truth, or their incapacity, are responsible for the passage of the Drainage Act, with the county boodlers who were sent to the penitentiary, but, so far as the taxpayers are concerned, the pilferings of the boodlers are, to the extravagancies of the Drainage Act, but as the shadow to the substance.

In discussing the subject of the disposition of sewage, extracts have been made from a work entitled "The Cleaning and Sewerage of Cities," by Prof. R. Baumeister of the Technical Institute at Carlsruhe, Germany, translated by J. M. Goodell, associate editor of the *Engineering News*, and published in 1891, and it may be said to summarize the latest conclusions upon the subject. The writer has had occasion to make some strictures upon the Herring report (which bears, however, internal evidence of having been chiefly the composition of L. E. Cooley), but Mr. Herring is undoubtedly competent to pronounce upon the character of Baumeister's work, to which he has written an introduction, in which he says, "The author, whose name is already familiar to a number of American engineers, is well versed in the subject, though not a practicing engineer. His impartiality, characteristic fairness, and judicial temper have fitted him to present the subject matter, concerning which all controversy has not yet ceased, in a more balanced and scientific form than I have seen in any other book." To this it may be added that to be a "professor" in a German Institute presupposes a degree of learning, capacity and thoroughness, not always associated with the title in this country; and further, that as teacher and writer, he is neither exploiting a theory, nor "working a policy."

Extracts from the report of Capt. W. L. Marshall of the United States Engineer Corps—located at Chicago—and from other authorities, will be made, and to determine the weight to be given to any man's opinions, it is necessary to know something as to who and what he is.

Capt. Marshall graduated from the United States Military Academy at West Point, the most thorough engineering school in the United States, in 1868. In the years 1870-71, he was assistant professor at West Point; from 1872 to 1876 he was in charge of the Government explorations and surveys in Colorado. He discovered the celebrated pass which was named after him, and is now known as Marshall Pass. From 1876 to 1881 he was assistant engineer of the Government canals upon the Tennessee

and Coosa rivers, in Alabama. From 1831 to 1884 he was in charge of the Government levee construction and river improvements of the third district, upon the lower Mississippi. From 1884 to the present time he has been in charge of the Government works upon the Fox, Wisconsin, Illinois and Chicago rivers, the Hennepin canal, and the harbor of Chicago. From \$500,000 to \$2,250,000 annually, have for several years past been expended by the Government under his direction. It will thus be seen that he has steadily advanced in his career, and it may be assumed that his opinions are as valuable as any that can be obtained upon engineering matters within his cognizance.

W. Santo Crimp—from whose work upon “Sewage Disposal Works,” published in London in 1890, and republished in this country, extensive citations are made—is a practical sanitary engineer of recognized standing and ability in England.

Dr. C. M. Tidy, from whom a forcible utterance upon the subject of the self purification of rivers is quoted, is also a man of large experience and authority in sanitary matters.

Mr. Charles A. Allen is the engineer of the city of Worcester, Mass. He was sent to Europe by the city in 1884, and examined the various systems of sewage disposal there, and the precipitating works at Worcester were erected under his direction. His report, published in 1887, bears abundant evidence of the thoroughness and intelligence of his investigations.

In undertaking an investigation in what was, to the writer, a new and untrodden field, he was necessarily dependent upon living authorities for a great deal of information, and he wishes to express in the most unqualified manner his obligations to Capt. W. L. Marshall, S. G. Artingstall, former engineer of the Drainage Board, and L. H. Clark, city engineer of Chicago, and to Charles A. Allen, city engineer of Worcester, Mass., and to Edgar Williams, who was employed by the Drainage Board while Mr. Cooley was chief engineer, and who alone, of the assistant engineers, remained faithful to his employers after the discharge of Mr. Cooley.

It is not too much to say that to the assistance of these gentlemen, always courteously rendered, the following discussion owes very much of whatever value it may possess.

Messrs. Greeley, Carlson & Co., and many others rendered welcome aid; it was understood by all that the matter was one of public interest, and they seemed anxious to further the inquiry.

Some readers may find the extracts tedious. They must remember that the writer has no pretensions to speak with authority, and he can only quote the words of those who are conceded to have such pretensions. The dispatches from Ottawa, Peoria, and elsewhere, which are copied at length, as to the effects of the floods of May and June, 1892, are the testimonies of living witnesses, and are certainly more satisfactory than the summary of their contents could be.

The liability of the city of Chicago for such damages as are there described, is one of the most serious objections to the Drainage Act, and those dispatches should be read carefully, even though it be a "twice told tale." The accounts of floods down the river will be more interesting to Chicago people, when they shall have to pay the damages.

The idea that it should all be charged to the drainage works seems ridiculous, but they will be a contributing factor, and it will be for a jury to decide whether Chicago is liable or not.

In this connection it may be said, that while the treatise may appear too lengthy, there seems no place where it could be materially abbreviated. One of the longest topics, that of the efforts made by the old Drainage Board to carry out the law, was necessary on account of the unjust clamor against them, and to put the record of Mr. Cooley clearly before the public.

Not a little of the descriptive matter, as of Chicago River, etc., is a re-statement of what is generally known, but in the first place it was necessary to state these matters in order to give a complete presentation of the subject; and

Secondly, in the rapid growth of the city there is a continual influx of those to whom these matters are not familiar; and

Further, it must be remembered that it is much harder to undo the work done, much harder to repeal the law, than it would be to discuss the subject as an open question.

Time and again it has been said to the writer by members of the Legislature from Chicago, who voted for the Drainage Act, that it was the best that could be done in the Legislature. This can not be true. In the first place, the men who said this wanted nothing different. They were satisfied that a great water-way was a glorious thing, when, in fact, they knew nothing about it, and those members who were on the commission of 1887 took no steps to inform themselves about anything connected with the drainage of Chicago. It can not be true, because it is not the

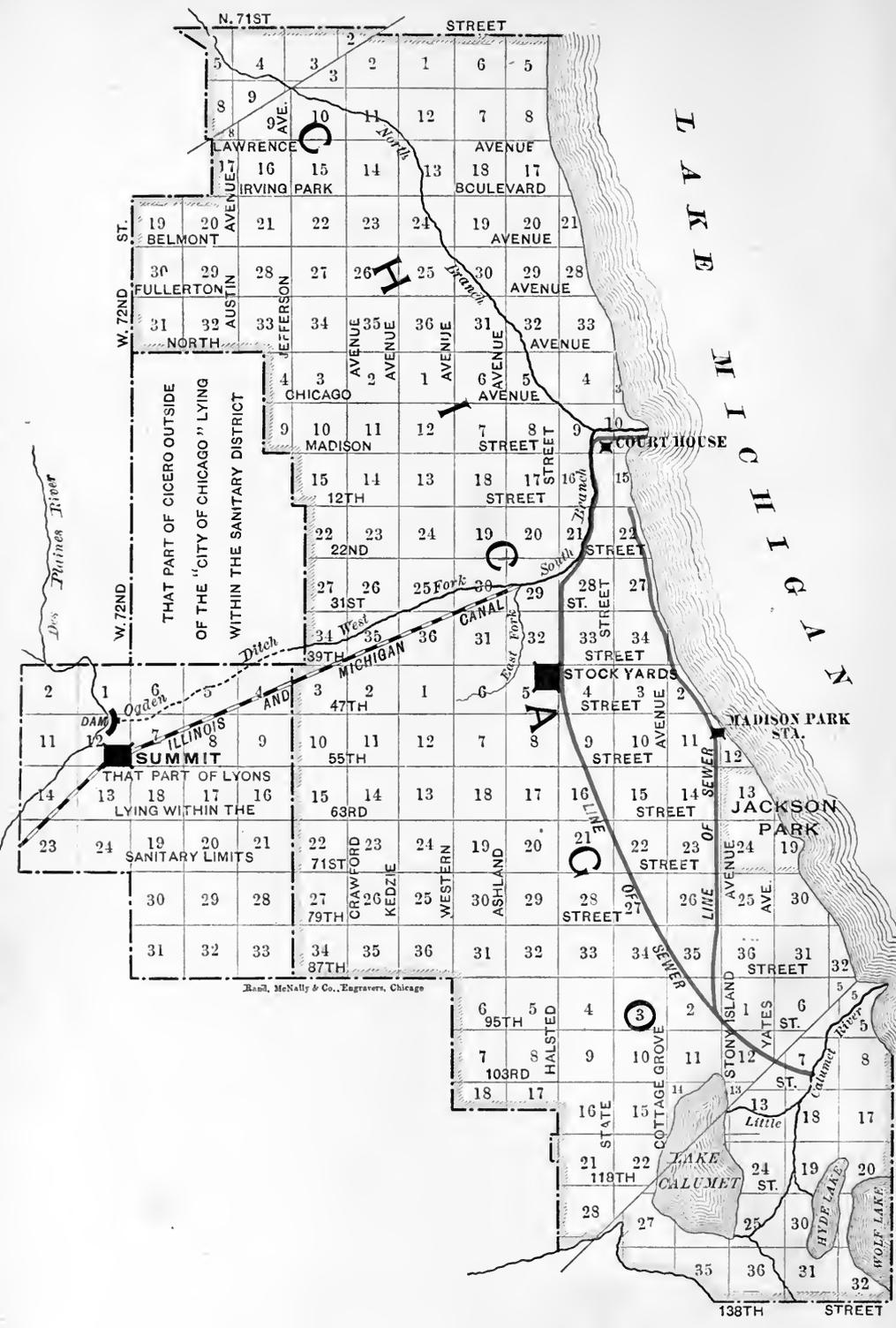
best thing; and it may be confidently assumed that the people of the State of Illinois would have been glad to do for Chicago the very best thing that could have been done. It is not true that the prejudices or grasping desires of the people down the river will be allowed to control the action of the State. The people of the State of Illinois recognize the fact that Chicago is not made up of millionaires, and that its population of one million three hundred thousand souls, is, in the main, a hard-working, active, energetic people; and that, if Chicago has grown beyond any other city in the world, it is due to the energy, comprehension, and good judgment of those who conduct its great commercial and manufacturing interests.

The people of Illinois are proud of Chicago—proud of its past, proud of its present, proud of its future, in which, at no remote date, they expect to see not the second, but the first city, of our great Republic. They will treat the sanitary wants of the city in a broad, generous, and comprehensive manner, and if it is shown that the Drainage Act threatens to impose unnecessary and grievous burdens upon its people, they will rejoice in the opportunity of making the necessary changes in its provisions.

In the following pages an effort has been made to point out the errors in the law as a Drainage Law, as even a law for the creation of a water-way, and to outline a system which will accomplish all that can be desired, at one-fourth to one-tenth the expense which the present Drainage Act will require. It may safely be affirmed, that the drainage question can be disposed of by the city of Chicago for less than \$4,000,000, and within one year from the time when the necessary financial legislation shall have been perfected. As matters now stand, however, it is not to be expected that the people of the State will take the initiative. Chicago must speak first in a matter vastly more important than the holding of national conventions, than presidential elections, than Columbian Expositions. It is needful that the people speak out, and in no uncertain tones. Let it go forth that no man can go to the Legislature who is not only pledged, but who is heart and soul devoted, to the repeal of the Drainage Act, and the work will be done.

If the views of the writer are correct, as expressed in the following pages, it will be done—these views must stand or fall on their own merits.

Chicago August, 1892.



Rand, McNally & Co., Engravers, Chicago

The Drainage and Water Supply of Chicago.

Nothing need be said as to the vital importance, or of the pressing necessity, that some rational system shall be devised to remedy existing evils, both as to the water supply and drainage of the city. There are probably those who will declare that it is only necessary to carry out laws now upon the statute book, in order that the city may secure these results to the fullest extent, and in the best possible way, but if there are such, there are very many others who believe that the Drainage Act of 1889 can not be executed; that it would not answer the purpose even if executed, and that its execution, even if possible, would impose a grievous burden of taxation, and one wholly unnecessary. It is now six years since the first attempt was made to solve the question. The Common Council of the City of Chicago in January, 1886, authorized the Mayor to employ competent engineers, at the expense of thirty thousand (\$30,000) dollars, to solve the question. Sixty-five thousand (\$65,000) dollars was spent by the city, and nearly five hundred thousand (\$500,000) dollars has been spent by the Drainage Commissioners, and practically we are no nearer a result, nor have we much more knowledge than we had in 1890, when Capt. Marshall, who surveyed the route under the orders of the Secretary of War, made his report.

It is proposed, in the following pages, to make a plain statement of the situation, and offer some suggestions as to the remedy. To this end, it will be well enough to first outline the various factors which enter into the question.

BOUNDARIES OF THE CITY.

The lines on all sides are irregular, but it is correct enough for all practical purposes, to say that the north line of the city is about $7\frac{1}{2}$ miles north of the court house, the south line is about $16\frac{1}{2}$ miles from the court house, and the west line is about 7

miles west of the court house, and that these boundaries comprise an area of 180 square miles of territory.

The population of the city, by the census of 1890, was 1,099,850, and may now be estimated at 1,300,000. The boundaries of the city and of the drainage district, as established under the law, are substantially the same.

THE WATER SUPPLY AND ITS CONTAMINATION.

As is well known, the water supply is taken from Lake Michigan. It is inexhaustible in quantity, and of the best quality, provided it is not contaminated by the sewage of the city. There is a general notion that the lake is polluted by water flowing out of Chicago River—this is true only in time of flood; ordinarily there is a slight current from the lake into the river. That the causes of contamination of the lake may be understood, it is necessary to explain the existing system of sewers. Briefly, it is as follows: The sewage from all that portion of the city bounded north by Congress Street, south by Sixty-seventh Street (about the south line of Jackson Park), and west by Clark Street, is discharged into the lake through trunk sewers located, one at Twelfth Street, one at Twenty-second Street, one at Thirty-fifth Street, and two or more in Hyde Park. The sewage from the east half of the town of Lake View also empties into the lake. The sewage from the remainder of the city is discharged into the various branches, or into the main stem of the river. There were at the close of the year 1891 over 880 miles of sewers in the city, costing more than \$12,000,000.

Of the population of the city, about 300,000 live in districts, the sewage from which drains into the lake; about 950,000 live in the districts draining into the river, and there are supposed to be 50,000 living in localities having no sewer connection with either lake or river.

The intakes to the tunnels are so far from the outlets of the sewers emptying into the lake, that in ordinary weather their discharge has no material effect upon the water supply of the city; a portion of the output sinks to the bottom near their respective outlets, and the remainder is dissolved, and the impurities consumed by the oxygen of the pure water.

The great body of the sewage, as already stated, flows into the river; the current is very slight, and there are large deposits from this sewage upon the bottom of the river; dredging is con-

stantly going on to keep the channel open, and scows laden with the matter are towed out, and their contents dumped into the lake a few miles from the mouth of the river. From the report of the Commissioner of Public Works for 1891, it appears that more than 240,000 cubic yards of dredged material were taken from the river in 1891 by the city. The report for 1890 shows that about \$69,000 was expended for this purpose during that year. Large sums are also expended by private parties for the same purpose. It is said that other refuse is disposed of in the same way. The water along the shore of the lake is also contaminated by rubbish thrown into it along the banks. A violent wind arises, the output of the sewers, the deposits near their openings, and the filth deposited in the lake by scows, or along the shores as above stated, is churned up, and the lake for miles around is affected. This is the usual source of contamination to our water supply.

The Des Plaines River, having its source in Wisconsin, flows southerly and passes about two miles west of the upper end of the south fork. At that point, its level at low water is eight feet above low water level of the lake. The ground intervening between the Des Plaines River and the end of the south fork is low and swampy, a part of it so low as to be called Mud Lake.

Some years since, Messrs. William B. Ogden and John Wentworth opened a trench through the bank of the Des Plaines, and dug a ditch through the low lands to the west fork, the consequence of which was, that the waters of the Des Plaines were diverted, and carried down into Chicago River. Subsequently, the city erected a dam at this point, and restored the bank to its original height. There is, however, a depression in the bank at this point, and when swollen by the spring floods, or very heavy rains, the waters of the Des Plaines pour over this dam, and sweep down through the ditch into Chicago River, washing out into the lake the contents of the river and the various slips, with their accumulated deposits of sludge. What the condition of the lake is at such times need not be described.

A portion of this wash is probably deposited on the bottom of the lake, and contributes to make the water unfit to use when it is agitated by high winds. If the sewage deposits were all kept from the lake, the water would at such times be roily from the sand at the bottom of the lake, but that is clean and would speedily settle.

THE QUANTITY OF SEWAGE.

The quantity of sewage is necessarily limited to two sources, viz., the water pumped, and the rainfall. In the absence of measurements only a general estimate of the quantity of sewage is practicable. The quantity of water pumped is susceptible of a sufficiently close estimate, but the quantity which finds its way into the sewers is necessarily conjectural.

The quantity of water pumped during the year 1891, was more than sixty-three billions five hundred and fifty-one millions of gallons.

In figures.....	63,551,000,000 gallons.
Daily average for the city.....	174,000,000 “
Average per capita, daily, (population 1,300,000).....	134 “

This includes all the water used by the fire department, all used for manufacturing and building purposes, the supply of several thousand steam boilers, that used for street and lawn sprinkling, as well as that for domestic consumption.

A great deal of the water used by the fire department and in manufacturing finds its way eventually into the sewers, but it is fair to suppose that one-tenth of the average daily supply of water pumped and distributed through the mains, disappears by evaporation, from use at fires, from steam boilers, street and lawn sprinkling, building purposes, in domestic use, and water supplied to territory not sewered, and which does not reach the sewers.

Average daily supply (in gallons).....	174,000,000
One-tenth evaporated.....	17,000,000

Average daily sewage..... 157,000,000 gals.

With a population of 1,300,000, this would be a daily sewage per capita, of about 121 gallons.

With reference to the use of water in European cities, Mr. Herring, in his introduction to the work of Baumeister, writes as follows:

“It is asserted that the German practice in designing water-works is to allow forty gallons per head per day. In America

NOTE.—No one can form any estimate of the quantity of water pumped from reading the figures. The quantity of water will be better comprehended, perhaps, to say it is more than enough to fill a lake seven miles long, two miles wide, and twenty feet deep.

“the water consumption is much greater, and also varies in different cities, reaching in some cities more than three times that amount.”

Baumeister says, page 9:

“From tables prepared by Grahn and Thiem, it is certain that the consumption of water in German cities has a daily average for the year of from four to fifty-eight gallons per person—generally from $6\frac{4}{10}$ to thirty-seven gallons. The larger figures that are sometimes found, especially in America, are due to wasteful habits. In designing water-works, the present German practice is to allow forty gallons per day per person. In England, thirty-four gallons are taken as the basis, in designing water-carriage sewage systems.

“The system used in Berlin offers special advantages for the determination of the difference in water consumption among different classes of people. The sewage pumped from a thickly populated, but poor district, averaged, according to the 1887–88 report of the commission, $21\frac{4}{10}$ gallons per head per day; in districts with a larger street surface, and somewhat higher class of residents, $26\frac{4}{10}$ gallons per head per day; in manufacturing districts thirty-seven gallons; in the most fashionable districts, $44\frac{9}{10}$ gallons. The average of all the districts was a little over “twenty-six gallons.”

Baumeister gives a table at page 21, from which it appears that the average daily sewage in certain European cities is as follows:

16 English cities, not named,	6.36 cubic feet or about	51 gallons.
London.....	7.06 cubic feet or	56½ “
Berlin.....	3.53 “ “	28 “
Paris.....	5.30 “ “	42½ “

The daily average in Chicago for each person, we have seen, is 121 gallons.

THE RAINFALL.

The contribution from the rainfall in Chicago is a more uncertain quantity. The average annual rainfall in Chicago for the past twenty years has been about thirty-six inches. The average number of rainy days annually during that period, when something more than a trace of moisture existed, was 130. Divided by seasons, the annual average precipitation for spring and fall, each, has been something over nine inches, for summer over ten inches, and for winter over six inches. The quantity of rainfall

that finds its way into the sewers of a given area depends largely upon whether the rain is violent or slow and drizzling, upon the flatness of the surface, whether the ground is already soaked, and upon the proportion of water-proof surface, such as roofs, paved streets, sidewalks, etc., to the open ground.

Baumeister, page 17, says:

“According to Knauff, the maximum quantity of storm water “is from 50 to 70 per cent. from paved streets, and from 40 to 50 “per cent. from flat roofs.”

This estimate is made with reference to the size of the sewers necessary. From the fact that the percentage of water from paved streets is given as greater than that from flat roofs, it would seem that the computation is made from cities where the flow from streets is more rapid, on account of being at a greater declivity.

It goes without saying that the streets of Chicago are about as level as can be made. Further, it is only upon occasions of storms of unusual violence and duration that there will be any wash from macadamized streets, and the same may be said, though in a less degree, as to street wash from streets paved with blocks, either of wood or stone. Any one who will take the pains to observe, will see that a current along the gutters is a very unusual occurrence in Chicago. November 8 and 9, 1891, were very rainy days—1.6 inches of water fell, about one-half on each day—but the rain was steady and without violence, and there was little or no current in the gutters.

The total rainfall in Chicago from Sunday evening, May 1, to the morning of May 5, 1892, as observed at the signal office, was three inches. As is well known, the effect of those rains was to cause a great rise in the rivers of Northern Illinois. Mr. Frankensfeld, chief of the signal station in Chicago, had been requested to observe the effect of rain upon the gutters of paved streets, and he says that the fall of six-tenths of an inch in an hour and a half, on the evening of May 1st, produced but slight effect in the way of street wash—after the streets had been soaked, of course the water ran off. As has been stated, the average number of rainy days (including snow) per year, for the past twenty years, has been 130; the average rainfall, thirty-six inches; and the greatest amount, viz., ten inches, has fallen during the summer months, when storms are less frequent but more violent.

From the records of the signal station in Chicago, it appears

that there have been twenty-eight cases of excessive rainfall in Chicago within the past twenty years, occurring as follows:

January, none; February, none; March, one; April, none; May, four; June, eight; July, six; August, two; September, three; October, one; November, two; December, one.

This record does not include storms of long continuance which were not violent, but it is the violent storms which create the greater portion of the street wash. There are times when there is a great deal of water from roofs and streets entering the sewers, even overtaking them, especially in the closely built business portions of the city. It is doubtful whether storm water has any considerable effect, as a source of pollution, upon the sewage of the city. It appears from the record of the weather bureau in Chicago, that the average number of days in each year, for the past twenty years, when the rainfall exceeded one-fourth of an inch, was forty-two.

Upon the subject of storm waters, Mr. Crimp says, "It was found from the records of rainfall that there were only from fourteen to twenty one days in each year, on the average, when the daily fall exceeded a quarter of an inch, and in this connection Sir J. Bazalgette, in his testimony before the Royal Commission on Metropolitan (London) sewage discharge said, "if we can divert the sewage from the river in dry weather altogether, on all those days excepting the fourteen to twenty-one, according to the season (a very wet season has been thirty days), we shall sufficiently divert the sewage from the river to make it clear."

CHARACTER OF THE SEWAGE.

Mr. Benzette Williams, the present Chief Engineer of the Drainage Commission, in a carefully prepared paper read by him on May 5, 1891, before the Joint Committee of the Senate and House, in opposition to amending the Drainage Act, stated that "Chicago is the greatest filth-producer in the world." This is certainly an offensive form of statement. To have said that the output of the stock yards was a greater source of pollution than any industry carried on in any other city, would have been true and unobjectionable. As put by Mr. Williams, the statement is to the effect that the wash from the people of Chicago is dirtier than that of the people of any other city. By far the greater portion of the sewage of Chicago is household or domestic sewage, and

it is difficult to see how ordinary domestic sewage can vary in character, except in the matter in dilution. Household sewage must be substantially the same in all civilized nations, except as it is flushed with a greater or less quantity of water, and it can not be questioned that the household sewage of Chicago is diluted with nearly three times the quantity of clear water more than that of any European city. If the aggregate of the sewage is so heavily charged with filth, it must be from sources other than Chicago homes.

The ordinary sources of such other pollution are chemical works, sugar refineries, distilleries, breweries, tanneries, shoe factories, printing establishments, and street wash. These are called ordinary sources of pollution, because establishments much of the same general character are found in all large cities, and street wash is common to all, with probably a much less percentage in Chicago than elsewhere.

Mr. Williams produced an array of statistics as to chemical analyses of Chicago River water. It was scarcely necessary to analyze the waters of Chicago River in order to establish the fact that it is greatly polluted. In fact, the chemical argument had no rational deduction; it was thrown in as a sort of embellishment to the objector, to give him, for instance, the appearance of a man of great scientific knowledge.

There is doubtless an extraordinary source of pollution to the sewage of Chicago in the output of the packing houses, under which is included the kindred industries of fertilizing works, glue factories, etc., and the wash from the cattle pens; as also, it is said, there is a liberal contribution from the gas works.

The greatest source of pollution to the sewage of Chicago is undoubtedly from the stock yards. As indicating something of that contribution, it may be mentioned that during the year 1891 there were slaughtered there, more than 2,000,000 head of cattle, 5,500,000 of hogs, 1,500,000 of sheep, and 200,000 calves. With all the appliances for utilizing the blood, bones, etc., of this immense number of animals, it is obvious that the contribution to the sewage must be enormous. Added to this must be the wash from the yards—besides the number of animals killed there, one-half as many more were shipped alive, and the quantity of pollution from this source must be very great.

Aside from the output of the stock yards and the gas works,

Compliments of
GEN. JOHN C. SMITH,
65 Sibley St. Chicago.

SEWAGE FROM THE STOCK YARDS.

17

the sewage of Chicago is probably less corrupt than that of any European city.

I. Because it is fair to assume that in those older cities there are proportionately a greater number of chemical works and other industries, the wash from which affects the sewage, than in Chicago.

II. From the greater use of water the sewage is more diluted.

III. The street wash is probably much less in quantity.

Whether the output from the yards is, as has been estimated, a good third of the polluting element of the river, or, in the condition in which it reaches the west fork of the South Branch, it amounts to a good half, need not be determined. As will be seen further on, the sewage from the stock yards becomes putrid before it reaches the pumps at Bridgeport. It is well known that putrid sewage is not only more offensive, but it is less affected by the purifying influences of fresh air and fresh water than is fresh sewage.

As to the gas works, there is not now, and never was, any excuse for allowing this refuse to be turned into the river.

The disposition of the sewage from the stock yards will be considered in another connection.

A few words may not be out of place here as to some of the elements of sewage.

On page 21 of Baumeister is given a table of the analyses of the sewage of Berlin and eight other German cities, of Paris, of London, and of the average of sixteen other English cities. In some of these cities excrementitious matter does not enter the sewage, and it is with reference to this table that he says, at page 22, "The figures in the last column are of especial value, as proving the statement sometimes met with, that the actual effect of excrement in sewage is less than that determined on theoretical grounds. Both the English and Prussian government engineers have long held this view."

At page 112, he says, "The question as to whether sewage may be directly discharged into public water-courses, or must first be more or less purified, is still a matter of debate in both scientific and official circles. It has already been shown that the presence or absence of excrement does not materially affect the character of sewage. The actual presence of such matter does not produce the effect which theory apparently points out

“as probable. From a chemical point of view, the elements and products of disassociation of excrement (that is, of sewage where such matter is not allowed) are identical with those of the remaining organic substances in house and industrial sewage. Moreover, the quantity of sewage does not depend to any extent upon the method in which excrement is removed. Hence, regulations concerning the disposal of sewage should perhaps apply to all classes, and be based only on the proportions of nitrogen, chlorine, and other elements present.”

The River Pollution Commissioners of England say in their report, after a table of the analysis of the sewage of water-closet towns and midden towns (towns where excrement is gathered and deposited in pits), “These analytical numbers show a remarkable similarity of composition between the sewage of midden towns and that of water-closet towns. It seems hopeless therefore to anticipate any substantial reduction of sewage pollution by dealing with solid excrementitious matter only.”

It may be added that the principal discussion of this question in scientific circles has been as to whether complete sewage can ever be sufficiently diluted and purified so as to be available for drinking purposes or, as it is called, potable water. That question is not material to the present discussion. No one claims that the Des Plaines, below Joliet, or the Illinois River would be available, or is desired, for domestic use; except for the short distance between Lockport and Joliet Lake, they are sluggish streams, and the water turbid and heavily charged with organic matter, and would be so if no such place as Chicago existed.

CHICAGO RIVER.

To understand the sewage question, some little description of the river is necessary.

The main stem is about three-fourths of a mile in length, extending from the lake westward to the foot of East Lake Street, with an average width of about 300 feet. Thence, it branches nearly at right angles north and south. The North Branch has a course from the main stem generally west of due north, and is navigable for about five miles. At Fullerton Avenue, which is about four miles from Lake Street, the city has erected pumping works, with a capacity of about 13,000 cubic feet per minute, by which water is pumped from the lake through a conduit into the river. Sewers on both sides discharge into this branch of the river, from the fork at East Lake Street to about one mile above Fullerton Avenue.

The South Branch extends from the main stem, in a general course west of south, for a distance of about $4\frac{1}{4}$ miles, when it divides into what are generally known as the east and west forks; between the forks and the main stem at Lake Street, it varies in width from ninety-five feet at the Adams Street bridge, to 170 feet just above Lake Street, and in depth from eleven to fifteen feet.

It is navigable for the largest lake freight vessels up to the fork, though the depth of water is rarely sufficient to permit them to carry a load to their full capacity. It is crossed by seventeen bridges for city travel, and four railroad bridges, and, with three exceptions, all with stone piers in the center of the stream; it is lined with docks, elevators, and other large buildings; sewers open into it from both sides. There are thirteen slips extending at right angles, of an average length of 1,200 feet and width of 100 feet, and of sufficient depth for vessels, presumably about the same as that of the South Branch.

The canal pumping works are located on the west fork, about 300 feet beyond the point of junction with the east fork. The west fork is navigable for a distance of about two miles above

the pumping works, and, with water at a depth varying from four to six feet, extends some four miles further. Sewers discharge into it at various points for about three miles above the pumping works; its course for about one mile from the junction is nearly due west, when it bears off to the southwest. The east fork of the South Branch extends from the point of junction about due south one half a mile, where it divides again—the east fork and its branch is about one mile long. All the sewage from the stock yards enters the east fork, beside that from other sewers draining the town of Lake. Neither branch of the river has any living supply. Except in times of heavy rains, or the melting of large bodies of snow in its water-shed, or the overflow of the Des Plaines River, its only tributaries are the sewers emptying into it. The height of the water in all the branches depends upon the level of Lake Michigan. Under such circumstances, the water would become extremely filthy in a very short time were it not for artificial circulation; this is obtained for that portion of the North Branch between Fullerton Avenue and Lake Street, by the pumping works at Fullerton Avenue, the water from which creates a slight current toward the main stem, and keeps that portion of it below Fullerton Avenue in a tolerable condition.

The pumping works at Bridgeport throw into the canal an amount of water slightly in excess of the output from the North Branch and that from the sewers entering the South Branch. This excess is drawn up the main stem from the lake.

The sewage from the entire river is collected in the South Branch, and, as the current is very slow, probably not more than one-half mile in twenty-four hours, the sewage there collected becomes decomposed. Whatever current is produced up the South Branch is only between the main stem and the pumping works. The sewage which enters the east fork of the South Branch from the stock yards and the town of Lake, and that which enters the west fork above the pumping works, and that which enters the North Branch above the Fullerton Avenue pumping works, remains stagnant and in process of decomposition, except as it is moved along by the fresh sewage behind, and oozes into the artificial current made by the pumps.

THE ILLINOIS AND MICHIGAN CANAL.

The work had its inception in an Act of Congress, passed in 1822, by which the State was authorized to survey and mark out through the public lands a canal from the Illinois River to Lake Michigan.

In 1823 the Legislature of the State established a commission to make the survey.

In 1827 Congress gave a right of way 240 feet wide, and 284,000 acres of land to be sold and the proceeds applied to the building of the canal.

In 1836 the Legislature passed an act for the prosecution of the work. The canal was to be sixty feet wide at the surface, thirty-six feet wide at the bottom, and six feet deep, and ninety feet on each side of the canal.

The work was to be paid for from sale of the lands granted by Congress. Sales of land were slow, the work dragged, contractors were unpaid, and finally, in 1843, the work stopped. In that year the Legislature authorized the issue of canal bonds to the amount of \$1,600,000, to complete the work. They were to be a lien upon the canal lands and revenues, and the canal property was to be placed in the hands of three trustees, one to be appointed by the Governor of the State and two to be selected by the bondholders, who were to retain control of the property until the bonds were paid. This arrangement was carried out, work was recommenced in 1845, and the canal was completed so as to be put in operation in 1848, and remained in the hands of said trustees until 1871, when, the debt having been paid, the canal was turned over to the State.

The original plan of the canal was to cut deep enough from the South Branch through and past the summit, a distance of $26\frac{1}{2}$ miles, for a sufficient supply of water by natural flow from the lake. The means to do the work were not available, and the bottom of the canal, when put in operation in 1848, was nine feet above the level as originally established. Water was supplied by pumping works at Bridgeport, and by a feeder from Calumet River, across which a dam was built, and a portion of its waters turned into the canal.

In 1865 the State Legislature passed an act with a preamble substantially as follows:

WHEREAS, It is understood that the city of Chicago, in order to purify Chicago River by drawing water from Lake Michigan, will advance sufficient money to accomplish this desirable result, and whereas the original plan of the canal was to cut down the summit so as to draw a supply of water from Lake Michigan, which plan was abandoned in consequence of the inability of the State to procure the necessary funds, and whereas the Summit division of the canal was so changed as to require the principal supply of water to be obtained through the Calumet feeder, subject to serious contingencies, and by pumping with the hydraulic works at Bridgeport,

Be it Enacted, That the city of Chicago may enter into an arrangement with the Board of Canal Trustees, with a view to the speedy accomplishment of the work, etc., the expenditure not to be more than \$2,500,000. At the same session the State Legislature passed an act which authorized and required the Board of Public Works of the city of Chicago, with the approval of the City Council, to adopt and execute a plan "for cleaning the Chicago River and its branches, and keeping the same in a pure and healthy condition."

The said Board of Public Works was authorized to contract with the trustees of the Illinois & Michigan Canal for the widening and deepening of said canal, so as to take the water of Chicago River. The city was authorized to borrow \$2,000,000 to do the work, and to have a lien upon the canal tolls until the money was repaid. The canal trustees were authorized to make a contract in conformity with the terms of the act.

The dam across the Calumet, above mentioned, caused the flooding of large tracts of land in the State of Indiana, and this was probably one of the serious contingencies mentioned in the preamble above quoted. The Legislature in 1871 passed an act requiring the removal of this dam, which was done. It was expected that the enlargement of the canal would provide a channel through which, by the natural flow, the waters of the South Branch would be sufficiently purified, and the canal adequately supplied with water.

In pursuance of those acts, the city raised the money, and the channel of the canal was deepened eight feet, the work being completed in the spring of 1871, and the expectations founded upon the work were for a time realized.

The turning of the current through the South Branch into the canal carried with it, however, the greater part of the sewage of the city; sludge was deposited along the canal, the sides of the

canal sloughed off into the channel, and it was thus gradually contracted.

The city continued to grow with unexampled rapidity, the canal commissioners made inadequate efforts to keep the channel clear by dredging, the flow through the canal decreased, and the South Branch, in a few years, again became offensive.

Before leaving this topic, it is but just to say that the State, in view of the vast destruction of public property by the great fire of October 9, 1871, promptly and generously came to the aid of the city, and on the 20th of the same month passed an act, repaying the city for its expenditure to the amount of \$2,955,340.

As a matter of some interest in connection with the history of the canal, it is well enough to state that the entire cost of the work, including the money repaid to the city of Chicago, was \$9,513,021; of this amount, \$5,886,039 was realized from sales of land granted by Congress, and \$2,933,691 by tolls upon the canal, which for several years were very large. It has not, however, paid the expenses of maintenance and operation since 1879.

In view of the offensive character of the water flowing through the South Branch into the canal, the Legislature in 1881 passed certain joint resolutions to the effect that the Board of Canal Commissioners should open certain sluice-ways from Des Plaines to the canal near Summit, etc., at an expense not exceeding \$10,000, provided that the canal commissioners should first confer with the Mayor, or the proper authorities of the city of Chicago, and if said city should proceed without delay to cause a flow into the canal from the Chicago River sufficient to dilute and purify the waters, and thus remedy the evil complained of, said flow not to be more than 60,000 cubic feet per minute, including the ordinary flow into the canal from the Chicago River, or so much as in the judgment of said commissioners said canal could carry, and if this shall be accomplished by the first day of September, 1881, the commissioners should accept it in lieu of obtaining a supply of water from the other sources named. "Provided further, that said commissioners are hereby directed to take care of the 60,000 cubic feet per minute above contemplated, if so furnished by the city of Chicago."

In pursuance of those resolutions the city immediately undertook the construction of the pumping works at Bridgeport. A contract was made in August, 1881, to build the pumps; they were completed in 1885, and have ever since been in operation. They

cost over \$280,000, and the expense of their maintenance and operation for the past three years has been about \$70,000 annually.

The contract of the city called for a capacity of 60,000 cubic feet of water per minute; it is very doubtful whether they have averaged over 35,000 cubic feet per minute for any month since they were put in operation. Regarding the capacity of these pumps, it is proper to say that the city contracted with one of the largest and most substantial concerns in the country for their erection. The contract provided that there should be a continuous test of all the pumps for forty-eight hours against eight feet head of water, at a speed of 100 to 125 revolutions per minute.

On a test trial in April, 1885, they were found insufficient. The contractors endeavored to improve them, and in December, 1886, another test trial was made before a commission of which Benzette Williams was chairman. Instead of a continuous test of forty-eight hours of all the pumps, it was reported by Mr. Williams, after a test of eight hours, of two of the pumps, with the furnaces freshly cleaned before starting, that "the contract was complied with in every essential respect." That the pumps as constructed are not now, and never were, a compliance with the contract of the city is conceded on all hands, and the matter is not only of interest in itself, but as a commentary upon Mr. Williams' ideas of what constitutes an essential compliance with the terms of a contract.

There has been an abundance of crimination and recrimination on this matter of the pumping works at Bridgeport—the people down the river insisting that the city is derelict, and that if the required amount was pumped, the water flowing through the canal would not be so objectionable, while the city claims that in 1889 it proposed to put in another plant, and that the canal commissioners refused permission.

By the terms of the resolutions, the canal commissioners were required to provide for the passage of 60,000 cubic feet of water per minute. Whatever may have been the capacity of the canal in 1885, there is no doubt that it could not now permit a flow, at the rate mentioned, without a greater current in the canal than is permissible with its advantageous use as a means of water transit.

It is further claimed that the people down the river have been active in inciting the canal commissioners to this pernicious inactivity, to the end that Chicago should be forced into the construction of a great water-way as a means of relief. Whether

this latter claim is well founded or not, it is very certain that if the quantity of water required by the resolutions of the Legislature was pumped by the city, and disposed of by the canal commissioners, and the stock yards, gas works, and other large sources of pollution were required to dispose of their sewage in some other way, the water of the canal would be unobjectionable.

THE ACTION OF THE CITY OF CHICAGO.

It is apparent from the foregoing recital that the city has promptly endeavored to carry out the views of the Legislature. The deepening of the canal by the city relieved the State of the expense of maintaining pumping works at Bridgeport, and of the Calumet feeder, and disposed of any questions which might arise, if the dam was kept up. It is apparent, from the preamble to the Act of 1865, that the Legislature understood that the State was to be the gainer by the deepening of the canal. It was to have been expected that the flow from the South Branch would occasion more or less deposits in the canal, and it was clearly the duty of the canal commissioners to have kept the channel clear. They had the means to do it. The canal was out of debt, and the receipts from tolls alone, during the nine years 1871-79, exceeded the expenses by \$330,429, and there were, in addition to this, the receipts from rent of water power and sales of land.

It was the first duty of the canal commissioners to have kept up the plant; they did nothing of the kind, and the result was, that by 1881 the flow from Chicago River was so obstructed that its condition was as bad as it was before the canal was deepened.

As has been seen, the Legislature required the commissioners to put the canal in a condition to dispose of 60,000 cubic feet of water per minute, but whatever measures they took to that end were feeble and inefficient. The reports of the commissioners bewail the deposits from Chicago sewage in the bed of the canal, while at the same time they report the receipt of thousands of dollars annually as rents for the water power furnished by the water pumped into the canal by the city of Chicago, and despite, too, the fact that without the water flowing in the canal, by reason of the deepening of it by the city, and by pumping, the canal would not have been navigable.

That the pumps at Bridgeport are not in compliance with the

resolutions of the Legislature in 1881 was, at the outset, no fault of the city, and that no steps were taken to remedy the defect, other than the proposal of the city in 1889 to erect another pumping plant, which was vetoed by the canal commissioners, is due to the fact that from the rapid growth of the city it became obvious that measures of a more comprehensive character must be taken. The erection of a new plant would have given relief, and the city would cheerfully have submitted to the expense and undertaken the work, even as a temporary expedient, had it been permitted so to do.

The subject of the drainage of Chicago was actively discussed by the press and in the City Council, and finally in January, 1886, action was taken which resulted in the employment of Mr. Herring. Private citizens of Chicago took up the matter, and expended large sums of money, on their own account, for the purpose of obtaining information upon the subject of the drainage of the city, but both the city and private citizens placed the matter in the hands of those who were either captivated with the idea of a great water-way from Chicago to the Mississippi River, or were exploiting a "policy," and the interests of drainage were subordinated to these ends.

That a stupendous error was committed in the selection of the men to investigate the matter will probably become apparent as we proceed, but the point now insisted upon is, that ample means were provided, and diligent efforts were made, and in the best of faith, to the end that a system of drainage should be devised which would be adequate to the present and future needs of the city for a long period, and do away with complaints from people down the river; that those measures were ill-directed, that irritating delay has been occasioned, that hundreds of thousands of dollars have been expended uselessly, will appear hereafter, but this was the fault of individuals, and not the fault either of the city or of its people, except in so far as they are responsible for the acts of the man who happened to be mayor of the city.

THE HERRING REPORT.

As the Herring report is yet referred to by the advocates of a great water-way, and was the basis for the present Drainage Act, it is worth while to give it some attention.

The City Council, on the 27th of January, 1886, adopted certain resolutions with a preamble, by which the Mayor (Harrison) was authorized to appoint a commission, to consist of one engineer and one or two consulting engineers, to devise a system of drainage and of water supply for the city.

The character of the investigation to be made by the commission was fixed in the following language:

“ The duty of the Drainage and Water-supply Commission shall be to consider all plans relative to drainage and water supply which may be brought to its attention;

“ To make such examinations and investigations and surveys as may be deemed necessary.

“ To collect all information bearing on this problem.

“ To consider all recent developments in the matter of sewage disposal, and their application to our present and future needs.

“ To consider and meet the necessity of increasing our water supply, and of protecting the same from contamination.

“ To remedy our present inadequate methods of drainage and sewage disposal.

“ To consider the relations of any system proposed, to adjacent districts, and whether there may not be a union between the city and its suburbs to solve the great problem.

“ To determine the great question as to the interest which the State and the United States may have in the disposal of sewage by way of the Illinois River, and

“ To devise plans to meet any objections thereto, if such a system shall be thought best, and in general

“ To consider and report upon any and all things which relate to the matter of water supply and drainage of the city of Chicago.”

The commission were to report on the whole matter, fully, with plans and diagrams complete, with estimates of the first cost, and cost of maintenance, not later than January, 1887 (when the Legislature would be in session).

Ten thousand dollars a year was allowed as salary to the chief engineer, and consulting engineers were to be employed—all the expenses not to exceed \$30,000.

Mr. Herring was employed, and entered upon duty March 28th; Mr. Benzette Williams as consulting engineer on September 17th, and Mr. Artingstall, December 21st, 1886—the latter was then city engineer, and his connection with the matter was only nominal.

Mr. L. E. Cooley was the principal assistant, beside whom there were four other engineers, among whom was Mr. Ossian Guthrie.

In January, 1887, Mr. Herring made a preliminary report, which was submitted to the Council by Mayor Harrison with a message, in which he said that he had been in constant consultation with the chief of the commission during the progress of the investigations, and he then proceeded to laud the glories of a ship canal in the most extravagant fashion.

With a mayor holding such opinions for an employer, Ben-zette Williams for counselor, and L. E. Cooley and Ossian Guthrie for assistants, what could have been expected? Why, that there would be a water-way report, or that Mr. Herring would resign. He did not resign. The report proper consists of thirty-four pages in large type, and padded with open spaces; the entire matter is less than three columns of an ordinary newspaper. Three pages are devoted to a settlement of the questions involved, which he gravely sums up on page 14 as follows: "The problem therefore demands the attainment of two ends—the protection of the water supply and the removal of the river nuisance;" and further, on the same page, he says, "Among the possible methods of getting rid of the Chicago sewage, there are but three that have been deemed worthy of an extended consideration, namely—a discharge into Lake Michigan, a disposal upon land, and a discharge into the Des Plaines River."

As a summary of the methods of disposing of the sewage, it is noticeable that he omits any mention whatever of disposing of it by precipitation, either wholly or in part. He omits any mention of what the present canal can do without objection, and he gaily skips forty miles, to the Des Plaines at Joliet.

Two and a half pages are devoted to our present sewer system, four pages are devoted to speculations upon the population, present and future, of Chicago, and about three and a half pages are consumed in discussing the question as to disposing of the sewage on land, but he finally concludes that this would cost too much, and is therefore impracticable. He makes no mention of the fatal obstacle of the climate, which would have enabled him to dispose of the question in half a page.

And now we come to the water-way part of the report. This

occupies pages 28 to 37, and is a jumble of all sorts of odds and ends, but there is nowhere a clear, definite plan outlined.

He would have the waters of both branches of the Calumet turned into Wolf Lake. What the waters of the Calumet have to do with draining Chicago River is not explained; he had already declared that the questions involved were—to keep the water supply pure, and abate the river nuisance.

He would have a channel from the Des Plaines to the lake, somewhere north of the city, to carry off the flood waters of the Des Plaines, so that they would not come down through the Ogden ditch into the river.

He assures us that he has gauged the Des Plaines, the Calumet, the North Branch, and the rainfall; surveyed the water sheds; examined the river channels, and reconnoitered all the country around the Des Plaines, the North Branch, the Calumet River, and Salt Creek, and, after all this, “the information upon which definitely to decide this question will be given in our final report.”

In the name of the Prophet—figs!

At page 31 he says, “For the purpose of estimating the cost of the water channel, we have assumed 3,600 feet for the cross section, and a velocity of the water three feet per second, or two miles per hour.” (By cross section is meant the area of the width multiplied by the depth. A channel 200 feet wide and 18 feet deep, filled with water, would have a cross section of 3,600 feet.)

Upon the vital question of cost, he says, on page 34, “A channel from the south fork to Joliet, of the capacity heretofore given, will cost between \$17,000,000 and \$21,000,000.”

There is not a syllable as to the supply of water for this canal. No mention is made as to how much water the South Branch can supply.

There is no mention as to what was to be done with the water at Joliet.

Not a figure is given as to the number of yards of earth and rock excavation.

Not a word as to the millions of dollars which the right of way would cost.

Nothing is said as to the effect of the volume of water upon the hundreds of thousands of acres of bottom lands of the Illinois River Valley, which would be flooded. Lake Michigan is

seventy-six feet above the level of the Des Plaines at Joliet Lake, and that fall is mostly between Lockport and Joliet Lake (a broadening of the Des Plaines three miles below Joliet), and he says not a word as to whether 600,000 cubic feet of water per minute are to be turned, a roaring torrent, down that incline, or are to be let down with locks; and if with locks, not a word as to that large item of expense.

Nothing is said about the millions of dollars that it would cost to supply the water for such a canal.

He finds it practicable to build a water-way to Joliet, because there is the low ground along the Ogden ditch, and a "depression" at the Sag; but he has not a word about the millions of cubic yards of rock cut between Willow Springs and Joliet.

That such things as bridges over a water-way 200 feet wide would be required, and would have to be paid for by those who made them necessary, does not seem to have been thought of.

It is a grave matter to charge that these omissions were intentional, but how any engineer of moderate capacity could overlook all these elements is inconceivable. By the resolutions of the City Council of Chicago, the sum of \$30,000 was appropriated for the survey, and a full report was to be made, including the plans, route, cost, etc. The writer has been informed, upon the most undoubted authority, that it was openly avowed by some of the men conducting the investigation, that the city of Chicago was paying the bills, and that when the \$30,000 was gone there would be more from the same source.

Mr. Cooley, who was Mr. Herring's chief assistant engineer, and who is now a drainage commissioner, is authority for the statement that the Herring Commission cost \$65,000. The city was evidently a good cow to milk.

The whole energy of the movement was to commit the city of Chicago to a visionary scheme of a water-way, to which drainage was an incident, and it looks as though the cost of the undertaking was intentionally and studiously concealed.

It is sheer nonsense to say, in excuse, that this was merely a preliminary report. Mr. Herring knew that a full report, with plans and estimates, was to be forthcoming by January, 1887. He had five engineers associated with him, and could have had more if necessary. Salt Creek and Calumet River were unimportant features in his work. He is proposing a grand scheme,

and yet in nine months time he can give but a meager, and that erroneous, outline.

In the spring of 1891, the writer met Mr. Herring in the office of Mr. Benzette Williams, in Chicago. The subject of a water-way, as provided for by the present Drainage Act, was under discussion, and the writer complained that so little was made known as to the cost of the work, before people voted on the adoption of the law. Mr. Williams replied, "Perhaps that was not policy." "Not policy!" Not policy for whom? Not policy for the taxpayers of Chicago to know what they were voting for, or not policy for water-way enthusiasts, who would have the city of Chicago committed to an undertaking of which it knew neither the nature or extent?

No further report was ever made by that commission. It lingered along until April or May, 1887, the members drawing their pay regularly, until discharged at that time. The Herring report is a thing of the past. It has been succeeded by others, and is only now made the subject of observation because it is a part of the history of Chicago drainage; because if it had been what it ought to have been, the Drainage Act of 1889 would never have been adopted, and because it is still quoted in opposition to attempts to amend that act.

THE COMMISSION OF 1887.

At the session of the Legislature in 1887, two or more bills were introduced. One, known as the Hurd-Winston bill, in the line of a water-way, was pushed forward, and was thought likely to pass, but the rivermen secured an amendment which led to its abandonment.

No legislation, or at least none of any value, was obtained, but finally, on motion of Mr. Riley, a member from Joliet, a resolution was adopted that a commission be appointed, consisting of four members of the Legislature and the Mayor of Chicago, "to examine and report to the next session of the Legislature, "upon the subject of the drainage of Chicago and its suburbs." The reader will please note the words, it was the *drainage* of Chicago they were to investigate and report upon.

Here again, the water-way crowd made their mark. The commission as appointed, consisted of Riley of Joliet, Bell of Peoria, and Eckhart and McMillan of Chicago—all of them in favor of a great water-way. Mr. Roche was mayor, and he too was a water-way man. The commission made no report of any description to the Legislature upon the subject committed to them, but presented the Drainage Act, substantially as it was passed, and now stands on our statute books.

In response to an inquiry by the writer as to whether the commission made any examination of the subject of drainage, one of the Chicago members, after a pause, replied, that they "attended a meeting at Peoria."

This was held on the 11th and 12th of October, 1887, and was a meeting of people from four or five States, in favor of water-ways "and an appropriation." It was controlled by the people of the Illinois River Valley, and was unanimous that every exertion must be put forth to secure a great water-way between Chicago and the Gulf of Mexico.

The members of the commission also thought it desirable to call a meeting of people, from towns down the river, to discuss the provisions of a bill to be introduced into the Legislature at

the coming session, and accordingly such a meeting was held at the Council Chamber in the City Hall of Chicago on December 4, 1888.

Mr. E. Sanford, a lawyer at Morris, was one of those present, and took part in the discussion, and afterward, in the spring of 1891, was selected by the city of Morris to resist the proposed amendments to the Drainage Act, and prepared a pamphlet for that purpose, from which is quoted, as to the proceedings of the meeting at the city hall.

He says that Mayor Roche presided, and stated that "the primary object of this bill will be to construct a water-way down to the Mississippi, and the citizens of Chicago want the sewage question disposed of at the same time." Mr. Sanford says further, that Mayor Roche, in answer to the inquiry, "Is not the real question of this conference, Chicago sewage?" replied, that "this committee was appointed to consider the water-way, and then to see if it was advisable to use it for sewage."

The language of the resolution by which the commission was created, as it is found in the session laws of 1887, has been quoted above. To re-read the published proceedings of that meeting, in the light of what has since transpired, it would seem that the so-called commission, having prepared the present Drainage Act, it was deemed a stroke of policy to have a meeting in Chicago, where the people from down the river should air their obstreperousness, as a means of cutting off any opposition to the bill in Chicago.

The fact was, that neither the commission created by the Legislature, nor the city itself, under the leadership of Mayor Roche, took any steps to acquire any more definite information, either as to the drainage of Chicago, or as to the cost and practicability of this water-way scheme, than was known in January, 1887.

Incapable of examining the matter, or indifferent to the momentous questions committed to them, and possessed of vapory notions as to the value of a great water channel between Chicago and the Mississippi River, and withal, terrorized by the bluster of the river people, they not only advocated the construction of a work of which they had but a feeble conception, but submitted to have it loaded with requirements the most illogical and unfair.

Attention will now be called to some of the provisions of the Drainage Act.

THE DRAINAGE ACT OF 1889.

It is understood that the present law, substantially in the form in which it appears on our statute book, was prepared by and under the direction of Riley of Joliet, Harvey B. Hurd, a lawyer of Evanston, L. E. Cooley of Evanston, and Benzette Williams of Western Springs, a hamlet on Salt Creek in the western part of Cook County—four gentlemen, neither of whom reside in Chicago, nor within the drainage district, and three of whom, viz., Messrs. Riley, Cooley, and Williams, are not taxpayers in the drainage district. Probably the then mayor (Roche) and other advocates of a water-way were advised with, but it does not appear that any men having regard to the sanitary interests of Chicago or the welfare of the taxpayers, as matters first to be considered, had anything to do with framing the law. The act was passed solely as a measure for the construction of a water-way, and if Chicago was to get any benefit from it as a means for disposing of its sewage, that was only incidental.

The act was to be submitted to the people for adoption. It was approved by the then mayor (Mr. Roche), who was said to have some knowledge of engineering; by the Citizens' Association, which was composed of public-spirited men who claimed to have given attention to the matter, and were supposed to be acting intelligently, and it was enthusiastically supported by the daily press of Chicago, with possibly one exception; it was declared to be the only solution of the drainage question, and that, as such, it was full and complete. Its practical operation was not understood, and it was adopted with a comparatively small dissenting vote. It was tested by legal proceedings, and the case carried to the Supreme Court of the State, but it was held valid, and proceedings were taken to carry out its provisions. The law has been published repeatedly, and can be found among the session laws of 1889, but attention will be directed to some of its more important provisions.

NINE DRAINAGE TRUSTEES.

SECTION 3. This section provides for nine trustees to constitute the Drainage Board. The act was passed before the towns

of Hyde Park and Lake and the city of Lake View were annexed to Chicago. It was expected that they, and, if Hurd and Cooley could manage it, Evanston, also, would become part of the drainage district, and they could not at that time properly be subjected to the control of the city of Chicago, which was principally interested in the matter, as a means of drainage. The device of nine trustees for the entire district was therefore adopted. Since the passage of the act, nearly all the territory affected by its provisions, and all the territory identified with the city of Chicago in the matter of drainage, has been annexed to the city, and there is now no reason why the city should not direct and control its drainage affairs as well as any other.

It is true that small portions of the towns of Lyons and Cicero are within the limits of the drainage district as at present established, and are not within the city limits, but these exceptions could be easily disposed of.

THE DRAINAGE BOARD SHOULD BE ABOLISHED.

In the first place, it is without a head. By Section 4 they are authorized to elect a president, but he has not, by the law, any executive powers conferred upon him—he is simply the presiding officer at meetings of the board. As to his powers, they are the same as those of the other members—no more, no less. Nothing can be done without the authority of a majority of the board. The natural outcome of such a condition of things is, that there is no individual responsibility; cabals are formed to get control of a majority; movements are planned, and carried through without discussion, by the strength of a majority vote. It has been publicly stated, and the charge published, that the minority have not, in all cases, had free access to the documents belonging to the board.

Second. It is a secret institution. Here is a corporation having the power to tax the people of Chicago \$1,000,000 annually, and issue bonds to the amount of \$15,000,000, and engage in an undertaking involving the expenditure of an amount of money of which they can not, or will not, give an estimate, and to subject the city to millions of dollars of liabilities annually, and there are no public discussions as to plans and projects.

Third. It is an extravagant board. On the 19th of December, 1891, the clerk and acting secretary of the board certified

that its expenses, up to December 8th previous, had been \$334,659.77, and since that time, to and including August 1, 1892, they have expended \$153,567.51, making a total of \$488,227.28.

This money is paid by the same people who paid \$65,000 for the Herring Commission, and makes an aggregate of over \$550,000, and about all that has been realized from this outlay, is some incomplete engineering. Whatever may be said of the City Council of Chicago, its proceedings are open, and all important measures are discussed; its members are keenly alive to the necessity of economy and prudence. The Drainage Board should be abolished, and whatever powers are necessary be conferred on the city government; it may be that an amendment to the Constitution would be necessary, but our recent experience with the \$5,000,000 World's Fair fund indicates that this is no material obstacle.

THE CANAL MUST NOT BE USED.

SECTION 17. This section provides that no portion of the canal outside of Cook County shall be used. Why this provision was inserted must be left to conjecture. Here is a strip of land extending from Chicago River to Joliet, 240 feet wide, with a canal already dug, sixty feet wide, and yet only the portion within the limits of Cook County can be used. This canal is public property—belongs to the State—and, practically, as we have seen, did not cost the State anything; it will be of no possible use after the proposed water-way is built. It is not to be supposed that the city will continue the use of the pumps at Bridgeport after the proposed canal is built, and without an artificial supply it would not have two feet of water in it. It does not pay expenses now, with water furnished by the city; the State will never supply it, and it will be so much waste land. Why then should it not be used for the proposed water-way? And why limit its use to that portion within the limits of Cook County? If any part of it could be used, what reason was there for making a distinction between that in Cook County and that beyond its limits? The people of Joliet and down the river were professing only an interest in a sufficient flow of water from Lake Michigan to do away with the objections to the sewage of Chicago, and, as it was immaterial through what channel the water flowed, this provision could not have been material to them:

In the light of \$65,000 spent for engineering by the city for the Herring Commission, of which Cooley and Benzette Williams were the principal members, and of the fact that in all, something over \$550,000 has been expended, and, of this large sum, all which has not been expended for engineering has simply been as an adjunct to it, this restriction would seem to have been inserted for the purpose of necessitating a vast amount of so-called engineering work. That it was a pretty successful piece of engineering of itself is apparent, when we find that Cooley was immediately elected chief engineer, at a salary of \$6,000 per annum; that Benzette Williams is now chief engineer at a salary of \$9,000 per annum; that Cooley is now a drainage commissioner at a salary of \$3,000 per annum, and that the Drainage Commission, on the 17th of February, 1892, provided for an unlimited number of assistants at from \$2,400 to \$3,600 per year.

SUITS TO BE BROUGHT IN PREJUDICED LOCALITIES.

SECTION 19. This section provides that the drainage district shall be liable for all damages occasioned by flooding, and suit may be brought in the county where the property is situated. As to the bringing of suits where the property is located, in theory this would seem fair enough, but the practical result will be, that all questions as to damages for flowing, and the amount of such damage, will be submitted to juries naturally biased in favor of their neighbors, and with no particular friendship for the great city of Chicago. That these feelings will have a powerful influence upon their verdicts, no one familiar with jury trials can for a moment doubt. The great additional flow of water proposed by the Drainage Act is to be emptied into the Des Plaines at Joliet. About ten miles below Joliet, the Des Plaines and Kankakee rivers unite, forming the Illinois River, which extends in a southwesterly direction to the Mississippi River, a distance of about 265 miles. The current is very sluggish, and for a great portion of its course it is bordered with low bottom lands.

The effect of 300,000 cubic feet of water per minute added to its contents must be very great, and it is easy enough to foresee that in cases of damage for overflowing, witnesses and juries would be swift to attribute all possible damage to the water from the drainage district.

UNNECESSARY AMOUNT OF WATER REQUIRED.

SECTIONS 20 and 23. As these sections both relate to the quantity of water to flow through the channel, they may be considered together, so far as that question is concerned. The channel when first opened must be large enough to produce a flow of 300,000 cubic feet of water per minute.* This is at the rate of 200 cubic feet per minute for each 1,000 of 1,500,000 people, and when the population of the city exceeds that number the canal must be enlarged so as to keep up that proportion. That is, when the city reaches a population of 2,000,000, provision must be made for a flow of 400,000 cubic feet of water per minute. This is at the rate of 2,304 gallons of water every twenty-four hours for every man, woman, and child in the drainage district. We have seen that the sewage supply daily of each man, woman, and child is 121 gallons, so that the requirement of the law is, that for every gallon of sewage there shall be more than nineteen gallons of fresh water added. To take a practical view of the matter at a closer range, and a view which very many will understand from experience, let us take the case of a family of five, composed of a man, wife, two children, and one servant, and instead of a water supply by turning a faucet, let it be supposed that it is brought from a well and cistern.

A liberal estimate of the daily slop would be:

- 1 pail chamber.
- 6 " kitchen.
- 3 " face and hand washing.
- 3 " daily, or 21 per week, for bathing.
- 5 " daily, or 35 per week, for clothes washing.

18 pails, of $2\frac{1}{2}$ gallons each, make a daily average of 45 gallons.

The daily consumption of water per capita, in Chicago, is shown to be 121 gallons, or, for a family of five, 605 gallons, which is about thirteen times the quantity of actual sewage as estimated above; and the requirement of the law is that this daily sewage of 605 gallons must be increased nineteen times, before it can be allowed to start on a journey of forty miles to Joliet.

The principal discussions of the dilution of the sewage have been by European writers, and are based upon the use of from

* A cubic foot of water is about eight gallons.

one-fourth to one-third the water used in Chicago. If any one will reflect a moment, it will be apparent that, taking an average family of five, and allowing the household wash and waste from that family to be diluted so that the flow into the sewage is over 600 gallons daily, it is simply preposterous to say that it must have nineteen times that amount of water added to it in order that it shall be inoffensive at a distance of forty miles.

The practical result of that requirement is, that taking the actual daily sewage of a family of five, with water drawn from well and cistern, as averaging forty-five gallons daily, for the entire family, this forty-five gallons must be increased to 11,520 gallons, or water enough to fill an ordinary freight car to the top, before it can be allowed to enter the great water-way.

The great quantity of fresh water required by the Drainage Act was an arbitrary requirement, not sanctioned by any concurrence of respectable authority, is palpably unnecessary, and was done in the interest of a great water-way rather than in that of the sewage question.

SEWAGE MAY NOT BE ALLOWED IN THE CANAL.

SECTION 22. This section provides that this act shall not be construed as a contract on the part of the State with any sanitary district formed under its provisions, and new requirements may be imposed, or the act repealed altogether. This provision was doubtless inserted by the river valley people, in view of the fact that they have been consulting lawyers as to enjoining the city from pumping, or allowing, a flow of water into the present canal, and the lawyers find themselves confronted with certain obligations on the part of the State, arising out of the legislation of 1865 and 1881, above mentioned. To cut off all questions of that kind, it is provided, in substance, that the city may go on and build a great water-way, and take its chances as to being allowed to use it as a means of disposing of its sewage. If the declaration of John A. Roche, at the meeting at the city hall in December, 1887, above referred to, is correctly stated by Mr. Sanford, and if that statement has any binding force by reason of the fact that he was not only mayor of Chicago but a member of the commission of 1887, it would seem as though the city would have small reason to complain if its sewage was excluded from the canal.

THE USELESS ROCK-CUT.

SECTION 23 again. It is further provided in this section, that while in no case shall the channel be less than fourteen feet deep, when through rock-cut it shall be of the depth of eighteen feet, and 160 feet wide. Before that clause in the law was inserted, and before its adoption by the people, the length of the rock-cutting should have been made known. The Herring report was silent on the subject, and, in fact, the length of the rock-cut has never been stated in any of the reports of the various engineers of the Drainage Commission. Various routes for the canal have been advised by the different engineers of the Drainage Board, except Mr. Cooley, who, while engineer, never advised anything, but remained "at large"; the length of the rock-cutting may vary some few hundred feet, depending on the route adopted, but it is about 16½ miles.

This additional depth of the rock-cut will require the excavation of over 2,000,000 cubic yards of stone, or stone enough to fill a strip of Lake Michigan the whole length of the Lake Front from Park Row to Randolph Street, and twice as wide as the present Lake Front grounds—a strip 6,000 feet long, 800 feet wide, and 11½ feet deep. This enormous quantity of stone is to be excavated, not for a channel for 300,000 cubic feet of water per minute, but for a channel of 600,000 cubic feet of water per minute, which is to be flowing through it in the hopeless future, when the United States Government will pay for the damages of flooding additional hundreds of thousands of acres of lands on the Illinois River Valley, caused by pouring that quantity of water into the Illinois River. It is no part of the drainage system; it is that much more than is necessary for a flow of 300,000 cubic feet per minute, and belongs to the nebulous idea of a great water-way. It is a burden imposed upon Chicago by the exactions of the people of the valley, conjointly with the folly and incapacity of those who undertook to represent the city, if indeed baser motives of personal "policy" had no part in the matter.

The pretense under which this provision was made, for a rock-cut so much deeper than the other part of the canal, was that in case the General Government should embark in the enterprise above indicated, then—the water being in the canal—rock excavations to enlarge it could not then be made, and therefore that the rock-cut must be made in the first instance.

This claim is shown to be without foundation. Mr. Artingstall, a former engineer of the Drainage Commission, has reported that the rock can be excavated cheaper under water than above. It is true that Mr. Cooley says that he disagrees with Mr. Artingstall, but the latter has a reputation for ability, sobriety of judgment, and perfect plain dealing, and under those circumstances it is needless to discuss the relative value of their opinions.

Whether the rock can be excavated after the water is let into the canal cheaper than before—that is to say, whether wet-cut is cheaper than dry-cut—is immaterial; it is enough to know that the question of the relative cost is a matter of controversy. There can not be, under such circumstances, a very great difference, and the excavation by wet-cut is admitted to be entirely practicable.

To go ahead and expend at least \$3,000,000 upon the utterly improbable contingency of its becoming available by the action of the National Government, is a proceeding destitute of the semblance of propriety.

Mr. Cooley does not agree with Mr. Artingstall—he favors the large cut. He will doubtless be found on the side of the greatest possible expenditure, so long as he has any connection with the Drainage Commission.

COMMISSIONERS TO BE UNFAIRLY SELECTED.

SECTION 27. This section provides that before water shall be let in the canal, three commissioners, one each from in or near Joliet, La Salle, and Peoria, shall pass on the work, and they must report that it has been done in conformity with *their* views of the law, before water is allowed to enter the channel. That this is unfair is obvious at a glance. The city may expend \$30,000,000 to \$50,000,000 to carry out the law, and then men must be selected from localities which have been most violent in their denunciations of Chicago, to pass upon the work.

The law is plain enough in its requirements, and it is an unheard of procedure that the only men who are to pass upon its fulfillment, are really parties to the case. The provisions of the law should have been exactly the reverse. It should have provided for the appointment of men from congressional districts, no part of which consisted of territory bordering on either the Kankakee, Des Plaines, or Illinois rivers. The reasonable pro-

vision would have been, to have had the matter determined by engineers from outside the State, appointed by the Governor, but it certainly should not be done by men whose stock of political capital, in their several localities, consists in their abuse of Chicago.

As a specimen of law-drafting for a water-way, the act has a strange incongruity. Section 23 provides that any channel taking the waters of Lake Michigan into the Des Plaines or Illinois rivers, shall be large enough to maintain a continuous flow of at least 300,000 cubic feet a minute, with a current not more than three miles an hour. It is further provided that if the channel is made in the Des Plaines River, it shall be opened down a slope between Lockport and Joliet to the upper basin, wide and deep enough to carry off the water coming down from above.

Now, there is a slope from Lockport to the upper basin of twenty-eight feet. The distance is $4\frac{1}{2}$ miles. A continuous flow down such a slope will be at the rate of six to eight miles an hour or more, which is, of course, too rapid for navigation. It thus appears that by the law a channel 160 feet wide and eighteen feet deep is to be excavated through solid rock a distance of some sixteen miles, and to terminate in a rapid chute of $4\frac{1}{2}$ miles in length, down a steep declivity. There is no provision whatever for connecting this channel with the water of the Des Plaines or Illinois rivers for the purposes of navigation.

Much has been said and written about the great water power which the people of Chicago were to provide for Joliet. As to the value of water power, it is a noticeable fact that the present water power at Joliet has never been entirely made use of; and further, there is a superb water power at Momence which has not been used for years. But it is not probable that any attempt will be made to create a water power at either Lockport or Joliet.

It can only be developed by the construction of an aqueduct from a point in "Section 14" down to the upper basin. The recent bids show that the cost would approximate \$6,000,000. The Drainage Board are not authorized to go into speculative schemes; they are given the authority to control any water power which may be developed as an incident to drainage work, but the creation of independent work for that purpose is not authorized by the law.

Beside these specific objections to the law, there is the general

objection that a law professedly enacted for the purpose of providing means to dispose of Chicago sewage is in fact a law for the building of a great water-way, and nothing else.

The drainage commissioners having inquired of their attorneys whether they might not provide temporary relief to the city of Chicago by increasing the flow through the canal to 80,000 cubic feet per minute, said attorneys, on the 9th of March, 1892, reported that they could not; closing their opinion in these words: "We find no warrant in the law for your affording relief to the city of Chicago except through a channel which shall conform to the requirements of the act creating the district, as set forth in Section 23 of said act."

Attention has thus been called to some of the more objectionable features of the act, and in this connection it might appear that the next topic in order would be the effort at the last session of the Legislature to amend it; but before this, in view of the unjust and untrue statements that the old Drainage Board had not attempted to execute the law, it is proper to review the efforts made to carry out the law as it now stands, and, in so doing, to call attention to the conduct of one man, who is now exercising very great influence in the present Drainage Board.

EFFORTS TO CARRY OUT THE LAW.

The necessity of doing something to obviate existing evils from Chicago sewage was imperative. Some, if not all, the Drainage Commission were enthusiastically in favor of a great water-way; the people had decided that it should be built, and, as soon as elected, they set about it. The old Drainage Board has been the subject of a good deal of flippant criticism on account of its alleged slowness of action. The most serious charge that can be brought against them in that behalf is their retention of Cooley until December, 1891; why they did not forthwith discharge him on the 27th of August, 1890, upon the reading of his reply to the letter of President Murry Nelson, is inconceivable. It was due to Mr. Nelson that this should have been done then and there. President Nelson wrote him August 12th, suggesting that he discontinue the setting water gauges in the Des Plaines River and elsewhere, as a useless expense. Mr. Cooley replied on the 18th, saying, in substance, that he should do no such thing, and that if the board should insist upon it, he wanted a "commission of experts."

The first meeting of the drainage commissioners was held January 18, 1890, when a temporary organization was effected. February 1, a permanent organization was effected, rules and an order of business adopted, and permanent officers elected, among whom was L. E. Cooley, to be Chief Engineer.

February 6th.—"*Resolved*, That the Chief Engineer is hereby "directed to collect and secure for the board all obtainable data "and engineering information concerning the works necessary "to accomplish the purpose of the creation of the sanitary "district."

February 8th.—An ordinance for the issuing of \$1,000,000 in bonds was passed. (NOTE.—Wherever quotations are made, they are taken from the official printed proceedings of the board.)

February 8th.—Chief Engineer Cooley being called upon, "stated that all the work preliminary to the actual work of construction would require till the spring of 1892."

February 15th.—“On motion, Chief Engineer Cooley was “permitted to have embodied in the minutes his position with regard to the time of construction.” “The report of officers being called for, Chief Engineer Cooley “speaks in reference to a question as to what steps should be “taken to secure the co-operation of Congress. Mr. Cooley “states he had matter to present on the subject, which, however, “it may not be ‘policy’ to disclose at present.”

“Motion is made to go into executive session, and carried.”

The minutes are silent as to the deep disclosures of Mr. Cooley on that memorable occasion. On the same day, however, the board adopted a resolution in part as follows:

“That the Chief Engineer be hereby directed to secure and “have in readiness to proceed to work, at or before May 1, 1890, “a sufficient staff and force to do all the necessary engineering work “to enable the board to commence the work contemplated by “law, at the earliest possible time thereafter. Chief Engineer “Cooley being called upon, explains that while others were numerous, specialists for his work were few; that time is required “in which to secure them, as well as the necessary special instruments needed. Mr. Cooley then continues at large.”

The published proceedings of the board, as will be seen, show that he has been “at large” ever since. It is rather a remarkable circumstance, that thus early in the action of the board an employe should have been allowed to usurp any such position in the board as is indicated by the above quotations from their proceedings. What business had an employe to insist that his position as to the time of construction, should be incorporated in the proceedings of the board?

March 1st.—“The Chief Engineer is instructed to report to “this board in accordance with the resolution of February 6th, “to collect and collate data, etc.”

In the meanwhile, a case was pending in the Supreme Court of the State to determine the legality of the Drainage Act, and nothing further appears to have been done until June 14th, when a meeting was held at which President Nelson spoke as follows: “Gentlemen, we now have the decision of the Court. There is “nothing in the way to prevent our going ahead as rapidly as “possible. You all have the same idea, no doubt. I have but a “single request to make, and that is that you be as concise and

“rapid as may be, that we may get rid of the accumulation of studies we have been pursuing for the last six months and get direct to work.”

On the same day, “Chief Engineer Cooley being called upon for report, asks for a week’s time—granted.”

June 18th.—“The Chief Engineer is hereby authorized and directed to make all necessary investigations, borings, examinations, and surveys between the Chicago River and its south branches and forks, and the summit, or thereabouts, to enable the Board of Trustees to locate any one of not less than four (4) routes for the purpose of constructing such channel as will be according to law, and also for supply channels therefor; and from that point to Lake Joliet; to make like investigations of the Des Plaines Valley for like purposes, and further examination to enable him to inform the board of the relation of the channel and works, aforesaid, to the sanitary district, and to all the territory to be affected beneficially or otherwise by the construction and operation of said channels and works.”

July 26th.—“President Nelson expressed some apprehension at the delay in the Engineering Department, and suggested that a committee should be appointed to aid him.”

“Mr. Prendergast thereupon moves, and Mr. Wenter seconds, the following resolution, and the same is adopted, Mr. Alt-peter voting in the negative: That a committee of three (3) on Engineering Department be appointed by the President, which shall see to the execution of the orders of the board, concerning the engineers’ work of the district.”

“President Nelson appointed as the committee, Messrs. Hotz, Wenter, and Prendergast.”

September 9th is the following:

“WHEREAS, The Engineer was requested to state in open meeting, on July 1, 1890, whether he had sufficient means of all kinds, by reason of the action of the board up to and on that date, for furnishing means to carry out the resolution of June 18, 1890, and further, to state at what time he would be able to file such a report as would enable the board to locate a route as far as Summit, conforming to the resolution of **June 18, 1890**, and to file a petition to condemn **the lands necessary** for such a route; and,

“WHEREAS, The Engineer then and there stated that he had
 “all means necessary for that purpose, and that such report
 “would be ready for the board’s action within one hundred days
 “from the 1st day of July; therefore, be it

“*Resolved*, That the Engineer be directed to file such report
 “within thirty days from this day.”

“The roll being called on the passage of the resolution,
 “Messrs. Hotz, Prendergast, Willing, and President Nelson (4)
 “voted aye; Messrs. Gilmore, King, and Wenter (3) voting no,
 “Mr. Altpeter not voting, and Mr. Russell being absent from the
 “room. President Nelson declared the motion passed.”

September 10th.—“*Resolved*, That the Committee on Engi-
 “neering be instructed to confer with the Chief Engineer, to
 “examine the work of the Engineering Department to date,
 “and report to this board at the earliest practicable time, with
 “such recommendations as they may deem best.”

October 15th.—“The Chief Engineer submitted the follow-
 “ing letter, which was read:

“ENGINEERING DEPARTMENT,
 “SANITARY DISTRICT OF CHICAGO,
 “RIALTO BUILDING, CHICAGO, October 15, 1890.

“*To the Board of Trustees, Sanitary District of Chicago.*

“GENTLEMEN: I am unable to file the report called for by
 “resolution of September 9th, at this time. I had intended to
 “lay before you at this meeting a communication in relation to
 “this report. I have been unable to prepare this, as my time
 “has been too fully occupied by the Committee on Engineering.
 “I can lay this matter before the board by Friday, if the board
 “desires, or at the next regular meeting of the board.

“Very respectfully,

“L. E. COOLEY,
 “*Chief Engineer.*”

November 7th.—“The Committee on Engineering Depart-
 “ment presented the following report, viz:

“REPORT OF THE COMMITTEE ON ENGINEERING.

“The Committee on Engineering begs leave to report that,
 “pursuant to directions of the board heretofore given, the com-
 “mittee has investigated the progress of the work of the Engi-

“neering Department, and, without at this time going into details, states the result of its investigation to be:

“First. That the Engineer acknowledges that he informed the board, on or prior to July 1, 1890, that a report would be filed, within 100 days from that time, sufficiently complete to enable the board to locate the route of the main channel between the Chicago River and the summit, and that on September 13th a statement confirmatory of the above was made to the committee by the Engineer, he then promising to file such a report by October 15th. No such report has been filed, and none is ready to be filed, and the nearest thing to fulfillment of that promise that the committee can discover is, that the Engineer now promises to report perhaps by Christmas, and perhaps not for a considerable time thereafter; but even as to this report, he states that it will not be sufficiently complete to enable the location of the route of the main channel at the place indicated; hence, such a report as is now promised would be valueless.

“Second. The expenditures of the department are nearly double what the Engineer informed the board they would be, at the time the final ordinances were being prepared for the raising of the funds.

“Third. At all times, and especially since the decision of the Supreme Court affirming the validity of the act under which the board is organized, it has been the desire and judgment of the board, as the Engineer knew at all times, that the channel between the Chicago River and Summit should be located at the earliest practical moment. Not the least reason for this judgment is the fact that the land in that vicinity is rapidly increasing in price.

“Fourth. It seems to the committee that there has been too great scattering of forces generally, and too little concentration of forces on this portion of the work.

“As the result of its investigations, the committee believes that up to date the work of the department has not been sufficiently energetic and practical. In view of the fact that the Engineer is now continually calling for increase of force, and other expenditures largely in excess of that formerly indicated by him as the proper and sufficient amount, and as the committee has found an insufficiency of practical results yet obtained, and as the Engineer claims that notwithstanding the

“findings of the committee, he has pushed the work with proper speed and economy, the committee recommends the employment of a consulting engineer, and further that the statements of the Engineer, which are in type-writing, be referred to the attorney, with the request for an opinion as to the limitations of the power of the board.

CHRISTOPH HOTZ,

“*Chairman.*”

“CHICAGO, November 7, 1890.”

“On motion of Mr. Willing, seconded by Mr. Gilmore, the report was received and adopted, Messrs. Altpeter, Gilmore, Hotz, Prendergast, Willing, and President Nelson (6) voting aye; Mr. Wenter voting no.”

November 19th.—“Messrs. Willing and Prendergast each questioned Chief Engineer Cooley as to whether the data and memoranda in the possession of himself and employes in the Engineering Department, collected, collated, and obtained during working hours, and at the expense of the sanitary district, was to be considered as personal or private property, or property of the sanitary district, to which Chief Engineer Cooley replied that it was the property of the sanitary district.

“Mr. Prendergast presented the following, viz.:

“*Resolved*, That the Engineering Department, and all officers, members, and employes thereof, be directed to preserve and file with that department all data and memoranda now or hereafter in their possession, and to destroy nothing of that kind.”

November 26th.—“*Resolved*, That the Chief Engineer be, and he is hereby directed, to suspend immediately all field or other work upon the Upper Des Plaines River, except gauges, and all work outside of the district and below Joliet, and to make additional surveys and borings between Chicago and Summit, if such additional investigations shall be necessary, and to make compilations from such field notes and other data as are now in his control, or the control of the employes of the board, or which shall be obtained in accordance with this resolution, so as to enable the board to locate any one of not less than four (4) routes for the main channel between Chicago and Summit, and that he make report thereon to this board, with all convenient speed.

“ On the roll-call, Messrs. Gilmore, Hotz, Prendergast, and Willing (4) voted aye, and Messrs. Altpeter, Russell, and Wenter (3) voted no, whereupon the resolution was passed.

“ A roll-call on the following was then taken:

“ *Resolved, further,* That the Chief Engineer be, and he is hereby directed to abstain from obtaining information concerning land values and facts of record in the Recorder's office, relating to the territory between Chicago and Summit, until the further order of this board. These resolutions not to apply to the investigation of the South Branch heretofore specially ordered.

“ On the roll-call, Messrs. Altpeter, Gilmore, Hotz, Prendergast, and Willing (5) voted aye, and Messrs. Russell and Wenter (2) voted no, whereupon the resolution was passed.”

December 10th.—“ Mr. Willing presented the following resolution, viz.:

“ *Resolved,* That the Chief Engineer be, and he hereby is instructed and directed to deliver forthwith to the clerk the documents, notes, and materials, and all copies thereof, relating to the report of the Committee on Federal Relations.

“ Mr. Willing moved, and Mr. Hotz seconded, the passage of the said resolution, and the same was adopted.

“ On the roll-call, Messrs. Altpeter, Gilmore, Hotz, Willing, and President Prendergast (5) voting aye, Mr. Wenter (1) voting no, and Mr. Russell (1) not voting.

“ Mr. Willing offered the following resolution, viz.:

“ *Resolved,* That Chief Engineer Cooley be instructed to deliver into the vaults of this board to-morrow, Thursday morning, December 11, 1890, the report on Federal Relations, in its present condition, and all copies thereof in his possession, or under his control.

“ Mr. Willing moved the adoption of the said resolution, seconded by Mr. Gilmore, and the same was passed.

“ On the roll-call, Messrs. Altpeter, Gilmore, Hotz, Russell, Willing, and President Prendergast (6) voted aye, Mr. Wenter (1) voted no.

“ *Resolved,* That Gen. John Newton be, and he is hereby made consulting engineer upon a compensation to be fixed by the Finance Committee, after consultation with Gen. Newton, and subject to the approval of the board.

“ On the roll-call, Messrs. Altpeter, Gilmore, Hotz, Russell,

“Wenter, Willing, and President Prendergast (7) voted aye, noes none; whereupon it was declared unanimously passed.

“In response to an inquiry by President Prendergast, Chief Engineer Cooley said that his report, as also a copy thereof, on the subject matter relating to ‘federal relations,’ was at his private residence; that Mr. Rooney, one of his subordinates, had another copy in his possession, and that those two were the only copies in existence.

“Mr. Hotz presented the following resolution, and moved its adoption, seconded by Mr. Willing:

“*Resolved*, That the employment and tenure of office of L. E. Cooley, Esq., as Chief Engineer of the Sanitary District of Chicago, be, and the same is, hereby terminated.

“On the roll-call, Messrs. Altpeter, Gilmore, Hotz, Willing, and President Prendergast (5) voted aye, and Messrs. Russell and Wenter (2) voted no, whereupon the said resolution was duly passed.”

The foregoing extracts from the printed proceedings of the Drainage Commission show their earnestness and activity to carry out the law. It thus appears that the board were earnestly, nay, even impatiently, pushing forward the engineering work; two engineers of large experience and high standing have stated to the writer that one well-equipped engineering party could have made a thorough preliminary survey of the route, from Chicago to Joliet, in thirty days. The Herring Commission had from April 1st to January, and Mr. Cooley, with all that Herring had done at his disposal, had from July 1st until December. The fact was, that Cooley frittered away time and money in useless details; the work to be done was to dig a ditch from Chicago to Joliet, and his paramount duty was to locate one or more routes, and give their cost. Instead of that, he was dawdling around the country with “a reconnaissance of the Illinois Valley,” “a comprehensive investigation of the water-sheds of the Des Plaines and Chicago rivers,” “with the distribution of population,” with “hydraulic investigations,” with “a topographical reconnaissance of the country north and west of the drainage district,” etc. See his statement in the drainage proceedings, pages 43 and 44.

As appears by the proceedings of February 8, 1890, above quoted, Mr. Cooley was then laying out the ground for a life interest in his employment. He had been chief assistant to Mr. Herring, and knew what had been done by that commission,

and yet he stated that it would require two years of engineering before a spadeful of earth could be turned.

It would seem, further, from the proceedings of the board, that they entertained apprehensions that the subordinates considered their books of field notes as private property. That those subordinates were devoted to Cooley, rather than to their employer, was shown by the fact that, when Cooley was dismissed, they, with one or two exceptions, either left or were dismissed for insubordination.

After his discharge from the office of chief engineer, Mr. Cooley published a large double-column pamphlet, of some 125 pages, with the title "The Lake and Gulf Water-way as Related to the Chicago Sanitary Problem."

How much of it related to the Chicago sanitary problem, and of what value his services were, as the Chief Engineer of the drainage district, in locating a route, and to what extent he devoted himself to that work, and how far he chose to obey the instructions of the board, as contained in the resolutions of February 6th, March 1st, June 18th, and September 9th, may be judged from the following extracts from the preface to that pamphlet:

"This report was practically completed ten months ago, but
" as the policy herein outlined was not in harmony with that of
" the majority of the Board of Trustees of the sanitary district
" it has not been published. * * * * It is now placed before the
" public in very nearly its original form. * * * * Readers who
" look for a discussion of the sanitary problem of Chicago will be
" disappointed. The available data had been practically ex-
" hausted by the labors of the Drainage and Water-supply Com-
" mission of 1886 and 1887 (the Herring Commission), and of the
" State Board of Health."

The value of the Herring report has been considered, and what the State Board of Health had to do with locating the route for a canal from Chicago to Joliet, is something that no one but Mr. Cooley can understand.

On December 17, 1890, Mr. Worthen was made Chief Engineer, and on January 13th Messrs. Worthen and Newton made a report as to the cost of a canal from Chicago to Joliet, to be built in accordance with the Drainage Act, as being \$22,700,000.

In a further report, made February 21st, they declared that the present canal must be widened and deepened, and estimated the expense of that work at \$3,200,000.

It was broadly stated in the first report that provision must be made for an additional supply of water, but they made no suggestion as to what additional supply was necessary, nor how it was to be procured, and the probable cost, nor any estimate of the cost of right of way.

With an estimate of \$26,000,000 for labor and material to construct the work, and the obvious necessity for several millions of dollars more for right of way, and for an additional supply of water, and for bridges, etc., staring them in the face, the commissioners sought relief by having the act amended, so as not to require the unnecessary rock-cut and the superfluous quantity of water.

THE EFFORT TO AMEND THE ACT.

On the 7th of March, 1891, the board adopted a minute, addressed to the citizens of the drainage district, in which was set forth, in substance, their inability to construct the canal as required by law with the means provided, and the necessity of its amendment in the two particulars of the useless rock-cut and the unnecessary quantity of water required; and on March 21, 1891, a resolution was adopted that the act ought to be amended in those respects, and also in the provision limiting the use of the Illinois & Michigan Canal to that portion within Cook County.

In pursuance of that resolution, a member of the Drainage Board went to Springfield, in the spring of 1891, to present and urge the proposed amendments before the Legislature, which was then in session. Benzette Williams saw in this move something which threatened his "policy"; L. E. Cooley of Evanston likewise saw something which threatened the possibility of a future fat salary for little work, and they hastened to Springfield to oppose the amendment. Harvey B. Hurd of Evanston was also on hand in opposition to the proposed amendment. This is no place to indulge in personalities, but the wonderful devotion of Mr. Hurd to the sanitary interests of Chicago, and his eagerness in behalf of this idiotic drainage scheme, require explanation. It has been charged against him that his interest is purely personal; that he is interested in a tract of swamp lands on the Des Plaines River, north of Chicago, which he expects will be drained, if the water-way scheme goes through. Whether the charge be true or not, he does not live in Chicago.

He has not established any particular reputation as a public-spirited citizen, and to those who know his record as revisor of the statutes of Illinois, who remember what was said of him when he was candidate for Judge of the Supreme Court, and, later, his record as County Commissioner of Cook County, his opinion will have no special weight. He should have no voice in the settlement of the question.

The river valley people were frantic in their denunciation of the proposed changes. The Chicago members of the Legislature were divided; some were indifferent, some incapable of understanding the necessity of the case, some were either out-and-out water-way men, or were under the control of men who were, and some were either personally or politically hostile to the representative of the Drainage Board, and so the effort to amend proved abortive. The city of Chicago and the Drainage Board were represented by a public officer; he was one of the men to whom had been confided the work of executing the law. After a careful study, aided by the best engineering ability in the country (Messrs. Worthen and Newton), they had found the execution of the law impracticable, and sought to have it amended. Mr. Benzette Williams of Salt Creek, and Messrs. Hurd and Cooley of Evanston, joined the valley people in resisting the amendment. Cooley is now commissioner, and Williams Chief Engineer.

CHANGES IN THE BOARD.

As originally constituted, the board consisted of six members elected upon a citizens' ticket and three members elected on the Democratic ticket; of these, three of the men elected on the citizens' ticket, viz., Messrs. Nelson, Hotz, and Willing, and one upon the Democratic ticket, Mr. John A. King, have resigned. Some, and probably all of them, did this because they were convinced of the impracticability of the law, and further that they would not be parties to the imposition of such a ruinous and wholly unnecessary burden of taxation upon the people of Chicago.

Mr. Murry Nelson is an old and highly respected citizen of Chicago, and well known as a man of great public spirit. Mr. Willing is a retired merchant; he was for many years an active member of the great mercantile firm of Marshall Field & Co. Mr. Hotz is a prominent German, and is the managing partner of the great wagon manufacturing firm of Scheuttler & Hotz.

John A. King is president of one of the National Banks of Chicago. All of them are men of large means.

On the 21st of April, 1891, the resignations of Messrs. Worthen as Chief, and of Gen. Newton as Consulting Engineer, were accepted by the board. These two men were of national reputation; they had been in office only about three months; their salaries were each \$10,000 per annum; it is fair to infer that they accepted the positions with the expectation of retaining them, and, in the absence of any other reason given, it is reasonable to conclude that they resigned because they looked upon the drainage scheme as a huge fraud, and would not be identified with it. There is now one vacancy and three new members, viz., Eckhart, who was a member of the Legislature that passed the act, and a member of the Legislative Commission of 1887, before referred to, and who is, or at least has been, a pronounced advocate of a great water-way; then there is the Cooley aforesaid, and a Mr. Boldenwick from Lake View, who is said to be a mild type of water-way enthusiast and an industrious politician. Mr. Wenter has been made president of the board.

One of their first acts was to oust Mr. Artingstall from the position of Chief Engineer, and install Mr. Benzette Williams, of Bridgeport pumps, etc., memory, in his place. To the extent of having secured a salary of \$9,000 per annum, he is reaping the benefit of his "policy." They have undone all that their predecessors did, and have been making furious efforts to show how quickly they are going to build a canal; in addition to a route laid out by Messrs. Worthen and Newton, and another by Mr. Artingstall, they had some five other routes planned by Mr. Williams, and Cooley had a project for still another. Mr. Williams and his old-time associate Cooley have been at outs as to the route, and the former wanted a commission of a board of "experts" to decide the matter. These Chief Engineers are strong on the "expert" question. This "expert" business is a good deal like the making of silver shrines for Diana of the Ephesians, of some two thousand years ago; it "brings no small gain unto the craftsmen."

It may be claimed that the conduct of the Drainage Board in letting contracts and in purchasing real estate, are evidences of their present disposition to push the work forward to a speedy completion. Some of the members of the board may have that idea, but so far as Mr. Cooley is concerned the only way to judge of him for the future, is by the past.

The history of the Engineering Department gives good foundation for the belief that the present hurried movement is made for the purpose of fastening the "policy" of building this big ditch upon the public, and as a measure of resistance to any attempt to repeal the law.

When these ends are secured, it will probably be found that drainage work will go slow enough to afford life-long employment to some of the men now engaged in it, and in the meantime the people of Chicago will get along as best they can, for a decent water supply.

The records of some of these men have been given. It is enough to say of Mr. Wenter that he voted against the resolution of September 9, 1890, calling upon Cooley for a report; he voted against the report of the Engineering Committee of November 7, 1890; he voted against the resolution of November 26, 1890, directing the Engineer to confine his work to the route between Chicago and Joliet; he voted against the resolution of December 10, 1890, calling upon the Engineer to turn over certain papers to the Engineering Committee, and voted against the dismissal of Cooley on the same day.

On July 22, 1891, the old Drainage Board adopted a route for the canal between Bridgeport and Summit, in pursuance of the recommendations of Chief Engineer Artingstall. Mr. Wenter was a member of the Committee on Engineering, and signed the report approving the route, and he also voted for the route, yet upon a resolution that the Chief Engineer employ the necessary assistance for locating it, Mr. Wenter voted no. What the future will disclose as to the character of the present board, of which Mr. Wenter is president, remains to be seen.

THE COST OF THE PROPOSED WATER CHANNEL.

Something like a half million of dollars has been expended, and yet we have no definite statement of the work to be done, nor estimate of its cost.

Many people have an idea that when a channel is completed, through which 300,000 cubic feet of water per minute may course from the Chicago River to the upper basin, the work will be done; members of the Drainage Commission are rubbing their hands in gleeful fatuity over the opportunity of letting contracts to the amount of \$10,700,000 for excavations to be made between Willow Springs and Lockport, as a huge stride toward the creation of a great water-way.

No one ever doubted that \$10,700,000 in money would dig out a good deal of earth and stone, but a great many have believed, and do still believe, that this is but an inconsiderable part of the expenditure involved in the completed work.

It is worth while, then, to review these contracts, and note what will be accomplished by their fulfillment, and what will still remain to be done. On the 17th February, 1892, the Engineer of the Drainage Board reported that Route 3, from Willow Springs to the upper basin, would require 4,613 acres of land, and that the cost of the excavation would be \$10,777,320. This route was adopted by the board March 2, 1892. On June 8, bids for this work were opened, and the lowest bid was \$17,105,935.83. The Engineer's estimate was too small by the sum of \$6,328,615.83. Or, his estimate covered about 60 per cent. of the lowest bid that could be obtained. Commentary upon such an estimate is superfluous.

It would seem that some such outcome was expected, for two other propositions were put forward; by the first, the board was to keep the channel dry and remove all the stone and dirt. It would seem as though this plan was devised so that a low bid might be secured, and that, as in the past, their extravagant bills had been paid every month without observation, so, monthly bills for keeping the channel dry, and removing the earth and

rock excavated, would also pass without criticism. The bids for the work under this scheme were \$10,111,731.87.

The commissioners had still another project, and that was to stop the work at Section 14, near Lockport; the distance from Willow Springs to the upper basin was $18\frac{3}{4}$ miles, and this proposition was to dig this ditch from Willow Springs, and stop about $4\frac{1}{2}$ miles short of the upper basin, they "reserving the right to "make all river, canal, and railway changes independent of the "main work."

The lowest bids for this work amount to \$10,696,754.98.

The Drainage Board concluded that they did not have \$17,000,000 handy, and so they abandoned any idea of a contract for the work from Willow Springs to the upper basin.

A sort of partnership between the Drainage Commission and the contractors, by which the latter were to loosen the dirt and rock, and the former carry it off, was objected to by some of the working majority of the board, and that had to be abandoned; the only alternative was to fall back on the short job.

On the 18th of June, the joint committees of the board (which constitute a majority of the board) reported in favor of undertaking the work on the short job upon the basis of bids amounting to \$10,696,754.98.

The grand project of a magnificent water-way from Chicago to the Mississippi dwindled, first, to a useless water power at Joliet, and, in their report of June 18th, above referred to, it slumps to the proportions of "a tail-race," and the expenditure of thirty-odd millions of dollars this side of Lockport is to be made in order to create a feeder for it.

In the report of June 18th, above referred to, the committee say as much, and that must be taken as their final word, until they speak again.

A rock-cut channel, fourteen miles long, 160 feet wide; and eighteen feet deep is to be cut and a channel costing \$10,000,000 from Bridgeport to Willow Springs, and \$6,000,000 or \$8,000,000 more are to be expended for the enlargement of Chicago River, and all to terminate in a tail-race.

Slight as are the claims to respect of water-way enthusiasts, a proposition to expend this amount of money for such a purpose can scarcely be credited to them; but their plans for a water-way have broken down, and they must do something; that something, as they say in their report, is to wait until they can

get more money, or until the Federal Government takes hold of the matter.

As above stated, the lowest bids amounted to \$10,696,754.98.

The joint committee further say, "there must be added, the "cost of right of way, structures (such as bridges, dams, etc.), "and work not submitted to bids.

"That the cost of right of way may be assumed for present purposes to be \$800,000."

The engineer reported on the 17th of February, 1892, that the structures, etc., requisite on Route 3 would cost \$677,000.

Making an aggregate of	\$12,173,754.98
To this should be added 2½ per cent. for contingencies, and a like amount for engineering	608,687.74
	<hr/>
	\$12,782,442.72
To this must be added the cost of the sluice-way, which the joint committee report at	1,500,000.00
	<hr/>

This makes an aggregate for the expense of the water channel from Willow Springs to the upper basin of

	\$14,282,442.72
--	-----------------

And beside all this, there is "the work not submitted to bids."

In this presentation of the case, it must be remembered that the only solid ground we have, is that of the bids; for the cost of the tail-race, of bridges, moving of railroad tracks, and of the right of way, we have to depend upon the report of the Drainage Commission and its Chief Engineer.

If his estimate of the cost of excavating Route No. 3 is a fair sample of his work, then large additions to his figures must be made. Of "the work not submitted to bids," the public are not advised. It is evidently another case for secret session.

We now come to the cost of the water channel from Chicago River to Willow Springs. On the 7th of June, 1892, the Engineer made a report upon six different routes for a channel with a capacity of 300,000 cubic feet per minute. The lowest of these estimates was upon the line of the present canal, with a narrow right of way, and was \$5,899,963, and contemplated railroad changes of some six different railroads, with eleven tracks and a switching yard, etc.; and he says in his report that his estimate gives "no idea of the relative injury to railroad property as not "being susceptible of estimate."

The addition of any specific amount to this estimate would seem to be unwarrantable, unless the data upon which it is made were given; but in view of such of his estimates as we have been able to compare with the actual figures, and in view of some further opportunities which will be mentioned hereafter, it would seem that an addition of 33 to 40 per cent. should be made to any estimate proffered by Mr. Williams. He proposes radical interference with six different railroad systems, and to such an extent that he can give no idea of the injuries, "as not being susceptible of estimate."

Without wasting time in commenting upon such a confession of impotence, is it not the more prudent course to treat his estimate of \$6,000,000 as being a scanty 60 per cent. of the actual cost, and set down the real figure, as being \$10,000,000, making the total for the channel from Chicago River to Lockport, and thence by sluice-way (or, as the Engineer not improperly designates it in this connection, "tail-race") to the upper basin, the sum of \$24,282,442.

In addition to the main channel and sluice-way, there are various subsidiary works which will be necessary, as:

1. The entire rebuilding of the walls and dams of the upper and lower basins, and extensive protecting walls along the Des Plaines River in Joliet.
2. The construction of a tunnel from the lake to the east branch of the south fork, to create a current which will carry off the sewage of the stock yards.
3. An intercepting sewer along the lake to take up the sewage now emptying into Lake Michigan.
4. The enlargement of Chicago River.
5. To these items of expense must be added the liability for damages for flooding lands, and the destruction of property in the Illinois River Valley.

Of these items in their order:

First. The upper basin at Joliet is 4,000 feet long, 300 feet wide, and from six inches to sixteen feet deep.

The lower basin is about 2,600 feet long, 250 feet wide, and about of the same depth as the upper basin. They are faced with an indifferent stone wall, which, while fairly adequate for present use, would not answer with an additional flow of 300,000 cubic feet per minute.

These basins are kept well filled by the 35,000 cubic feet per

minute now pumped at Bridgeport, and would have to be raised much higher for the proposed additional quantity of water. To do this, the present walls must be torn out and new walls constructed.

The tops of the present walls lining the basins are about on a level with the land adjoining, and the increase in height would have to be high and strong enough to contain the waters from the proposed channel, with the flood-waters of the Des Plaines added. It will be remembered that serious damage was done in Joliet during May and June, 1892, by the flood-waters of the Des Plaines.

The following dispatches are taken from the Chicago *Daily News* of May 5, 1892, as to the effects of the flood in May:

“JOLIET, May 5th.—The rain last night was the heaviest that ever fell in this district. The Des Plaines River and the canal have overflowed their banks, and the citizens living within a half mile of the river have been notified to move out. No business is being done, and all are helping to save life and property.

“At Hydes’ mill, one mile north of Joliet, on the river bank, is the most dangerous place. The lock at this place may be taken out at any moment. If such should happen, the entire business part of Joliet would be under water, and buildings in the valley would be swept away. At the Jefferson Street bridge, in the heart of the city, the water is overflowing the river banks, and the basements of stores, as well as dwelling-houses along the river, are full of water.”

As to the June flood at Joliet, the following is taken from the Chicago *Herald* of June 24, 1892:

“JOLIET, ILL., June 23d.—The Du Page and Des Plaines rivers have risen and the water is backing into the mills, factories, streets, and farm lands.”

If to the volume of water mentioned in these dispatches there be added 300,000 cubic feet of water per minute from the drainage channel, it can not be otherwise than that very great additional damage would ensue. For all this, the drainage district will be liable, hence the necessity of extensive and elaborate protecting walls of masonry.

Messrs. Worthen and Newton reported that this additional quantity of water would flood out the dams at the lower ends of

the two basins; that is, that the water would make a continuous course over these dams with little or no appearance of a fall. They suggested that the water should be taken in an iron cylinder, thirty-six feet in diameter, from the upper basin down past Joliet to empty into the Des Plaines. This would be a work of very considerable magnitude, and would not have been suggested by them unless the necessity was urgent.

There are no figures at hand upon which to base an estimate of the cost of the necessary work upon the basins, and to protect Joliet, but it would seem as though to erect several miles of heavy stone wall that \$2,500,000 was not unreasonable.

Second. The connection of the east branch of the south fork with the main channel.

In his report of June 7, 1892, the Chief Engineer estimates the cost of a conduit from the lake, and a system of intersecting sewers which would collect all the sewage of the city south of Thirty-ninth Street, including everything from the stock yards and slaughter houses, and convey the same to the east fork, with pumping works to raise the water flowing through the conduit, so that there would be a gravity flow to the main channel, as being \$346,280, and costing annually to operate \$12,000. This estimate is based upon the capacity and cost of a sewer 6,200 feet long and twelve feet in diameter, as costing \$40 per running foot, or \$248,000, and he proposed a conduit of that size to carry all the sewage of the South Side south of Thirty-ninth Street, and all the sewage of the stock yards, and the subsoil water which it would gather in its course, and provide for a change of water of the entire east fork of the South Branch once in twenty-four hours.

These figures are simply preposterous. This is not a case where the estimate is even 60 per cent. of the actual cost. Mr. Williams gives the distance from the lake to the east branch of the south fork as 6,200 feet.

What he meant by a conduit of that length it is difficult to imagine. The distance from the lake to the east end of the east branch of the south fork is 14,650 feet. The conduit must extend several hundred feet into the lake, so that it is safe to say the conduit will have to be 15,000 feet in length.

The Fullerton Avenue conduit is twelve feet in diameter and 11,898 feet in length from the lake shaft to the North Branch of the river. The distance from the lake shore to Fullerton Avenue

works is 11,195 feet. The west 4,270 feet of that conduit is an open trench, which is much less expensive than tunneling.

The actual cost of the Fullerton Avenue conduit, engines, and machinery was \$566,515.13, and this was with the open trench, above mentioned, for nearly half its length. What Mr. Williams meant then, in estimating the cost of the conduit from the lake to the east fork, twelve feet in diameter with the necessary engines and pumps, at \$297,000, is absolutely inconceivable.

Taking into account the additional length of the conduit, and the fact that it must be all tunnel work, it is certainly safe to estimate the cost of a tunnel twelve feet in diameter, from the lake to the east fork, at one-third more than the cost of the Fullerton Avenue conduit, which would be \$755,353.50, or 2½ times more than the estimate of Mr. Williams.

He estimated the annual cost of pumping 18,000 cubic feet of water per minute at \$12,000.

The Fullerton Avenue pumps have a capacity of 13,000 cubic feet per minute of the same kind of work.

The expenses of those works for the past three years were as follows:

1889 (which included \$6,000 for repairs).....	\$21,107.14
1890.....	15,620.63
1891 (about).....	15,000.00

Does Mr. Williams propose to revolutionize pumping works in Chicago or has he made a willful underestimate? Substantially, he proposes to do one-half more work for one-fourth less money than Chicago is now doing.

Third. An intercepting sewer along the lake from Twelfth Street to Thirty-ninth Street, of sufficient size to take up the output of these three main sewers, can probably be built for \$120,000, which should be added to the cost of the conduit as above given.

THE ENLARGEMENT OF THE CHICAGO RIVER.

Fourth. The question as to how 300,000 cubic feet of water per minute is to be supplied to the channel is of the first importance. Of what use is this expensive channel without water?

The only existing source of supply is by the way of the South Branch. From Lake Street bridge to the fork at Ashland Avenue is about 4¼ miles. At the Adams and Jackson street bridges

the river is ninety-five feet wide, and at twelve different and other places, between Jackson Street and the fork at Bridgeport, the width of the river varies from 115 to 140 feet, with an average width, at these twelve places, of 127½ feet.

The South Branch is crossed by seventeen city bridges and four railroad bridges, all except three having stone piers in the center of the stream. The quantity of water flowing up the South Branch necessarily depends on the rapidity of the current and the width and depth of the stream. In May, 1891, Capt. Marshall found the depth to vary from 10½ to 14 feet. He also made at that time an estimate, in cubic feet per minute, of the quantity of water which could flow up the South Branch at one mile per hour. His estimates were at fourteen given points, as stated below, and were figured both upon the depth of the water at that time and upon a uniform depth of eighteen feet, as follows:

POINT OF MEASUREMENT.	Number of cubic feet with present depth of channel.	Number of cubic feet with channel eighteen ft. deep.
Lake Street.....	191,198	242,986
Randolph Street.....	132,352	202,752
Madison Street.....	159,509	183,744
Adams Street.....	114,611	139,392
Jackson Street.....	131,789	164,736
Van Buren Street.....	148,579	206,712
Harrison Street.....	169,162	217,325
Polk Street.....	130,830	183,744
Wisconsin Central Railway.....	133,874	180,259
Twelfth Street.....	186,560	219,226
Chicago, Burlington & Quincy Ry....	139,348	199,901
Eighteenth Street.....	139,304	207,979
Fort Wayne Railway.....	114,400	173,606
Twenty-second Street.....	135,749	175,032
Halsted Street.....	128,990	182,160

This estimate does not take into account the piling around the bridge piers for protection, nor yet the more variable factor of vessels along the docks. The average width of vessels engaged in navigation from Chicago to the lower lakes is now thirty-eight feet. The new vessels being built are from forty to forty-two feet wide; their bottoms are flat, so that when loaded they

operate as an obstruction to the channel thirty-eight to forty-two feet wide. As a matter of fact, there are many places in the river where two of these boats opposite each other leave but little more than room for a tug to pass along.

By reference to the above table, it will be seen that at the depth of water existing at the time of Capt. Marshall's measurement, out of fourteen points given, there are only three which, at the rate of one mile per hour, or eighty-eight feet per minute, will allow the flow of more than one-half the quantity of water required, even when unobstructed by vessels.

Something can be done by way of deepening the channel, but docks, bridge piers, and buildings along the banks of the river have been constructed with reference to its present depth, and it is the prevalent opinion, both among practical men and engineers, that it would endanger their foundations to deepen the channel to a greater depth than eighteen feet.

Taking the most liberal estimate of the present capacity of the South Branch, if 300,000 cubic feet of water per minute is to flow toward the proposed channel, provision should be made for an additional supply of one-half that amount.

Mr. Williams, as Chief Engineer of the drainage district, is finally brought to face this question. On the 17th of February, 1892, he was directed to make estimates of three routes from the river to the summit, each estimate to include bridges, right of way, railway damages, and all other work.

On June 7, 1892, he made his report, and flounders around, twice in the Ogden ditch, once in the canal, once in the south fork, once in both the south fork and Ogden ditch, and once in both the south fork and the canal. Instead of confining himself to his duties as Engineer, and complying with the resolutions of the board to lay out the routes and give the estimates as directed, he usurps the functions of the board, and proceeds to discuss what ought to be done—not in a logical order; your genuine water-way crank has very little idea of logic. His true intellectual method is to continue "at large," and have a "policy."

One of the peculiar propositions of his report is, that it is no concern of the Drainage Board whether Chicago River continues navigable or not; they might co-operate to that end, but only as a matter of majestic condescension; he finds movable bridges an incubus, and that it is within the scope of his duties as Engineer

to discuss the questions submitted to him by the board, "with reference to the broadest sanitary, commercial, and political interests of this community and of the country at large."

Let one imagine for a moment the City Engineer of Chicago reporting to the Council, or the engineer of one of our great railroads indulging in such flatulence in a report to the Board of Directors! Entertaining such a conception of his duties as engineer, nothing definite could be expected.

Instead of ascertaining from intelligent sources the extreme velocity of current permissible in the river, and then stating the size of the channel necessary, the amount of land to be taken and its value, the cost of excavation, and the damages which would accrue by reason of the destruction of buildings, the rebuilding of docks, and the reconstruction of bridges, he measures the current of the floods down Chicago River in May, 1892, and concludes that "to preserve safe and easy navigation of the Chicago River the velocity should not exceed a mile and a half an hour." This conclusion is based, he says, upon the flood-tides of February, 1887, and May, 1892, and from "other information." What were the sources of his "other information," whether evolved from his "inner consciousness" or obtained from bridge tenders, does not appear.

The fact is, Mr. Williams was afraid to face the difficulty. He knew, what every one else knows, that to make the necessary changes in Chicago River would cost several millions of dollars, and his "policy" was to avoid giving an estimate which would startle the people of Chicago; his "policy" was to get the city irretrievably committed, and then, if there was too much current, the city would be compelled to protect its commercial interests by widening the river at its own expense; and so he increases the capacity of the channel one-half with a stroke of his pen, by computing upon the basis of a current of a mile and a half an hour. With very little inquiry Mr. Williams could have ascertained that one mile per hour, or eighty-eight feet per minute, was the extreme limit of a current for the channel; dividing his 300,000 cubic feet of water by eighty-eight, he would have found that he must have a channel with a cross section of 3,409 feet; dividing this number by eighteen as the extreme limit of depth, he would have found that 189 feet was its necessary width.

That he did not do this, is simply of a piece with the men of

his kidney, in their concealment of the difficulties, and the giving of inadequate estimates of the cost of their colossal humbug.

The determination of the size of the channel was simple enough, and it would seem as though honest engineering would have presented the real facts, instead of bobbing sinkers, at intervals of five years, in the viscous waters of Chicago River.

Having accomplished the achievement above mentioned, of enlarging the capacity of the river, he then indulges in some cheese-paring prattle about minor changes, into which it is not necessary to follow him.

Upon the question of the current permissible in Chicago River, Mr. J. S. Dunham, president of the Dunham Towing & Wrecking Co., writes as follows:

“CHICAGO, June 9, 1892.

“To _____, Esq.

“DEAR SIR: Yours of the 9th inst., making inquiries as to my knowledge and opinion of navigation in the South Branch of Chicago River, was duly received, and in reply will answer your questions as follows:

“1st. Are you familiar with navigation in the South Branch?

“ANSWER.—Yes.

“2d. If so, how long have you been connected with such navigation, in what capacity, and in general what are your means of knowledge about such navigation?

“ANSWER.—Have been a tug-boat owner in this harbor for the past thirty years.

“3d. What, in your judgment, is the extreme limit of speed per hour at which a current up the South Branch can be allowed consistent with its available use by the class of vessels now entering Chicago harbor?

“ANSWER.—Three-quarters of a mile per hour.

“4th. Would a current at the rate of $1\frac{1}{2}$ miles per hour be objectionable, and if so, why?

“ANSWER.—Yes, for the reason that we could not manage a modern vessel with any degree of safety to the vessel.

“Yours respectfully,

“J. S. DUNHAM,

“President D. T. & W. Co.”

No one will claim a more extended experience, or greater practical knowledge of the navigation of the Chicago River, than is possessed by Capt. Dunham, and, as has been seen, he places the extreme limit at three-fourths of a mile per hour, or just one-half that of the engineer of the Drainage Board.

In view of the importance of the question as to whether a current of $1\frac{1}{2}$ miles an hour in Chicago River was permissible, the various representatives of the lines of lake steamers held a meeting in Chicago on the 15th day of May, 1892, to consider the matter, and the following was published in the Chicago dailies of May 16th as the report of that meeting:

ONE MILE AN HOUR THE LIMIT—LAKE LINE AGENTS CONSIDER
NAVIGATION ON THE CHICAGO RIVER.

“Lake Line Agents’ Association fixed a limit of one mile an hour as the greatest speed of the Chicago River current consistent with safe navigation. Mr. Artingstall gave the result of observations taken at Van Buren Street in the great freshet of May. The first day of the flood, 408,000 cubic feet a minute passed that point, at an average velocity of $4\frac{14}{100}$ miles an hour. The day of the heaviest flow, 468,000 cubic feet a minute passed at $5\frac{1}{10}$ miles an hour.

“From his observations, and the knowledge that the river would be narrowed, at all times, by large boats lying at the docks, and the permanent obstructions in the nature of bridge abutments and approaches, Mr. Artingstall said that he did not think it would be ever possible to secure a flow of 300,000 cubic feet of water a minute through the Chicago River, at $1\frac{1}{2}$ miles an hour, as now proposed by the Drainage Board. He did not think the river could be widened sufficiently to affect the flow materially, nor was it possible to deepen the channel to any degree.

“Capt. J. S. Dunham believed that the maximum current should not be more than three-quarters of a mile an hour. His experience in the freshet had shown him that a greater velocity than this would make the movement of vessels through the crooked South Branch dangerous.

“A resolution was finally adopted fixing the limit.”

Capt. Marshall also writes as follows concerning the necessary enlargement of the South Branch, and of the current which is

permissible therein, consistent with its safe navigation, and of the changes which would be required:

“ I should say that any appreciable current is more or less dangerous, and will affect more or less the rates of marine insurance on vessels and cargoes navigating Chicago River. In my opinion a current from one to $1\frac{1}{2}$ feet per second, or from two-thirds of a mile to one mile per hour, will mark the extreme safe or permissible current, and that even this moderate current will diminish the number and tonnage of vessels navigating Chicago River. The actual current in the river, due to the presence of the vessels themselves, will be greater than the above, at the location of the vessel.

“ The mean or average capacity (now) for discharge through bridge-draws on the South Branch is 138,220 cubic feet per minute. The average capacity of the river between the bridges is 188,408 cubic feet per minute; the least capacity of any open river section is between Mason’s and Allen’s slips, and is 110,880 cubic feet per minute; the least capacity at bridge spans is at Deering Street bridge, through which can be discharged, now, only 96,553 cubic feet per minute. All of the estimates herein made, are upon the basis of a current with a velocity of one mile per hour. When the river is in its usual condition, crowded with boats tied to the banks, or in motion against the current, with their submerged hulls obstructing the flow of water, the actual mean capacity is probably not greater than 60 per cent. of the above.

“ The maximum flowing capacity of the South Branch that can be obtained at any bridge, by dredging out the span channels to a mean depth of eighteen feet, without changing the bridges, is 243,000 cubic feet per minute; to obtain an equal discharge through the other bridge spans, all these other bridges must be reconstructed, the open channel widened to 160 feet, and dredged out to a depth of eighteen feet.

“ Two hundred thousand cubic feet per minute is the maximum capacity, in my opinion, that can be obtained in the South Branch without costly modifications in that stream.”

These are the figures for an open channel, unobstructed by vessels. It is apparent, then, that 160 feet in width and eighteen feet in depth is the narrowest limit permissible for such a flow of water. One hundred and sixty feet is the width fixed by the

law for the rock-cut and the earth channel from Bridgeport to Lockport, with an allowable current of three miles per hour, and comparatively free from obstruction by vessels.

The bridge above referred to by Capt. Marshall, is the one at Lake Street. It is obvious from the statement of Mr. Artingstall before the meeting of the agents of the different vessel lines, and of Capt. Marshall, as above, that a channel of sufficient size to convey 300,000 cubic feet of water per minute, at a current not exceeding one mile per hour, up the South Branch, can only be secured at the expense of radical changes.

Those changes will involve the taking of a strip of land of varying width, in some cases over fifty feet wide, all the way from Washington Street up to the pumping-works; also the destruction of more or less buildings, some of which, as elevators and warehouses, are very expensive. It will also involve the reconstruction of the docks on one or other side of the river the entire distance of $4\frac{1}{2}$ miles. Every bridge above Lake Street will have to be built new, with one or both new abutments, and in most cases new center piers. In many cases there will be large damages growing out of the change of the level of the street in making the requisite approaches. There will also be the cost of excavating the land taken, and dredging of the river to the requisite depth of eighteen feet.

Mr. Williams, the Engineer of the board, was directed, in February last, to make an estimate of the cost of a sufficient channel to supply the water for the canal which the Drainage Board proposed to build. After some $3\frac{1}{2}$ months he made a report in which he coolly ignores the directions of the board.

Any proper estimate of the cost of such a channel can only be made after a careful survey of the entire route. This has not been done, and under such circumstances no satisfactory estimate can be made. It is easy enough to see that the cost will run freely into the millions—probably from five to eight millions of dollars.

It was in view of such an outlook, and having some regard for decency in the matter of public expenditures, that Mr. Artingstall said that he did not think it possible to enlarge the South Branch sufficiently to furnish the amount of water required by the Drainage Act.

RECAPITULATION.

Such recapitulation as can be made then is as follows:

Bids for work from Willow Springs to within $4\frac{1}{2}$ miles of upper basin	\$10,696,754.98
Estimate for sluice-way	\$1,500,000.00
For structures	677,000.00
For right of way	800,000.00
Five per cent. for contingencies and engineering	608,687.70
	<hr/>
	\$3,585,687.70
Add $\frac{1}{3}$ for underestimate, and "for work not submitted to bids" ..	1,195,229.23
	<hr/>
	4,780,916.93
<hr/>	
Total of cost of work from Willow Springs to upper basin	\$15,477,671.91
Engineer's estimate for cost of work from Chicago River to Willow Springs by the canal, and not including injuries to railroad property	\$5,899,963.00
Add 40 per cent. for underestimate, and covering railroad damages	2,359,985.20
	<hr/>
Total for channel from river to Willow Springs.	8,259,948.20
Probable cost of enlarging Chicago River	6,500,000.00
Engineer's estimate of conduit from Lake Michigan to east fork, 6,200 feet in length, and engines, pumps, etc	\$298,000.00
Add, for underestimate in length, and probable cost as compared with the Fullerton Avenue Works, as heretofore shown	457,353.50
	<hr/>
Total cost of conduit	755,353.50
Probable cost of intersecting sewer from Twelfth Street to Thirty-ninth Street	120,000.00
Probable cost of intersecting sewer south of Thirty-ninth Street	100,000.00
Probable cost of rebuilding the walls of the upper and lower basins and dams, and protecting walls for Joliet	2,500,000.00
	<hr/>
The people of Chicago have thus presented to them, as what will probably be an underestimate of the cost of the proposed works, the sum of	\$33,712,973.61

As to the annual damages for flooding down the Illinois River, hereinafter discussed, while the sum total will be very large, there are no sufficient data for anything other than a conjectural estimate. It is probable that in some years the waters would remain within the banks, notwithstanding the proposed addition to their volume. If, however, we suppose that there will be an annual average of 150,000 acres of land overflowed by reason of the waters from the drainage channel, and that the annual value of such lands is taken at the moderate sum of \$12.50 per acre, we have an annual tax of \$1,875,000 for that item alone. Added to this is the liability for damages for the destruction of bridges, factories, warehouses, dwellings, etc., as mentioned in the dispatches hereafter quoted.

LIABILITY FOR DAMAGES.

Fifth. We have now to consider the very important question of the liability of the city for damages occasioned by flooding lands, the destruction of buildings, the drowning of cattle, and possibly for the destruction of human life by floods down the Illinois Valley. As has been stated, suits can be brought in any county bordering on, or traversed by, the Illinois or Des Plaines rivers, in which are the lands affected by flooding. The fall in the Illinois River does not exceed $1\frac{1}{2}$ inches to the mile. It is a sluggish stream, with low banks, and bordered by extensive stretches of bottom lands. The character of the river and of the lands adjoining, is thus described by Capt. Marshall in his report:

“The Lower Illinois partakes more of the nature of an estuary than of a river. Its banks reach only to mid-stage, but are not annually overflowed. Its slope is only 0.15 foot per mile.

“The bottom lands which are overflowed at stages above average high water, vary in width from a few hundreds of feet to five miles, generally densely covered with timber, and cut up by numerous sloughs, lagoons, and ponds. A large area, however, of the higher part of the bottoms is cultivated, whenever not submerged before seeding time, and this cultivated area is annually increasing.”

As to the volume of water of the Illinois River, and the practicability of deepening its channel, he says: “As already stated,

“the extreme flood discharge of the Illinois River at Marseilles, Ill., is about 70,000 cubic feet per second. Below that point it receives many large tributaries, and drains a much larger area than above it. The Fox River, the two Vermillions, Big Bureau Creek, Sangamon River, Spoon River, Crooked Creek, the Macoupin River, and many others, probably swell its extreme flood discharge at its mouth to from 120,000 to 150,000 cubic feet per second.

“It may then be said that the channel of the Lower Illinois, without overflow, will not discharge one-third of its natural drainage at floods. The impracticability of preventing overflow, then, by such methods as enlarging the channel of the Lower Illinois by the removal of the dams therein and dredging, is apparent, when it involves the increase to three times its present capacity, of a channel more than fourteen feet in depth below the crest of the banks, and varying in width (not including Lake Peoria) from 600 feet to 1,400 feet, and 225 miles in length, from La Salle to the Mississippi River.”

The estimate of Capt. Marshall, quoted hereafter (p.86), that from 100,000 to 300,000 acres of land were subject to inundation, was intended by him to be very conservative; but he has stated privately that in his judgment there were 400,000 acres of land in the Illinois Valley liable to be overflowed. As already stated, Capt. Marshall has charge of the Government works on the Illinois River, which include the dams and locks at Henry, Copperas Creek, La Grange, and Kamphouse, and his opportunities for forming a correct judgment are, probably, better than those of any other man living. It is true that these bottom lands are overflowed at times by the waters of the streams tributary to the Illinois River, but this is occasional, while the proposed canal is for a permanent and steady contribution to the volume of water. It is therefore obvious that at flood seasons the water will reach the flood stage sooner, will rise to a higher point, and will remain longer than if no such addition is made. No one can tell the effect of such an addition; computations are idle. There are twenty-four counties in which suits may be brought, claims for damages will be submitted to local juries, the plaintiff's attorney will recover his fees for services, from the Drainage Board, the “oldest inhabitant” and ancient fishermen will be standing witnesses to prove that the water

never rose so high, or remained so long, and it will be for the jury to say whether the plaintiff has been injured by flooding caused by the Drainage Board, and if so, how much.

Capt. Marshall states that these lands are being improved. This has been done notwithstanding the risk of overflow, and of damages without compensation, as chances would be taken for an occasional crop; but with the certainty that damages could be recovered from the great city of Chicago in case of overflow, their improvement will be much more rapid.

During the months of May and June, 1892, there were heavy rains in Illinois, Indiana, and Wisconsin, raising the Kankakee, the Des Plaines, and the other tributaries of the Illinois to a great, but not unprecedented, height; of course the effect upon the Illinois River was very great.

The following dispatches from some of the localities on the river are taken from Chicago papers:

[From the *Chicago Tribune* of May 5th.]

“OTTAWA, May 4th.—The most disastrous work of the flood in this vicinity occurred in the town of Marseilles. The Illinois River rose to a point eighteen feet over low-water mark, and by the pressure of the angry waters two of the immense gates of the water-power were swept away, and all the factories, including the Clark paper mill, were compelled to suspend operations. At Ottawa, the Fox and Illinois rivers overflowed their banks, * * * * people living on the bottoms were compelled to leave their homes, and thousands of dollars worth of property was destroyed.”

[From the *Tribune* of May 7, 1892.]

“PEORIA, May 7th.—The La Marsh drainage district, in the lower end of this county across from Pekin, is now a watery waste. The picture is one of desolation and destruction, and the work of two years has been swept away; household goods of every kind are floating about the river and the inundated district. There was a large amount of live-stock of all descriptions in the district, and the loss from this source will be very great. It is impossible at this hour to form any estimate of the loss, but it will be very great.”

[From the *Tribune* of May 9, 1892.]

“PEORIA, May 8th.—The river at this point is four miles wide. Any number of small houses have been carried away or submerged; and where thousands of acres of fine wheat were growing a few days ago, there is nothing now but an angry flood. The crops are totally ruined, and the land, which has been farmed continually since 1844, will be so cut up as to be practically valueless.

“The loss in some places alone will reach hundreds of thousands of dollars; the waves are rolling high and the greatest danger is to be feared.”

[From the *Chicago Herald* of May 4, 1892.]

“MARSEILLES, ILL., May 3d.—From appearances a miracle only can save Marseilles from threatened inundation. The almost unceasing rainstorms that have raged up and down the Illinois, Fox, and Kankakee valleys, since Sunday night, have precipitated upon this large area thousands upon thousands of tons of water in excess of any heretofore encountered flood. The rivers have been rapidly rising since yesterday, and the Illinois, from far above Marseilles to the navigable waters below La Salle, is nearly a mile wide, and deep enough in the channel to float the largest lake vessels. The waters have already risen some eighteen feet above low-water mark, and in this city the situation is desperate.

“A long levee on the north side of the river and also above the dam has for years kept back the waters of the spring floods. To-day the new flood-gates of the water-power system went out, and water began flowing over the levee. Nearly five hundred men employed in the factories below, which would receive the heaviest part of the flood were the levee to break, were put to work upon the embankment with shovels and teams, and succeeded in fighting back the waters until to-night by driving piles and placing two feet of earth upon the top. But at 9 o'clock this evening, though the men are still at work, the waters are slowly gaining upon them, and are already creeping over the eastern end of the levee, which may break at any moment. Should the levee break, some fifty families, who have already moved to the high lands beyond the canal, would be

“ rendered destitute, and all the district between the canal and
 “ the river would be buried under fifteen feet of water.

“ The breaking of the levee may mean the sweeping away of
 “ nearly every manufacturing institution in the city, including
 “ the Illinois Valley paper mill, the largest in the world; the Mar-
 “ seilles Manufacturing Company’s works, the John F. Clark
 “ mills, the Dawell flouring mills, and many new industries, in
 “ which millions are invested.

“ Besides the damage done here, miles upon miles of valuable
 “ crops put in upon the Illinois bottoms for twenty miles on
 “ either side of Ottawa are under water, involving a loss of
 “ \$50,000 to farmers. The Kickapoo and other bridges have
 “ gone out, and Allen Park, Ottawa, and all of the lower islands
 “ are flooded. At 10 o’clock to-night the waters are still rising,
 “ and the Pioneer Fireproof Construction Company’s works in
 “ Ottawa, the Utica road, and a portion of Utica are under water.”

[From the Chicago *Herald* of May 7, 1892.]

“ OTTAWA, ILL., May 6th.—Seas of water are over and in the
 “ five unfortunate Illinois cities—Ottawa, Marseilles, Peru, La
 “ Salle, and Utica. The Illinois has risen steadily through the
 “ day. To-night the cities are in total darkness, the result of the
 “ flooding of the electric light and gas plants. Boats are used
 “ for communication, and their twinkling lights, glistening over
 “ the unbroken expanse of water, add to the appearance of ruin
 “ which is all around them.

“ To-day the list of unfortunates by flood was added to by
 “ the numbers of people driven from houses which escaped yes-
 “ terday, but were invaded to-day. Despite all efforts the manu-
 “ facturing district was totally covered by water this afternoon.
 “ As the water rose, building after building would close down, and
 “ the employes leave to await the subsiding of the flood. It will be
 “ two or three days before the more fortunate of the flooded fac-
 “ tories can be entered at all, and it will take as much longer to
 “ remove the accumulations of mud and debris which came with
 “ the inundation. Ottawa will be helpless for a week at least.

“Marseilles, La Salle, and Peru are in an even more desperate
 “ condition. At Marseilles the river, steadily rising, is more and
 “ more dreaded, as the levees weaken. There is little hope they
 “ will stand much longer, and every one in the district threatened,

“has removed all property to high ground. At La Salle, the
 “situation is even more desperate than it was last night, the
 “water having advanced from two to three feet all around the
 “city, and the manufactories, the water works, street railway
 “and electric light plants still being under water. The same
 “condition is present at Peru, and in both cities all business is
 “practically suspended. At Utica the waters have encroached
 “still farther upon the lower end of the village from the river,
 “and the outlets east and west are blocked by water. Ottawa,
 “Marseilles, La Salle, and Peru are without electric light and
 “gas, and to-night are in total darkness. The waters still cover
 “Ottawa’s parks, and her street railway is useless.

“LACON, ILL., May 6th.—The Illinois river at this point is
 “higher at present than it has been for a quarter of a century.
 “The long-continued rains have swept out nearly all the small
 “bridges in the country. Travel between Lacon and Sparland
 “is suspended, except by small boats, the bridge across the
 “Illinois being covered with water and liable to be carried away.
 “The tracks of the Chicago, Rock Island & Pacific Railroad are
 “badly damaged between Peoria and Bureau, and all the trains
 “stopped. The bottom lands are all under water, and no corn
 “will be raised on thousands of acres.

“HENNEPIN, ILL., May 6th.—The heaviest rains for the same
 “length of time, ever known, commenced Sunday evening.
 “Three and one-half inches of water fell Sunday night, $1\frac{3}{4}$
 “inches Monday night, $2\frac{1}{2}$ inches Wednesday night, a total in
 “the three nights of $7\frac{3}{4}$ inches. The Illinois River is the highest
 “it has been since 1849, rising at the rate of two inches an hour.
 “Bottom lands are all submerged, and great damage has been
 “done to bridges and fences. No mail has arrived for two
 “days.”

[From the *Herald* of May 9, 1892.]

“PEORIA, ILL., May 7th.—At least 150 families of five hundred
 “souls on the river banks in this city, between here and Pekin,
 “and in the La Marsh drainage district, have been driven from
 “their homes by the rapidly rising waters. It is the most severe
 “flood which has occurred in this section of the country in many
 “a year, and it will not be until after the waters have receded
 “that anything like an accurate estimate of the loss can be made;

“and even then it will be very indefinite in its character. All
“night long the water poured through the break in the dyke of
“the La Marsh drainage district, and by daylight there was at
“least fifteen feet of water inside. It came through in a raging
“torrent.

“Water is now running into the barns of the transfer com-
“pany at the foot of Harrison Street. The electric light com-
“pany is threatened, and is building a bank to keep the water
“out. The Treusdale Manufacturing Company is doing a similar
“thing at its planing mill at the foot of Eaton Street. The
“Hanna wagon works, in the extreme upper end of the city,
“were forced to shut down on account of the high water. The
“cattle pens at nearly all of the distilleries are now within reach
“of the river, and the water is running into one or two of them.
“A rise of a foot or two would necessitate the removal of hun-
“dreds of head, entailing a heavy loss.

“BEARDSTOWN, ILL., May 7th.—The Illinois River is rising
“very rapidly at this point. The recent heavy rains have
“flooded the entire region, and rivers, creeks, and other tribu-
“taries are pouring in immense volumes of water, which are
“flooding the Illinois bottoms. The water is now fourteen feet
“above low-water mark, and is destined to go much higher.
“The whole country, from this city to the bluffs in Schuyler
“County, a distance of four miles, is one vast sheet of water,
“while below, at some points, it spreads over a territory from
“four to seven miles. The river has not been as high for many
“years. Thousands of acres of valuable land are submerged
“under four feet of water. Farmers who live in the bottoms
“have transferred their stock and movable property to the high
“lands, and from their places of safety sorrowfully look down
“upon their inundated farms. Fortunately, the rise was antici-
“pated, and no loss of life has occurred, but the damages done
“to the farmers will be stupendous. It is probable that no
“crops will be planted on the now submerged lands. In that
“event, thousands of acres of fertile land will remain idle during
“this year.

“HAVANA, ILL., May 7th.—The Illinois River at this point is
“from bluff to bluff, four miles wide, and is rising at the rate of
“one inch an hour, the highest water known since 1849.”

[From the *Inter Ocean* of May 21, 1892.]

“ALARM IN PEORIA.

“PEORIA, ILL., May 20th.—Special Telegram.—In the last four hours the Illinois River has risen four inches, and there is considerable alarm to-night lest the bridges, which have been subjected to such severe strains in the last two weeks, may go out.

“All the bridges between this city and East Peoria were swept out this evening. The entire Illinois Valley is a scene of desolation. Farms that are usually being worked at this time of the year are now under several feet of water. The farmers have abandoned the hope of being able to get a crop of corn in this year, as the season will be too late. It will take three or four weeks of the most favorable weather to get the water off the farms, and the ground will be too wet to work.

“The big ice-houses in this city are surrounded by water, and it was discovered to-night that the ice had been melted by the warm currents and washed away. This represents a loss of several thousands of dollars.”

The foregoing are samples of the dispatches from the river towns. The actual damage was very great in the aggregate. Every town on the river, and probably every farm, suffered more or less. There has been no attempt to ascertain the total amount, as there was no reason for so doing; but when the waters of Lake Michigan are poured down at the rate of 300,000 cubic feet per minute, there will then be abundant reason for collecting the amount, and the taxpayers of Chicago will have full opportunity to know what it will be.

If, in addition to damages for flooding lands, a flood should sweep through some of the river towns, actually accomplishing the great damage which was in May only threatened, and sweep away homes, warehouses, factories, bridges, etc., and destroy more or less lives, then Chicago would realize in the highest degree the blessings of a “tail-race.”

These are neither remote nor improbable consequences. They are the natural and certain results, sooner or later, of carrying out the present drainage scheme, and they are certainly appalling.

THE VALUE OF A WATER-WAY.

Some general notions as to the value of artificial water-ways are very prevalent, but a little examination will show that, except as a means of transit for a large existing commerce through a short channel, from one large body of water to another, such as the Suez, the Welland, the Sault Ste. Marie, and the Caledonian canals, and possibly a canal across the isthmus between North and South America, artificial water-ways have generally either been abandoned, or maintained at an expense beyond their income, by a tax of some sort upon the general public, or from resources other than tolls.

In the State of Indiana, the canals have long since been abandoned, and the tow-paths converted into lines of railroad track. In Ohio they have canals from Cleveland to Portsmouth on the Ohio River, and from Toledo to Cincinnati, and two short lines, aggregating in all 600 miles of canal, and costing \$15,000,000. For the three years ending January 1, 1892, their aggregate receipts from tolls, sales of water-power, and all other sources were \$325,000; their aggregate expenses during the same period were \$500,000. The receipts of all the canals have fallen from \$800,000 in the year 1851 to \$108,000 in 1891. Their continuance in use, however, is of a very uncertain tenure.

Even the New York & Erie Canal, so long the pride of the State of New York, seems destined to succumb to the inevitable. Traffic on the canal has for years felt the effect of railroad competition, and concessions have been made from time to time in order that it should continue in use, until finally the entire expense of maintaining it is borne by the State, and transportation is made free of tolls, and yet its use as a means of transportation has become unprofitable.

The following is taken from a Chicago paper of August 2, 1892:

"BUFFALO, N. Y., August 1st.—The statement of the exports "by canal from this port, from the opening of navigation to "date, is little short of startling, and corroborates the state- "ment that canal-boats are being tied up, and their owners seek- "ing other employment. Of the total receipts of grain in the "above period, which were 72,570,000 bushels, the largest on

“record, only 10,242,000 bushels were shipped by canal, the rail-roads getting all of the flour shipments, and 34,089,000 bush-“of grain, or, estimating flour as wheat, 54,000,000 bushels of“the total. The movement by canal is the smallest on record“for the same time, and only half the amount shipped in 1890 to“August 1st. The railroads have been carrying grain to New York“at 2½ cents a bushel, and this rate the canal-boat men can not“compete with under the present conditions.”

The future of that great line of water communication is a question of considerable interest, but this is neither the time nor the place for any extended discussion. Its continuance in use is doubtless a matter of State pride, and if the results of closing it should be such as some people prophesy, it would have not only an important bearing upon the future of the city of New York as one of the great grain markets of the world, but be of great importance as affecting the cost of transporting Western crops to the seaboard.

It is insisted, and with some apparent reason, that any sort of a canal or water-way operates as a restriction upon excessive charges for transportation by railroads, and that the effect is the same, whether a pound of freight is carried by water or not.

A careful study of the history of freight rates, and an analysis of the conditions under which rates by rail are affected by water communication, will probably show that this claim is not as well founded as many believe.

Take the case of the canal to Joliet; it is probably a fact that the rates by rail between Chicago and Joliet are higher in winter than they are in summer. To see what this proves, let us go back a little. Down to 1879, the receipts from tolls upon the canal were largely in excess of the expenses of operating it; prior to that time, railroads had been reducing rates, and the canal was compelled to meet them, until, in 1879, rates came down to a point where the canal could not secure freight by underbidding. The canal commissioners have made rates for that purpose ever since, but they could neither secure business nor tolls sufficient to pay expenses. The plain English of the matter is, that they are now, and for thirteen years have been, using the property of the State to make low rates between Chicago and Joliet; or, to put the matter in still plainer terms, they are bushwhacking the railroads with the property and money of the State.

Now the question fairly is, What would have been the rates by canal, if there had been no railroad? It is not to the point to say that if the railroads could carry freight in summer at one figure, that figure ought to be enough for winter carriage. The reason why railroads make this cut in summer may appear further on, but the fact of such cut in summer does not establish, and has no tendency to establish, the fact that the winter rates are unreasonable.

It is also insisted that the railroads are carrying grain from Buffalo to New York at a loss, in order to do away with the New York & Erie Canal, and, that this being accomplished, rates by rail will be put up to a ruinous figure, and that therefore the canal should be maintained even at public expense.

It is not worth while for one not in the counsels of railway managers, to undertake to speculate upon their motives, but there are some things which are obvious upon a moment's reflection.

For instance, a railroad must maintain its equipment of rolling-stock and its force of employes. Railroading, like manufacturing under similar circumstances, must sometimes be done even at a loss, rather than have the equipment degenerate for want of use, and the working force scattered for want of employment. It requires no effort of the imagination to suppose that railroads under such circumstances carry freight, not only without a margin of profit, but at an actual loss; in short, railway managers may well say, "Here is the work to be done, we have the means "to do it, and we are going to do it at a rate that will secure it." Another consideration affecting the rates of freight by rail, is the fact that very often empty cars are wanted at the other end of the road. It costs but little more to send full cars than it does to send them empty, and so a rate will be made, which, while it is transportation at a loss, this loss is not so great as it would be were the cars sent forward empty.

So far as the transportation of grain to the seaboard is concerned, there are too many rival lines, competition is so active, and the interests of the great lines of railway terminating in New York City are so vital, to preserve that city as the great seaboard market for grain, as against Portland, Boston, Philadelphia, Baltimore, and Richmond, and as against direct shipments to Europe by the way of the St Lawrence, or by the Mississippi River and Gulf of Mexico, that the probability of

extortionate rates by rail from Lake Erie ports to New York City is very remote.

So far as freights are concerned, the competition is so fierce that the most solemn agreements on the part of railway managers to maintain rates are constantly broken, even when aided by the rigorous provisions of the interstate railroad law.

Jay Gould has a lot of barges tied up and rotting along the Mississippi River. He did ship some grain by those barges to New Orleans. He is supposed to be addicted to ways that are profitable, and if there was a profit in sending grain down the river, it is more than probable that he would know it, and attempt to realize it.

There are people unkind enough to say that he built those barges as a stock-jobbing operation, and that they were intended more to affect Wall Street, than as a means of transportation. Those who are in the secret of his wizard-like performances can say whether this is correct or not.

To sum the matter up, it may be said, with perfect accuracy, that the transportation of freight by rail has revolutionized the commercial systems of the world. The lines of freight cars which one sees snaking in every direction across our broad continent, are exponents of a power which has contributed, more than any other single agency, to the development of the age in which we live.

To say that rates of freight are in general controlled by water competition, is to say that the greater is controlled by the less.

There are those who will say that this is manifestly so as to the great grain shipments from Chicago, and other lake ports, to Buffalo. Here, too, a little examination will show that this claim needs limitations. Old-fashioned vessels were fully loaded when 40,000 to 60,000 bushels of grain were stored in their holds; now, the great lake liners carry from 90,000 to 125,000 bushels of grain. The old-fashioned hull was pear-shaped, while now, the sides of new vessels are perpendicular, or bulge outward below the water line, and their bottoms are square to the sides; and, even as thus constructed, the new boats being built, as before stated, are of an increased width. In short, every effort is made to secure extension and economy of space, in order that they may secure freight. It is only as they carry these huge masses, that they can compete with shipments by rail. Deep-

water navigation upon natural water routes will probably be able to hold its own against railroad competition, on account of the immense cargoes which can be carried by a single vessel; but beyond this, for equal distances, water transportation will get only the leavings.

To compare any system of water freighting across the State of Illinois, or up and down the Mississippi, with those great transports upon the lakes, comes pretty near being ridiculous.

The eighteen-foot channel proposed by the water-way crowd is utterly impracticable, either across the State of Illinois, or up and down the Mississippi River; but if it were otherwise, if such a channel could be built and maintained, and vessels of sixteen to eighteen foot draught could pass Chicago, cross the State of Illinois, and thence up and down the Mississippi River, it would be well for some of these gentlemen who claim to have broad and comprehensive views, to explain what would be the effect upon Chicago as a grain market. It produces a "goneness" of feeling, to think that there are in Chicago, men supposed to be intelligent, who advocate the expenditure of millions of dollars by the city of Chicago for the construction of such a work.

Finally, upon the subject of water-way competition, it must be remembered that boats must be kept in readiness to do the business, and it is absurd to suppose that people are going to keep up boats ready for work but lying in idleness, simply as a check upon railroads.

The fact is, that the basis of all business is profit, and unprofitable water-ways must go into the limbo of other antiquated productions.

It almost seems idle to discuss the question of a great water-way in connection with the channel now undertaken by the Drainage Board. As we have seen, this channel terminates in a sluice-way $4\frac{1}{2}$ miles long, having a current six to eight miles an hour. Practically speaking, it may be said that by propositions two and three it has been demonstrated that it will cost \$6,000,000 to carry a navigable channel from Lockport down to the upper basin, and this without including the necessary expense of immense locks.

The value of a great water-way between Chicago and Joliet depends upon the improvement by the General Government of the Illinois River upon a scale commensurate with the work this side of Joliet.

The report of Capt. Marshall above referred to may be said to have put a final quietus upon any such project, so far as the United States Government is concerned. Upon the subject of the cost of a water-way, Capt. Marshall says: "No estimate has yet been made of the cost of securing a depth of ten feet of water to St. Louis; \$17,000,000 is estimated to get eight feet from St. Louis to Cairo; what it will cost to get and maintain the additional two feet in that region of moving sands, no one knows.

"No estimates have been made to carry ten feet to the mouth of the Missouri, nor to the mouth of the Illinois, nor fourteen feet, up the Illinois to La Salle, but for fourteen feet from La Salle to Lake Michigan, an estimate is herewith, of more than forty-eight millions.

"The definite estimates then so far submitted, foot up nearly one hundred millions, and leave us with eight feet draft below St. Louis, and not exceeding five feet above, to La Salle."

Capt. Marshall gives a table of the number and capacity of the steamers navigating the Mississippi River and its tributaries, and their draft and carrying capacity in 1890. There were only fourteen steamers drawing nine feet of water, and with a carrying capacity of 16,600 tons. There were 712 steamers drawing less than eight feet of water with a carrying capacity of 160,000 tons.

He further says that the largest Mississippi River steamer that reaches the mouth of the Illinois draws about seven feet of water, when loaded to its fullest capacity. Continuing, Capt. Marshall says: "No greater depth of channel than nine feet at extreme low water in Lake Michigan, across the Chicago Divide, seems necessary for navigation by the largest Mississippi River craft, which can neither reach it, nor use it.

"Beyond the Chicago Divide (that is, west of the summit) there is no apparent necessity at present, nor likely to exist in the near future, either national or local, for any channel of greater capacity than eight feet in depth between the Mississippi River and the Great Lakes."

Upon the question of the propriety of the United States Government undertaking the work of deepening the channel of the Illinois River, and of assuming to pay the damages caused by turning a large quantity of water from Lake Michigan into it, Capt. Marshall says in his report:

"This artificial discharge is not necessary for navigation

“anywhere along the line, and can not be said to benefit navigation anywhere to such an extent as to justify the United States Government assuming responsibility for flowage damage caused by it.

“The discharge is proposed to be constant, whereas if it were produced by the United States for the benefit of navigation it would be introduced into the Illinois only at low stages, when it would be beneficial to navigation, and harmless to property.

“Now, at any little summer freshet, producing a discharge exceeding 8,000 cubic feet per second at La Salle, damage by overflow would begin at that point, the artificial discharge being 10,000 cubic feet per second, and with greater natural discharge, become more and more widespread, as we progress down stream, at times when such overflows would not otherwise occur. Upon all rises of the river producing anywhere near bank-full stages, this artificial discharge would cause flowage damages that would not otherwise occur. The lands would become submerged at high water earlier, and the water remain upon them longer, than it otherwise would. From 100,000 to 300,000 acres of land in the Illinois River Valley will be subject to such conditions.

“That feature, therefore, in the Chicago drainage and waterway laws, that requires a constant discharge of from 300,000 to 600,000 cubic feet per minute, seems, in view of past experience, decidedly objectionable, if the water is to be introduced through any canal either owned or used by the United States for public purposes, if, by such ownership or use the United States can be made responsible for damages due to such constant discharge.”

Mr. Cooley has indexed his pamphlet, above referred to, in some dozen to twenty different places, upon what he terms the blunders, errors, misstatements, and omissions of Capt. Marshall. The latter still lives, however, and continues in charge of the Government work, and, upon occasion, can doubtless obtain the highest indorsement from capable judges as to his engineering capacity. The reader has had some means of judging as to whether Mr. Cooley is entitled to a like certificate.

This report of Capt. Marshall was made in 1890, and yet, in 1891, we find Cooley, Williams, and Hurd before the Legislature, resisting the application of the Drainage Commissioners in

their effort to modify the requirements of an eighteen-foot rock-cut channel, and we have Mr. Cooley's pamphlet, published in 1891, in advocacy of a great water-way. Possessed with this idea, they undoubtedly look forward to a time when it will prevail, and steps be taken to carry it into effect. No legislation in that direction has been taken, nor is any likely to be. The River and Harbor Committee of the House of Representatives is composed of men, many of whom have served upon it for years, and are thoroughly familiar with all questions affecting the Mississippi and its tributaries, nor is it likely that this committee will, through any political upheaval, be deprived of men of that character. They know that on the Lower Mississippi, during the palmiest days of river navigation, no boats were ever built drawing over nine feet of water, and that for the Upper Mississippi—that is, between St. Louis and St. Paul—boats were not built for a draft of more than six feet when loaded, and that the channel of the Mississippi River is constantly changing; that sand-bars are forming and disappearing, and that the attempt to maintain a channel in the river, of greater depth than will suffice for such boats, could only be successful at an expense far beyond what would be warranted, and wholly unnecessary.

A further consideration as to the uselessness of a great water-way between Chicago and the Mississippi River is the fact that the great grain shipments from the West reach the river by rail, and it is simple nonsense to suppose that bulk will be broken at river points, on freight between points west of the river and Chicago, or that any saving could be made in expense by the use of water transportation. The distances from points on the Mississippi River, at railroad crossings, to Chicago by rail and water, are as follows:

To Chicago from	By River—Miles.	By Rail—Miles.
La Crosse	853	276
Dubuque	720	184
Clinton	652	138
Savannah	675	138
Davenport	613	183
Burlington	529	206
Fort Madison	505	237
Louisiana	393	274

No man having the least practical knowledge of transportation, but will recognize in the extra handling of freight, insurance by river, the delay of several days in transportation,

the loss of interest while property is in transit, the inconvenience of being deprived of the use of capital by the delay in reaching the market, and the possible loss from a falling market while the grain is going by water, elements more than sufficient to cut off any competition between rail and water, on freight between points west of the river and Chicago, going in either direction. The great item of freight on the Lower Mississippi is cotton, and that will go to New Orleans for an Eastern or foreign market.

It is notorious that transportation on our Western rivers has been for the past twenty years rapidly on the decline; this has been apparent to the most casual observer; but that the matter should not be one of general impression, circular letters were sent in May, 1891, to many of the most important river towns upon the Mississippi, and its tributaries, containing this inquiry:

“What relation does the traffic (passenger and freight) by “steamer, now bear to the same traffic, twenty years ago.”

Some eleven replies were received, in substance as follows:

From Leavenworth, Kan.—Little or no traffic by steamer. Business increased 50 to 75 per cent.

(Signed)

H. M. MOORE,
Secretary Board of Trade.

From Cairo, Ill.—About half the up-river business. General merchandise business increased five to one.

(Signed)

E. W. HALIDAY.

From La Crosse, Wis.—The various packet lines have all disappeared, excepting the Diamond Joe Line, and that company has only recently made the upper river a regular route.

(Signed)

R. CALVERT,
Secretary Board of Trade.

From Dubuque, Iowa.—Not more than one third the freight by steamer now that there was twenty years ago. General business ten times as much.

(Signed)

E. B. FARLEY,
Secretary Board of Trade.

From MacGregor, Iowa.—River traffic one-sixth of what it was then. General business about the same.

(Unsigned)

From Winona, Minn.—Freight by river one now to fifty twenty years ago, except logs. General business four times greater now than then.

(Signed)

D. SINCLAIR,
Editor Daily Republican.

From Savannah, Ill.—Freight by river no comparison; way behind. General business has increased in the same ratio.

(Unsigned)

From Wheeling, W. Va.—River traffic fallen off 25 per cent. General business ten times greater.

(Signed)

H. QUARRIER,
President Board of Trade.

From Alton, Ill.—About one-fourth the number of steamboats on the Illinois and Mississippi rivers that there was twenty years ago, and they carry about one-fourth the freight that was then carried. General business more than doubled.

(Signed)

R. T. SARGENT,
Steamboat Agent.

From Hannibal, Mo.—Freight traffic by river one-half what it was twenty years ago. Business has increased 50 per cent.

(Unsigned)

From St. Joseph, Mo.—Traffic by steamer 1 per cent. of what it was twenty years ago. General business four times as large.

(Signed)

F. T. SCHRADER,
Secretary Board of Trade.

The decadence of traffic upon our Western rivers is further witnessed by the report of the United States Commissioner of Navigation, for 1890, as to the annual average amount of tonnage of water craft built for navigation on our Western rivers.

To condense the matter, this average is given in groups of five years from 1865 to 1890, as follows:

Years.	Annual Average	Tons.
1865-1870	51,901
1870-1875	“ “	55,717
1875-1880	“ “	42,552
1880-1885	“ “	38,580
1885-1890	“ “	11,355

There are about 17,000 miles of navigable waters of the Mississippi and its tributaries, and notwithstanding the immense growth and development of the country from the close of the war in 1865 down to 1890, especially of that portion west of the Mississippi, both north and south, it appears that the annual tonnage built for the five years ending with 1889 is scarcely one-fifth of what it was twenty years previous. These river craft are flat-bottomed, lightly built, and short-lived, and yet the requirements of river navigation have not been such as to maintain the actual tonnage. Year by year it has steadily declined.

It is in the face of such facts and figures that the city of Chicago is called upon to expend thirty to forty millions of dollars in the flatulent scheme of a ship canal from Bridgeport to Joliet. It would seem as though among the noisy advocates of this expensive work there should be found some one able and willing to give a calm and rational estimate of its value to the interests of commerce.

Cheap rates for the transportation of freight are very desirable, and may be secured by a State having sufficient resources, in various ways; it may build lines of railway or canal, and operate them without reference to the income to be derived therefrom; it may subsidize existing lines, or maintain them at public expense; all this is simple enough, but there is, or there ought to be, some underlying principle.

The only principle which can justify taxation of the public for such a purpose is, that it is for the general welfare; hence the questions to be considered in proposing any interference on the part of the State are, Who are to be benefited, whether the benefits are general, and whether they bear any proportion to the proposed expenditure.

These questions can not be answered by vague declamation or dogmatic assertions. If there is any substantial basis for the use of public money for the purpose of cheapening transportation, the advocates of such use should find some facts and figures in its support; and these facts and figures are not to be found in what the New York & Erie Canal accomplished fifty years ago, nor in what Manchester, England, is trying to do today, but in the needs of the day and hour, here where the scheme is to be worked out.

A somewhat laborious search through that mass of speculation and conjecture compounded by Mr. Cooley, and issued forth under the pretentious but obscure title of, "The Lake and Gulf Water-way as Related to the Chicago Sanitary Problem," does not disclose any facts, figures, or theory upon which such a channel could be considered of value. This composition, or mosaic of fragments, must be a "preliminary report"—it begins nowhere, rambles at will in a jerky, disjointed fashion, and concludes nothing. It is an amplified specimen of what may be expected when a man "continues at large."

Mr. Cooley says, speaking of a depth of ten feet of water in the Mississippi, between the mouths of the Illinois and Missouri

rivers, "No one will contend that this depth can not be had "over this twenty-four miles, if there is any wise purpose to be "subservd, as there would be." "As there would be." This is taken from an article written by Mr. Cooley and published in the Chicago *Tribune*, January 29, 1890, in advocacy of a ten-foot channel in the Mississippi, between the mouth of the Illinois River and St. Louis. "If there is any wise purpose to be subserved, as there would be!" Perhaps the fact that Mr. Cooley has declared the creation of such a channel "a wise purpose" establishes that fact. There are certainly no other reasons for believing it anything else than an act of supreme folly.

It may be said on behalf of Mr. Cooley, that he is an engineer; that he is a man of vast ideas; that he does not pretend to take cognizance of the sober realities of this work-a-day world, but dwells in the vast empyrean of sublimated ether, where his spirit roams at will, uncontrolled by the sordid elements of practical life—this may be so; if we take what he has written upon the subject of a water-way, as indicative of the sobriety of his judgment, this explanation would seem to be correct.

There is yet another apostle of the great water-way. Listen to Carter Harrison as he expounded the glories of a great water-way to the Common Council of the city of Chicago, in January, 1887:

"To-day there are distant rumblings of possible war between "this country and England, and mighty interests are alarmed by "the exposures made by scientific men of the ease with which "this and other lake cities may be blown into atoms by British "gun-boats, before this country can be ready for war. If this "canal, necessary for Chicago drainage, were now finished, gun-boats could be rapidly built which could lock up in the Welland "Canal England's navy, whereas, to build now a single gun-boat "capable of reaching Lake Erie would be a declaration of war.

"Government should build this canal, and should commence "it at once, and through its building unload itself of the idle "hundred millions in its vaults, which should be giving work and "bread to industrious laborers; and by the aid of such canal "placing itself in a position which would not bring a blush of "shame to the American cheek, by a repetition of the Mason and "Slidell fiasco.

"If Government will not build it, then Illinois, with its proud "position of third State in the Union, owing not a dollar of debt,

“should do the work. If the State, blind to its interests, refuses, “then Chicago should not supinely call upon national or State “Herculi for help, but should put its own shoulder to the wheel; “should demand of the State the privilege and power to do the “thing, and should build the mighty work. It should do that “itself which is necessary for its health and comfort, even if by “so doing it frees the nation from periodic scares by enabling it “to build gun-boats which would hold the keys to the Welland “Canal. It should finish the work itself, even though by so doing “it would give the Northwest a river capable of floating great “steamers between the lakes and the Mississippi, carrying on a “mighty trade, and worth more to the people in governing rail- “road traffic, and lessening extortions, than a dozen interstate “commerce bills.”

And it is by such rodomontade as this, and purblind blinking at the commercial value of a great water-way down along the Illinois bottoms, that Chicago is to be led into the expenditure of \$30,000,000 or \$40,000,000.

Undoubtedly this volume of water would dilute the sewage, and if it were necessary to build the channel for that purpose, we should have to submit; but it is not necessary; and further, as has been shown, the scheme was put through for the establishment of a great water-way, to which the sewage question was only incidental.

THE ENGINEERING PROBLEM.

The writer makes no pretensions to a knowledge of engineering, but it would seem as though all questions of a general character, involved in the creation of a canal from Bridgeport to the upper basin, ought to be understood by any man of practical common sense.

The Des Plaines River, flowing southerly, at a point about a half mile north of Summit—a station on the Alton Railroad, $8\frac{3}{4}$ miles from Bridgeport—turns rather sharply to the southwest, and flows in that general direction through a narrow valley, from one-fourth of a mile to a mile in width, to Joliet, a distance from that point of about twenty-five miles. The present canal and the Alton and Santa Fé railroads traverse the valley. The country between Chicago and Summit is level, but from Summit to Joliet are ranges of hills on both sides, and any canal from Summit to Joliet must go down the valley.*

The low-water mark of Lake Michigan is called Chicago datum, and is the level from which calculations of height or depression are made. Chicago datum is not an extreme low-water level. The lake stood at about datum for thirty days during 1889, and for half the year was only six inches above.

At the summit, the low-water level of Des Plaines is eight feet above datum, and, with a slight fall, continues above datum until Romeo is reached, twenty-five miles from Bridgeport, where the surface of low water in the Des Plaines is about level with datum. At Lockport there is a rapid fall of twenty feet, and between Lockport and Joliet there is a fall of about twenty-two feet, making the aggregate fall in the Des Plaines, from the

* The various points on the route to which references are sometimes made, and their distances from point to point, are about as follows: Bridgeport to Summit, $8\frac{3}{4}$ miles; thence to Willow Springs, $4\frac{1}{2}$ miles; thence to Sag, $4\frac{1}{2}$ miles; thence to Lamont, $3\frac{1}{2}$ miles; thence to Romeo, $4\frac{3}{4}$ miles; thence to the locks at Lockport, $3\frac{1}{2}$ miles; thence to head of Upper Pool, $3\frac{3}{4}$ miles; thence to the natural level of the Des Plaines at Joliet, $1\frac{1}{2}$ miles.

summit to the natural bed at Joliet, about fifty feet, and from Chicago datum forty-two feet.

The Des Plaines Valley is about one-half mile wide at the summit, one-fourth at Willow Springs, and over a mile wide at Romeo and Lockport. The surface of the valley is comparatively level between the hills on either side, and has a slope from Summit to Lockport, substantially corresponding to the level of the Des Plaines River; the so-called "Sag" cuts no material figure in the valley.

The bed of the Des Plaines River varies in width. It is about 200 feet wide at Summit, and from 400 to 600 feet wide between Willow Springs and Lamont.

This, then, was the engineering feat to be accomplished. Starting at Bridgeport, fourteen feet below datum, to dig a ditch to the upper basin, through a fairly level valley, for a distance of about thirty miles at a descending grade of five or six inches to the mile, and an increase of four feet in depth through the rock-cut.

About a half million dollars has been expended on that immense problem—at least the half million has been expended, and the figures of engineers and some office furniture is all there is to show for it.

It is a significant commentary upon that engineering work, that Congress passed an act in August, 1888, for the survey of a water-way from Chicago to the Mississippi River. The survey was commenced by Capt. Marshall in May, 1889. He surveyed a route from Calumet to the sag, from Bridgeport to the sag, from the sag to Joliet, and from Joliet to La Salle; made extensive borings and a complete profile map of the entire route from Lake Michigan to La Salle, and detailed estimates of the cost, and made his report to the Secretary of War on February 28, 1890, and all at an expense of about twenty-five thousand dollars. Great are the ways of great water-way men!

RETROSPECT.

Looking back over the history of the efforts which have been made by the people of Chicago to provide adequate means of drainage, the records of the men who have had to do with the matter, and the results which have been obtained, and anticipating those which are likely to follow if the present drainage scheme is carried

out, the man must be of an exceedingly optimistic temperament who can look with tranquility upon the past, or augur favorable results for the future.

Whether the Drainage Act was a wise enactment, or whether any of the men who were instrumental in procuring it, or have been connected with its execution, are deserving of censure, are questions which every reader must decide for himself, on the facts.

It has been reviewed as a Drainage Act, but, as is apparent, the effort of its contrivers was, to secure a great water-way.

Whatever may be, or may have been, the views of some wild theorists about a water-way, the fact is indisputable that the vast majority of the people of Chicago voted for the Drainage Act solely with reference to drainage. They were told by the Press, and by enthusiastic visionaries, that we should have a great water-way for the navigation of vessels of thirteen to seventeen feet draught from the Mississippi River to Chicago, and the commerce of the city doubled or trebled; that future generations would look at the vast work with admiration and awe; miles and miles of valuable docks were to line its banks, a great water-power was to be created, and numberless factories be moved by its surplus waters; vast quantities of valuable stone were to be excavated, which could be used in building; millions of cubic yards of earth were to be thrown up, which could be utilized in filling up the Lake Front, and, lastly, and not the weakest voiced among them, came the anglo-phobist, who averred that whereas, by treaty with England, the United States could now only maintain one war-vessel on our lakes, if this great water-way should be created, we could have down somewhere in the interior of the State a navy yard, with a fleet of Wasp and Hornet gun-boats ready to sweep the lakes of every "blarsted Britisher" that dared to show his head, and home rule for Ireland was to feel the effect.

All the talk about a navy to be held in readiness somewhere down in Peoria or Tazewell counties is sheer nonsense, and belongs to the brass-band order of oratory. The treaty can be abrogated by either party on six months' notice; it is no part of the obligations of the people of Chicago to provide means offensive or defensive against Great Britain, that is for the General Government.

But, supposing that all the foregoing attractions of a ship canal could be realized, the fact remains, that drainage was what

the people wanted. Remove the necessity for drainage, and the brilliant advantages of a water-way to the Mississippi would have been utterly disregarded, and the project overwhelmed with defeat; outside of a few vamping enthusiasts, and those who are indifferent to the burdens of taxation because they pay no taxes, or who see in public expenditures only opportunities to secure high salaries or political influence, the measure would have had few advocates and a trifling vote. People voted for the Drainage Act because they wanted drainage, and were told by those in whom they reposed confidence that this was the only way it could be obtained. No attempt was made to present the enormous, if not insurmountable, difficulties involved in carrying out the scheme, nor the great expenditure necessary to overcome them; nor was any honest and intelligent attempt made to devise the most practicable means of disposing of the drainage question.

THE FUTURE.

Turning from the disagreeable and thankless task of criticism of the Drainage Act, which was rendered necessary by the fact of its existence upon our statute books, it is with a sense of relief that attention is turned to a theory of construction, and to a discussion of the drainage question of Chicago on practical lines. An effort has been made to show that the Drainage Act is based upon absurd ideas, and that its execution will be attended with an extravagant expenditure in the present, and entail upon the city of Chicago continuing liabilities to an enormous amount for all future time.

There is such a thing as the confiscation of private rights under the forms of taxation, and the undertaking of extravagant and chimerical public works is one method of such confiscation; no majority, however great, can be a justification for the taking of a man's money or property, and wasting it in foolish enterprises.

It is not unlikely that the present Drainage Board will expend very considerable sums of money, and impose upon the city of Chicago serious liabilities, before a period can be put to their reckless transactions; still, relief can be obtained at the session of the Legislature in 1893, and it is believed that a sober investigation of the drainage question will demonstrate the necessity of the abolition of the Drainage Board, and a reconstruction of

the methods of relief, upon more prudent lines, even at the sacrifice of all the money expended, and a settlement of all the liabilities created by it. It is proposed then: First, to eliminate from the question all immaterial matters and settle upon the real difficulty; and, second, to discuss the methods of the purification of sewage—first, by irrigation; second, by precipitation; third, the self-purification of flowing water; fourth, attempt to solve the drainage question by the use of one or other, or a combination of systems, in a manner which will avoid contamination of the water supply of Chicago, and do away with grounds for complaint down the river.

FIRST, THE ELIMINATION OF THE QUESTION.

In a vague sort of a way, the question of public health is mixed up with the sewage question, without distinctly indicating how it is affected by the presence of sewage in neighboring waters. For instance, there is published by the Illinois State Board of Health a pamphlet of something over 100 pages with the ponderous title, "Preliminary Report of the Illinois State Board of Health, Water Supplies of Illinois, and the Pollution of its Streams, by John H. Rauch, M. D., Secretary, with Two Appendices: I. Chemical Investigations of the Water Supplies of Illinois.—By Prof. J. H. Long. II. The Illinois River Basin in its Relation to Sanitary Engineering.—By L. E. Cooley, C. E."

In a general way it may be stated, that about half of this publication is taken up with the report by Prof. Long of the analyses of over 750 samples of water taken from the Illinois & Michigan Canal and from various rivers, creeks, ponds, wells, and springs in Illinois, made by the direction of the State Board of Health; the remainder of the pamphlet consists of the several lucubrations of Dr. Rauch and L. E. Cooley, and seems to be in the main (so far as it has any intelligible point) an attempt to prove that the doctor was right in a controversy with some other doctor, about the self-purifying qualities of water, and that the sanitary condition of the people of the State of Illinois would be vastly improved by a great water-way from Lake Michigan to the Mississippi River.

This preliminary report was a final one; it never had a sequel; outside of its contribution to the general stock of knowledge on the self-purifying qualities of water, a topic not however germane to the question of the health of the people of the State of

Illinois, it has no practical bearing on questions properly within the scope of the board. The forty-eight printed pages of analyses of the contents of 750 two-gallon jugs of water, made by Prof. Long "under the direction of the Illinois State Board of Health," have no apparent value, except as above noted.

On the 17th September, 1890, Mr. Cooley announced to the Board of Trustees that he proposed to spend five or six thousand dollars for the analysis of the water of the South Branch; no useful purpose could be subserved by such a proceeding; everybody knows the water is vile—nobody proposes to use it for domestic purposes. His project was simply on a par with his water gauges, reconnaissances of water sheds, speculations upon population, and kindred maunderings, and the analyses of Prof. Long for the State Board of Health have no more practical value.

The greater portion of the London water supply is drawn from the River Thames. The sewage of the city discharges into that river, the flux and reflux of the tide extends to Teddington lock, about twenty miles above London, carrying backward and forward the sewage discharge of the city; hence the necessity of taking water above flood tide, and the water supply is taken at Hampton.

The Thames above Hampton drains 3,676 square miles of territory, with a population of 900,000, and though only portions of this area and of these inhabitants contributed to the contamination of the river, there was still enough to demand serious attention. The matter of the water supply of London was of the utmost importance, and in 1866 a royal commission was appointed, consisting of the Duke of Richmond, Sir John Thwaites, Chairman of the Metropolitan Board of Works; Colonel Harness, Chairman Board of the Royal Engineers; Sir Benjamin Philips, alderman of the city of London; Mr. T. E. Harrison, vice-president of the Institution of Civil Engineers, and Mr. Prestwich, an eminent geologist, to consider the subject. They devoted $2\frac{1}{2}$ years to the investigation. The most eminent chemists and medical men of London, among whom were Dr. Lyon Playfair, Mr. Simon, Dr. Farr, Dr. Parkes, Dr. Letheby, Prof. Wanklyn, Dr. Frankland, Dr. Odling, Sir Benjamin Brodie, Dr. Miller, and Dr. Angus Smith, testified before them. They made their report in 1869, and upon the question of the

value of chemical analysis of water for drinking purposes, the commission say:

“The question now naturally arises, Can we not by careful analysis of the Thames water discover what quantity of organic matters it contains; what is the nature and character of such matters, and how far they are deleterious or otherwise? We have endeavored to arrive at a solution of this question, but unfortunately without much success. The inquiry seems beset with difficulty; the organic matter is present in only very small quantities, and in shapes and conditions which are very difficult to identify and to reduce to actual measure. The treatment of them is still a problem in chemical science, only now beginning to be effectually studied, and the most eminent chemists are yet by no means agreed either as to the process most proper to be followed in the analysis, or as to the value and bearing of the results obtained.

“It does not follow that all organic matter in water is prejudicial * * * almost all our drinks other than water owe their distinctive qualities to the varieties of their organic contents, and hence it is clear that the presence of organic matter, *per se*, is not necessarily prejudicial.”

Dr. Frankland, the chemist of the Registrar General of London, and one of the most earnest sticklers for purity, said:

“It can not be too widely known that chemical analysis is utterly powerless to detect any matter positively injurious to health in any of the forms of animal refuse which go to contaminate water.

“It is for the physiologist, not the chemist, to say what influence the admission of excrementitious matters into drinking water has upon the health of the community. If his verdict is that they have none, then water analysis for sanitary purposes becomes useless.”

Be it understood that this inquiry was as to water for domestic use, by the people of London, and the report demonstrates the absurdity of the chemical investigations proposed by Mr. Cooley, and those actually made by the State Board of Health.

The entire scope of these professedly scientific investigations by Mr. Cooley and the State Board of Health was, like the foggy developments of the engineering question, simply an attempt to mystify common people as to the nature of the work. It was

done to create the impression that there was something wonderfully profound in the matter of digging a ditch to carry off foul water.

Now the plain proposition is insisted upon, that the presence of sewage in any body of water having a current, or subject to agitation, has no effect upon the general health, unless such water is used for domestic purposes. The general range of discussion in Europe, and probably outside of the ranks of water-way cranks, in this country, has been confined to the question as to the use for domestic purposes of water which has been polluted by sewage.

There is no city in the State of Illinois where the water supply is affected by sewage except Chicago, and the paternal guardianship of the State Board of Health is by no means essential to the welfare of that city. It is perhaps unjust to the State Board of Health to suggest that its interference in the matter extended beyond the action of its secretary, Doctor Rauch, who seems to have been a co-laborer with Mr. Cooley in his ship-canal vagaries. He rushed his report into print in April, 1889, at the time when the Drainage Act was pending in the Legislature; he states that the report was put through the Press without taking time to correct typographical errors. It is difficult to conceive, from the contents of the report, what reason there was for such hot haste, unless it was to aid in the passage of that act. He has since, like the Captain of the Pinafore (involuntarily however), been permitted to "seek seclusion."

Upon the question as to the effect of sewage discharge upon general health, it is sufficient to say that the entire sewage of the city of London empties into the Thames, and is washed back and forth as the tide ebbs and flows, and in that connection the following extract is made from Santo Crimp on "Sewage Disposal Works," page 25: "One of the conclusions and recommendations of the Royal Commissioners on Metropolitan (London) Sewage Discharge, 1884, is as follows: That it does not appear that hitherto, the sewage discharge has had any seriously prejudicial effect on the general healthiness of the neighboring districts. But that there is evidence of certain evil effects of a minor kind on the health of persons employed upon the river (Thames), and that there may be reasonable anxiety on the subject for the future."

The above may be taken as completely disposing of any pre-

tense that the health of the people of the State of Illinois, outside of Chicago, is in any way affected by its sewage. As to the health of the people of Chicago, there is no evidence that people living near the river, or working upon it, are unfavorably affected in health by the presence of sewage in the river. The Chicago sewage question resolves itself into: First, the contamination of the water supply of Chicago; and second, the unpleasantness of odors arising from it.

It is true that the Legislature of Illinois, in a "Whereas," once declared that millions of fish were poisoned in the Illinois River by the sewage of Chicago. This is palpably ridiculous. Since that time, four dams have been erected in the river, but there are other considerations which make it unnecessary to occupy time with the fish question. The matter of the water supply has already been alluded to and will be discussed further on. The question of noxious odors, then, is the only one affecting people down the river, and in this connection it is amusing to observe that notwithstanding the ravings of the people of Joliet about the bad smells which they occasionally inhale from the river as it pours over the dam, the highest priced property in Joliet is very near the dam.

There is no doubt, however, but that the odors from the river are at times very offensive, and it is conceded that the people there were justified in making complaint; but so far as they are concerned, the question must be strictly limited to that evil. It is no concern of the people down the river what the people of Chicago drink, nor where they get it. Their only concern is, that the nuisance of foul odors shall be abated. They have no right to direct as to how it shall be done, and least of all have they any right to demand that thirty to forty millions of dollars shall be expended by the city of Chicago to create a tail-race, a water-power, or a huge canal, if the end can be accomplished some other way at less than one-fifth the expense, and this leads to the question of the disposition which may be made of sewage.

THE DISPOSITION OF SEWAGE.

It is not to be expected that any extended discussion of the question of sewage disposal will be entered upon in this place, but as it is a matter which has received great attention in Europe, and very little in this country, and as one of the methods in general use in Europe seems most available for the people of Chicago, some general ideas may properly be given upon the subject.

Either separately, or in some form of combination, there are two methods of disposing of sewage, other than that of turning it into an adjoining stream or large body of water, viz., that of land irrigation and that of precipitation.

FIRST, BY IRRIGATION.

The method by irrigation consists in turning the sewage loose upon a tract of land, where by systems of surface drains it is spread over the surface, and by underdrainage the water, after being leached, is carried off. This method is in use in various places in Europe, some of which, with the population in 1884, and number of acres used at that time, are given in the following table, which is made up from the report of Mr. Allen already referred to:

Places.	Population.	Number of Acres.
Croyden, Eng.	60,000	540
Doncaster, Eng.	30,000	305
Wigan, Eng.	50,000	269
Paris	2,000,000	1,482 for $\frac{1}{4}$ of the sewage
Berlin	Sewage of 900,000	7,500 in use in 1884
Dantzic	100,000	395 in use in 1884

In Berlin the sewage is pumped to a height of sixty-five feet, and in Dantzic twenty-three feet, for delivery on the land.

These lands are farmed, and something is realized in rents, but the details are immaterial, as the system is impracticable in Chicago—for three reasons: First, no land is available; second, the quantity of sewage is three or four times as great per capita here, and third, our winters are often too cold. Mr. Allen visited the works at Pullman, and says of those works, of which, by the way, Mr. Benzette Williams was chief engineer:

“The sewage farm at Pullman has frequently been cited as being a place where successful purification of sewage (by land treatment) is accomplished in the winter, in a climate similar to that of New England. In order to fully satisfy myself as to the fact, I visited Pullman in January of the present year, accompanied by Gen. R. H. Chamberlain, superintendent of sewers of this city, and this is what we found: The farm has an area of about one hundred and forty acres, nearly all of which is devoted to irrigation; there are ten acres however set apart for a filtration area, this being thoroughly underdrained, the drains being about twelve feet apart. Upon the day of our visit it was quite warm; the thermometer registered 40° Fahr. We found that the sewage was all being discharged upon the filtration area, the first section of which was covered with sludge to a depth of about a foot. The sewage was running over this, to the second section, which was partially covered with ice, and then over the remaining area, which was entirely covered with ice, and was finally discharged into the effluent trench, without having been filtered in the least.

“The entire area was completely covered with sewage, and there was evidently no filtration taking place, as about the same quantity passed off at the lower end of the beds as was discharged upon the upper end.”

Mr. Allen considered the subject carefully, and concluded that the winters of New England, though not so cold as at Pullman, were too cold for the method by irrigation.

SECOND, BY PRECIPITATION.

In the method by precipitation, the sewage flows into immense tanks built of masonry, after being mixed with milk of lime (that is, slaked lime dissolved in water until it has the consistency of milk), or other cheap chemical, causing the solids to settle, and the water flows off very well cleared. There are two

methods in use; one, to let the contents of the tanks stand a short time for settling, and the other what is called the continuous process, where the sewage keeps up a very slow movement. In the city of Worcester, after having tried the still-water method, they are using the continuous process with satisfactory results.

The deposit, or sludge, has some value as a fertilizer in some localities. Under date of January 20, 1892, the city engineer of Worcester writes: "We have about concluded to burn the sludge, in fact have already begun to do so in a limited way, and have found it perfectly feasible. I believe this is the most desirable thing to do."

Under date of June 18, 1892, he writes: "We have disposed of all the sludge that we had on hand this spring to the farmers in the immediate vicinity, who have taken it and used it as a fertilizer. We are in hopes it will prove of sufficient value, so they will wish to continue it. We have therefore discontinued burning."

Whether the immense amount of filth which, according to Mr. Williams, is to be found in Chicago sewage would render the sludge more valuable, is a matter of detail not essential to the present discussion.

The system of sewage disposal by precipitation is in use quite extensively in England. Three of the largest places where it is in operation, with their population in 1883, number of gallons of sewage treated daily, original cost of works, and annual cost of maintenance, are given below from Mr. Allen's report:

PLACE.	Population.	Gallons of Sewage Daily.	Cost of Works.	Expenses. Yearly.
Bradford	200,000	8,000,000	\$300,000	\$20,000
Leeds	343,000	10,000,000	300,000	25,000
Birmingham	420,000	13,000,000	450,000	66,000

At the Leeds works the sewage has to be pumped eighteen feet to reach the tanks.

The quantity of lime used varies somewhat, but no estimate places it at more than one ton for each million gallons of sewage. The cost of precipitation in England is estimated as being about 25 cents per capita per annum. The tank capacity should be about equal to one-half the quantity of daily sewage.

In the Birmingham works, there are three large tanks 330 x 90 feet, and sixteen smaller, 150 x 50 feet. Leeds works have

twelve tanks, 100 x 60 feet. The Bradford works were originally constructed for another process, but they now use milk of lime; there are thirty-four tanks, 30 x 22 feet, and thirty-four, 22 x 14 feet, besides a reservoir, and some sludge tanks.

The tanks are generally filled to a depth of six feet. As will be seen by the above table, the daily sewage per capita of the three English cities mentioned is—for Bradford, about forty gallons; Leeds, about thirty, and Birmingham the same. The sewage per capita daily in Chicago is estimated at 120 gallons. This variance, however, does not affect the principle, it is only in its application—more tank capacity per capita being necessary.

As regards the results of the process Mr. Allen says:

Of Bradford.—“The effluent was very clear but was of a light amber color, entirely free from odor. The color being due, as was claimed by the superintendent, to the presence in the sewage of large quantities of refuse from manufactories.”

Of Leeds.—“The effluent as observed by me was very clear and without color, although I was told that at times it was somewhat discolored, owing to the large quantities of dye stuff and refuse from manufactories.”

The effluent from the Birmingham works was taken to a sewage farm below, of several hundred acres, where it was used for purposes of irrigation. The tanks are cleaned every three to six days in the still-water process.

The entire report of Mr. Allen, from which the foregoing extracts are taken, is extremely interesting, and, as showing how business is done in Worcester, Mass., it may be stated that the city of Worcester, situated on the Blackstone River, with a population, in 1883, of about 70,000, had a large number of factories, the refuse from which, with the city sewage, emptied into the Blackstone River. Great quantities of chemicals entered into the sewage, and people below were greatly annoyed by it. Litigation ensued, the State Legislature took the matter up, and in 1883 the City Council appropriated \$700 to defray Mr. Allen's expenses to Europe to investigate the question of sewage disposal. He visited England, France, and Germany, and made a careful examination of the different methods in use for the treatment and purification of sewage at the places above mentioned, and others, and visited the sewage farm at Pullman as above stated.

Mr. Allen reported the result of his investigation, and gave a clear and concise statement of the different methods of sewage disposal in Europe, cost of plants, and the results obtained.

Had Mr. Allen filled his report with far-away gibberish about hydrographic surveys, analyses of foreign sewage, reconnaissances of water sheds, disquisitions upon detritus, speculations upon population, asked for \$2,000 or \$3,000 to pay for an analysis of the waters of Blackstone River and Milbrook Creek, and called it a "preliminary report," it would have been a fair sample of documents familiar to readers of water-way literature in Chicago.

His report was a practical, sensible document, in which he recommended the erection of works for the purification of the sewage of Worcester by precipitation, and gave an estimate of the cost, which was not exceeded.

The outcome of all which was, such works were erected at an expense of about fifty-six thousand dollars, and have been in successful operation since some time in 1890. The works cover ten acres of ground. There are six tanks, each 100 feet long, 66 $\frac{2}{3}$ feet wide, and 7 feet deep.

In his report for the year ending November, 1890, he says:

"As a practical illustration of what is accomplished, samples of the sewage, and of the effluent taken at the same time, have been saved. Sewage five months old is the color of ink, and the odor from it is so foul that it is sickening, while the effluent of the same age is clear, colorless, and entirely without odor. I am perfectly satisfied that no decomposition takes place in the effluent, and that, so far as the Blackstone River is concerned, it is as unobjectionable as spring water could be. I do not claim that drinking water is manufactured at the disposal works. What I believe is, that the method of treatment is such, that when the whole sewage of the city is dealt with at the works, the Blackstone River will be entirely relieved of any further pollution from the city of Worcester.

"As to the cost of treatment, I think it will be more satisfactory to wait until after the works have been run another year before going into details. It is constantly being reduced, and at the present time it is well within the estimate made by me several years ago, namely, \$22,500 per year."

Upon the opposite page is a copy of a photograph of the works at Worcester, Mass.



PRECIPITATING WORKS AT WORCESTER, MASS.

In private letters he writes as follows:

“January 20, 1892.—I am satisfied that with 3,000,000 gallons of sewage per day, the size of the tanks at Worcester are just right, as we have obtained most excellent results, and I can see no reason why this same ratio would not hold good for 5,000,000 cubic feet of sewage. But for eight months past we have run the sewage through all the tanks, thus treating it by the continuous process, and have been able to get good results in treating 4,500,000 gallons per day, and fair results in 6,000,000 gallons per day. This method is much less expensive than the intermittent (or still water) application, owing to the greater ease with which the sewage is handled.

“We ran our works all last winter without trouble from frost, although we had days when the mercury was below zero.”

“June 11, 1892.—We are just at the point where we propose to enlarge our works, and, while the results obtained so far, have been beyond our expectations, we expect to produce still further and better results after the works are enlarged. The estimated population for 1891 was 86,000; the sewage costs us now for treatment about 40 cents per capita per annum; we are using about $2\frac{1}{2}$ tons of lime to four million gallons of sewage.”

“June 18, 1892.—In case this large amount of sewage (10,000,000 cubic feet daily) were treated, it (that is, the quantity of land necessary) would depend entirely upon whether the sludge were to be pressed and the water extracted before its disposal upon the land, or whether sludge pits were to be prepared into which the sludge would be pumped and allowed to dry by natural means. In the latter case the amount of land would be of course very much greater than in the former.

“We propose to enlarge our works so that we will treat at least 15,000,000 gallons per day, and in order to handle the sludge properly, we shall have to acquire more land. I shall recommend the purchase of at least thirty acres in addition to the ten acres that we now own. I think that 10,000,000 cubic feet of sewage would require, in order to work economically and to good advantage, something like 300 acres; but, as above stated, it all depends upon how the sludge is to be handled; if it were to be pressed, it is possible that it would be taken away by farmers for fertilizing purposes. In that case, the land re-

“quired would be only a few acres more than is necessary for the precipitation plant itself.”

In this connection it may be stated that the cost in England of pressing the sludge into cakes is about 25 cents per ton, and the product has about the same fertilizing value as barn manure.

Upon the general subject of the disposal of sewage, the following extracts are taken from Santo Crimp:

“One of the ‘conclusions’ of the committee appointed by the Societies of Arts in 1876 to inquire into various subjects connected with the health of towns was as follows:

“With regard to the various processes based upon subsidence, precipitation, or filtration, it is evident that by some of them a sufficiently purified effluent can be produced for discharge, without injurious result, into water-courses and rivers of sufficient magnitude for its considerable dilution, and that for many towns where land is not readily obtained at a moderate price, these particular processes afford the most suitable means of disposing of the water-carried sewage.”

The report of the Royal Commission on Metropolitan Sewage Discharge, 1884, contains the following most suggestive sentences:

“In the first place, no one denies that by any chemical precipitation, the suspended matters may be almost entirely removed; or, in other words, the sewage may be practically clarified. It is proved that with well devised, not too deep, and abundant tanks, so as to allow of complete subsidence (which may be well effected in a few hours), a clarified sewage may be prepared by precipitation, which will contain less than two or three grains of suspended solid matters per gallon. And as it is also admitted that the suspended matters are the worst causes of pollution and nuisance, it follows that the clarification must effect a great improvement.”

The following, taken from Santo Crimp, is a more detailed description of the works at Bradford, and the results:

“BRADFORD—PRECIPITATION.

“POPULATION, ETC. The town of Bradford has a population of 200,000 inhabitants (1885); the whole of the effluent is discharged into a small stream called the Beck of Bradford, a tributary of the River Aire.

" VOLUME OF THE SEWAGE.

"The daily sewage flow is about 8,450,000 gallons, the whole of which is conveyed to the sewage purification works, which the engineer for the works, Mr. Alsing, calculates to be capable of treating a daily flow of 12,000,000 gallons.

NATURE OF THE SEWAGE. In addition to the sewage from 4,000 water-closets, the waste from a large number of manufactories is allowed to enter the sewers. The greater part of this waste comes from dye works, wool-combing works, tanneries, and breweries. The manufacturers are not compelled to purify their waste waters in any way, which therefore contain, on being discharged into the sewer, all the noxious matters which are not considered worth extracting.

In consequence of the chemicals employed by the manufacturers, the discharges of refuse are of varying kinds, which make the sewage all the more difficult to treat. Its composition varies much from one day to another, and also at different hours of the day; it is very foul and of offensive smell, and carries in suspension a large amount of organic and silicious matters and a pretty large proportion of salts of lime.

"QUANTITY OF LIME EMPLOYED FOR THE PURIFICATION.

The quantity of lime employed for the purification of the sewage varies according to its strength; it is much weaker than usual at night and on Sunday, and it is also much less in strength during wet weather. According to Mr. Alsing, the proportion recommended at Leeds is one ton per 1,000,000 gallons. This proportion is reduced on Sundays to 10 cwt.; it is also reduced every night up to midnight, after which lime is not employed. In the accounts of the town of Bradford for the year 1883, the cost of lime for the year is stated to have been £995 7s. 10d. (about \$4,818), at the price of 9s. 10d. (about \$2.38) per ton; this represents a total of 1,990 tons of lime used during the year. The annual volume of water treated is about 8,450,000 gallons per day. The average proportion of lime used is, therefore, a trifle less than 13 cwt. per 1,000,000 gallons.

Two rows of tanks, independent of one another, are placed along the whole length of the front of the buildings at the works. The precipitating tanks, where the water is allowed to

“rest during the time necessary to allow the suspended matters
“to precipitate, are at a higher level.

“Below these are the filtering tanks in equal numbers, in
“which the effluent water from the tanks flows through a filter-
“ing medium, and there deposits the lighter matters, which are
“still held in suspension. The sewage, instead of flowing through
“all the tanks in succession, with a continuous movement as at
“Leeds, flows into one precipitating tank, and, after sufficient
“rest, passes from there into the adjacent filtering tank.

“The precipitating tanks are thirty-four in number, twenty-
“eight feet in length, twenty-two feet in width, and six feet in
“depth. Each of these is capable of holding 18,000 gallons, and
“is filled sixteen times in the twenty-four hours. The duration
“of the complete operation, comprising the filling of the tanks,
“the precipitation of suspended matters, the drawing off of the
“clarified water, and the removal of the sludge is, therefore, $1\frac{1}{2}$
“hours on the average. At this rate the thirty-four tanks
“are capable of purifying 10,000,000 gallons per day. In order
“to reach the quantity of 12,000,000 gallons per day, which Mr.
“Alsing informed us was the maximum quantity that the tanks
“are capable of treating per day, the duration of the complete
“operation is reduced to $1\frac{1}{4}$ hours. The filling of a tank, when
“the sewage is flowing at the rate of 8,450,000 gallons per
“day (or 908 gallons per second), occupies about three minutes;
“the sewage is allowed to rest for from thirty to forty minutes,
“the remainder of the time suffices for drawing off the effluent
“and the removal of the sludge.

“After the precipitation of the solids produced by the milk
“of lime, the clarified water is drawn off, and passes through the
“filtering tanks.

“ FILTERING TANKS.

“The sewage, in great part clarified, on leaving the precipi-
“tating tanks passes into an equal number of filtering tanks,
“which are placed at a lower level. The difference in the two
“levels causes a fall, in which the water is agitated and mixed
“with the atmospheric air.

“The filtering tanks are twenty-two feet in length, twelve
“feet in width, and three feet in depth, and are formed of coke
“breeze, which is placed on the bottom to a depth of from $1\frac{1}{4}$
“to $1\frac{7}{10}$ feet, through which the effluent filters downward.

“ The filters are renewed four times a year, while the coke breeze, after having been used as a filtering material, is exposed to the air for the purpose of drying and oxidizing it, and is then employed, mixed with coal, as fuel for the boilers at the works, in the proportion of two parts of coke breeze to one part of coal.

“ NATURE OF THE EFFLUENT.

“ The effluent flowing from the works is nearly colorless and without odor. It has no other smell than that which is given to it by the excess of lime which it contains.

“ DISPOSAL OF THE SLUDGE.

“ Returning to the tanks, where the matters in solution are precipitated by means of lime, the sludge is cleared away, by means of bottom sluices, into an aqueduct which carries it to tanks, from whence it is raised by means of centrifugal pumps to a height of twenty-nine feet; it then flows by gravitation through long wooden troughs to large reservoirs in the ground at the side of the works; here it remains until, by means of drainage and evaporation, it has arrived at such a consistency as will allow of its being loaded into carts and taken away. It then contains about 50 per cent. of water, whereas, on leaving the tanks, it contained at least 80 per cent. The liquid from the reservoirs is drawn off by means of carriers, and conveyed back to the precipitating tanks.

“ The engineer, Mr. Alsing, calculates the quantity of sludge annually produced at 6,000 tons. The town of Bradford has concluded an agreement with a contractor who receives the sludge, gratuitously. He then carts it away and sells it to farmers.

“ GENERAL ARRANGEMENT OF THE WORKS.

“ The works and appendages occupy an area of about ten acres, which is appropriated as follows:

	Square Yards.
“ Building	2,674
“ Tanks in masonry	6,926
“ Sludge reservoirs	9,658
“ Outhouses, roads, yards, storehouses, etc.	29,232
“ Total	48,490

“The building consists of but one story, and is divided into six parts, which are appropriated as follows:

- “1. Slacking and sifting the lime.
- “2. Making the milk of lime.
- “3. Sludge pumps.
- “4. Engine-house.
- “5. Boiler-house.
- “6. Stores.

“There is no disagreeable odor arising from the work, even in the hot season; this excellent result must, in great part, be attributed to the fact that the precipitated solids are not allowed to stop in the tanks, and do not remain in contact with the effluent.

“The works are situated at Manningshan, one of the most beautiful suburbs of Bradford, and do not appear to have given rise to any complaints from persons living in the neighborhood.”

A description of the system of sewage disposal by precipitation has thus been given at considerable length, because it is believed to be the system most applicable to the city of Chicago, and one which, applied to the most noxious portion of its sewage, will practically dispose of the sewage question altogether.

THIRD, THE SELF-PURIFICATION OF WATER.

Very many even well-informed people have an idea that noxious matters once mixed in water remain there until they sink to the bottom or are removed by mechanical means, the idea being that matter, though subdivided or dissolved into particles so minute as to become imperceptible, still remains. There are, too, many well-informed people who do not know that there is a very considerable mixture of atmospheric air in water; this is the case, however. The quantity varies, but in some rare cases it is said to exist to the extent of 20 per cent. of the volume of water. Oxygen is one of the constituent elements of both air and water, and in this connection, it may be said to act as a fire or consuming element in the destruction of matter; it operates to consume physical impurities. To what extent this operation proceeds depends upon the relative quantities of water, and of the air and matter mixed with it. If the water is stagnant, or has only a sluggish motion, and is considerably polluted, this operation of

burning does not take place to any considerable extent; if, on the contrary, the water is not greatly polluted, is in rapid motion, rippling over stones and falling over obstructions, it becomes more impregnated with air, impurities are consumed, and it becomes clear. This is one of the causes of the purity and brilliancy of mountain streams. Every one has noticed the difference in the appearance of water in a sluggish stream as compared with that in one flowing swiftly.

This action of the oxygen of the atmosphere is well understood and admitted, the only difference of opinion being as to the extent and vigor of the purifying process. Upon this subject citations will be made from works believed to be of the highest authority.

In the report above mentioned, of the commissioners upon the water supply of London headed by the Duke of Richmond, upon the contamination of the Thames above Hampton, by its drainage of 3,676 square miles of area, inhabited by 900,000 people, there is the following:

“Some of the noxious matter is removed by fish and other animal life, and a further quantity is absorbed by the growth of aquatic vegetation; but in addition to these abstractions, important changes are effected by chemical action. The organic compounds dissolved in the water appear to be of very instable constitution, and to be very easily decomposed; the great agent in this decomposition being oxygen, and the process being considerably hastened by the motion of the water. Now as such waters always contain naturally much air dissolved in them, the decomposing agent is ready at hand to exert its influence the moment the matter is received into the water; in addition to which, the motion causes a further action by the exposure to the atmosphere; and when (as in the Thames) the water falls frequently over weirs, passes through locks, etc., causing further agitation and aeration, the process must go on more speedily and more effectually. The effect of the oxygen on these organic matters when complete, is to break them up, to destroy all their peculiar organic constitution, and to re-arrange their elements into permanent inorganic forms, innocuous and free from any deleterious quality.”

Baumeister says, “This term, (self-purification of rivers) is employed to denote the purification which many rivers undergo, owing to the combination of the oxygen in the water, with the

“organic matter, to form non-organic substances. The necessary mingling of air with the water, increases with the velocity of the river. All devices like weirs are of aid in purifying rivers. The oxidation is more rapid with high, than with low temperatures, but the liability of putrefaction taking place is also greater. The oxidation is also much more rapid with fresh sewage than with that which has begun to putrefy.

“Observations on the self-purification of rivers have shown very divergent results. While English rivers appear to be almost universally lacking in this power, American and German streams in many cases, especially with dissolved matter, have shown very gratifying characteristics, even as regards the nature of the micro-organisms. The Pegnitz, for example, which receives all the sewage of Nuremberg, is contaminated for a short distance only. In Breslau, while the entire sewage was discharged into the Oder, there was a sudden increase in ammonia, organic matter, and bacteria just below the outlet of the trunk sewer; these things become gradually less further down the river, and at a distance of twenty miles from the city the water was as pure, chemically and microscopically, as before it received the sewage.

“Where the self-purification is to be assumed as quite energetic, as at Neisse, Munich, and Cologne, the residents further down the rivers will be troubled in no appreciable degree.”

The following table gives so far as obtainable, the population of the towns above mentioned, the names of the rivers into which their sewage empties, the volume of water, and the velocity of the current:

Name of City.	Population.	Name of River.	Volume of Water. Cubic feet per minute.	Velocity of Current per hour.
Nuremberg	110,000	Pegnitz	19,080	
Breslau . . .	300,000	Oder	42,360	1½ miles per hour
Munich . . .	260,000	Iser	85,400	2½ miles per hour
Neisse . . .	13,000	Bielarm	4,260	2½ miles per hour
Cologne . . .	} about 150,000	Rhine		

Continuing, Baumeister says:

“In place of purification, it is possible to use dilution as a means of obviating river pollution. Bremen offers an example

“of a city employing this method; here the sewage from one part of the place, the Altstadt, mingles with a small stream, the Wumme, and is then emptied into the Weser. The Wumme becomes very foul, being only a small stream, and it is now customary to pump water from the Weser into the city moats as reservoirs, whence a proper volume may be admitted to the already partly diluted effluent, to raise the final ratio of water and sewage to 5 to 1. In this way the total discharge is increased sufficiently to reduce greatly the danger of deposits and odors, and the foul water is more certainly removed.”

Capt. Douglas Galton is a sanitary engineer of high standing in England. In Van Norstrand's Engineering Magazine, 1885, Volume 32, is an article from his pen in which he writes as follows:

“Dr. Tidy recently remarked upon certain experiments, ‘I am certain that given a dilution of one-seventh sewage and six-sevenths fresh water fully aerated with a flow of two miles per hour, not a trace of noxious matter would be found at a distance of five miles.’”

As before stated, Dr. Tidy is a man of undoubted authority upon sanitary questions, and his being quoted by Capt. Galton, adds additional weight to his utterance.

In the minutes of the proceedings of the Institute of Civil Engineers (England) for 1889-90, Vol. 102, p. 367, appears the following: “Dr. Dornbluth, of Rostock, having urged that the discharge of the sewage of Gustrow (population 11,000) into the River Nebel, a tributary of the Warnow, from which the water supply of Rostock is derived, would so pollute the stream as to render it unsuitable as a source of domestic water supply, arguments based on the self-purifying powers of rivers were urged to prove those fears groundless. In order to have the purifying power of the River Nebel tested, Prof. Uffelmann of the Rostock Hygienic Institute, has undertaken a series of analyses of the river above and below the town. The water is being examined by chemical, microscopic and bacteriological tests; it is fifty miles from Gustrow to Rostock; the analyses have not been completed, but a manifest improvement, due to the self-purifying powers of the river is perceptible.”

The analyses of the undoubtedly vile waters of the Illinois and Michigan Canal at Bridgeport, Lockport and Joliet, are to the same effect. The current from Bridgeport to Lockport does not

exceed one mile per hour. Dr. Rauch says: "In other words, "over one-half of the sewage pollution disappears before reaching Lockport, twenty-nine miles below Bridgeport, and nearly "one-third of the remainder is lost in the next four miles; the "increased rate of purification in this distance being due to the "mechanical agitation of the water by falls, wheels, lockage, etc., "and the greater extent of surface exposed to aeration by the "union of the canal and the Des Plaines River.

"It is stated that an average of about 45,000 cubic feet per "minute, was being pumped from the river into the canal during "this period. Whatever the quantity, it is obvious that if the "volume of dilution had been increased by 20 per cent., the contents of the canal would have been entirely inoffensive to the "senses on reaching Joliet."

VALUE OF THE ILLINOIS AND MICHIGAN CANAL AS A MEANS OF COMMERCE.

It is not improbable that the bare mention of a doubt as to whether the Illinois and Michigan Canal any longer subserves any useful purpose as a means of commerce, will be received with surprise, and in some quarters, with derision and wrath. Nevertheless, this is a practical age—there is nothing especially sentimental about the matter, and it may be well enough to examine the facts.

The first striking fact which we encounter is, that the canal does not pay expenses.

Second. That it has not paid its expenses since the year 1879.

Third. That for the twelve years from and including 1880, down to and including 1891, the aggregate expenses of operating the canal have exceeded the receipts from tolls by \$263,829.57.

Fourth. That since 1885 the canal has been supplied with water at the expense of the city of Chicago; that for the three years ending December 1, 1891, the receipts of the canal from tolls were \$169,874.57, and that the expenses of the canal, outside of the pumping of water, have exceeded the receipts from tolls, in the sum of \$63,322.80.

It further appears from the reports of the commissioners of Public Works of Chicago, that for those three years it has cost the city of Chicago for the maintenance and operating of the pumping works at Bridgeport over \$70,000 annually, or in exact figures, \$224,494.37. If then we add the deficit from tolls for the past three years, to the cost of keeping the canal supplied with water during that period of time, we have an actual difference between the receipts from tolls, and the expense of maintaining the canal of \$287,817.17.

Now it is all very true that the foregoing figures do not represent the actual state of the account of the canal commissioners with the State of Illinois. It is true that the canal commissioners have received large sums of money from other sources.

They have received large amounts from leases of water power, from sales of property, from leases of land, from ice leases, and from miscellaneous sources, and have thus been able to get along without using the appropriations that have been made at nearly every session of the Legislature of late years, to sustain the canal.

It may, and doubtless will be said, that the city of Chicago was very glad to do the pumping for nothing, and should be very thankful that it was permitted to dispose of its sewage in that way. That would all be very true, if the city of Chicago was a part of the dominions of Great Britain, or was even part of another State. There is a method of speech somewhat prevalent in Illinois, to the effect that the people of the State stand in antagonism to Chicago. This is a form of speech which does not prevail in other States, or in other countries, toward or about their greatest city. State and national pride elsewhere, is gratified at the development of great cities, but there are not a few men in the State of Illinois, whose political capital seems to consist in malicious disparagement of Chicago; this is by no means general, but it has its effect, even upon those who would not be willing to acknowledge it. Of course there is no room in Chicago for such a feeling toward any portion of the State. She rejoices in being the chief city of a grand commonwealth, and in the prosperity of every part of it, and so, as to the use of the canal, she feels that as composing one-third of the entire population of the State, and as having infinitely greater interests in the canal, than all other portions of the State combined, that she has rights in it. She feels that she is not dealing with strangers, but is at home and among her own people. She recognizes the rule of morals and of law, "to so use your own as not to injure another," and the recital which has been given of her effort to avoid creating a nuisance with the sewage, shows that she has earnestly striven to meet the exigencies which her unparalleled growth has thrust upon her. No, Chicago eats no humble pie for the use of the canal, and no patriotic or fair-minded man would suggest that she should. And so, the question as to the best, and so far as the people of the entire State are concerned, the most available use to which the canal can be put, is one to be considered upon all sides, and certainly the question as to whether it pays its expenses, or whether it should be supported by the resources of the State, is not the least significant. This

question will most certainly arise when the expense of keeping it supplied with water, becomes a part of the cost of operating it. In case the city of Chicago should find other means for the disposal of its sewage, water must be furnished at the expense of the people of the State, or the canal be abandoned.

Examining in detail the resources of the canal commissioners, it must be admitted that the money received from leases of water power, ought to have been turned over to the city of Chicago. That is the doctrine of the Drainage Act, and is so obviously just, that argument is unnecessary. The State, in having water supplied for the purpose of navigation, certainly received a full equivalent for the use of the canal as a drainage channel. Revenues from the use of the water pumped by the city of Chicago should have been turned over to the city—it is not too late yet for the State to do an act of simple justice in that matter. The money received from leases and sales of land, and from sales of clay, etc., was received for the lease or sale of property belonging to the State of Illinois, and the use of it was the use of the resources of the State of Illinois to carry on the canal, and though not the same in form, it was the same in substance, as if the money had been taken from the State Treasury for that purpose.

Of course there is room for the contention as to the purposes for which the Government granted those lands. As we have seen in the brief history given of the canal, when the State repaid the city the expense of deepening the canal, it paid out something over \$700,000 more than up to that time had been, or has since been, the net receipts from tolls and sales of canal lands, so that properly speaking, those lands, and the rents of them, should be applied to reimburse the State.

Withdrawing from the canal commissioners the receipts from the sale of the surplus water power, and from the rents, and sales of land and property, would add to the annual deficit of the canal commissioners, some \$18,000 a year, and the expense of supplying the canal with water would be thirty to forty thousand dollars more.

Thus we have a plant of several millions of dollars in value, operated at an annual loss of a good many thousands of dollars, and it is certainly a fair question to ask, whether this shall be continued?

An examination of the different articles of freight carried, and

a comparison of the prices paid the producers of the grain shipped by the canal, with the prices paid to the producers of grain shipped the same distance by other means, will show that the former is no more than the latter; and even if there were a difference, it would be difficult for anyone to give a satisfactory reason why the people of the State at large should be taxed to pay for such an advantage.

If then the canal is of no value as a means of commerce, and is of great value for other purposes, and if used in some other way may be of great benefit to a far greater number of people than are benefited by its present use, is it not a proper question to ask, whether such present use shall be continued?

METHODS FOR THE DISPOSITION OF CHICAGO SEWAGE.

The only pretense of an effort ever made to devise a system for the disposition of Chicago sewage, and to preserve the water supply free from contamination, is that contained in the Herring report, which, as we have seen, was substantially some loose generalities upon the method by irrigation, and some equally vague suggestions as to the necessity of a great water-way.

Everyone knows that it is possible to dilute the sewage of Chicago with water from Lake Michigan to such an extent that the sewage would become imperceptible. Without any knowledge or means of information readily accessible as to the quantity of water actually necessary for the proper dilution of the sewage, and attention having been so uniformly directed toward a great water-way, most people have come to look upon this scheme as affording the only solution of the difficulty.

The advocates of a great water-way have thus had this advantage; their scheme involved no study or labor to understand it, and it was accepted without further examination. As we have seen, no adequate presentation of its cost was made, and the extent of the liabilities which would follow its execution was left entirely in the background; with a better understanding of these matters, it is probable that people will be willing to bestow a more critical examination upon other methods which may be suggested, to accomplish the necessary result.

The disposition of the sewage of Chicago, like most other undertakings, will appear simpler, and more easy of accomplish-

ment, as it is better understood, and it remains now to apply, either separately or in combination, the theories of sewage purification which have been heretofore presented, and see if there is not a rational means of getting rid of Chicago sewage at a reasonable expense.

DISPOSAL OF CHICAGO SEWAGE BY DILUTION AND SELF-PURIFICATION.

Attention has been called to the self-purifying qualities of flowing water, and there can be no doubt that this is an active and inherent means of purification, the only question being, whether this agency is potent enough to dispose of the vast mass of impurity contained in the sewage of Chicago, in such a manner as that it shall not be offensive. The first point to be noted is, that there is no complaint, nor apparently any grounds for complaint, until we reach Joliet, a distance of about forty miles. It is not pretended that offensive odors arise from it there at all times; in fact, it may be said that they are noticeable but a small part of the time. It would be more satisfactory if there were definite means of knowledge as to why the water is offensive part of the time, while at others it is not. As the character of the water of the South Branch, at the canal pumping works, is about the same, except during flood seasons, when the contents of the river are washed out into the lake and the pumps are idle, it is probable that the annoyance of the odors at Joliet is greatest during dry, hot weather, when the polluting matter in the sewage decomposes more rapidly, and occasions offensive odors as the waters pour over the dams.

Referring to what has already been said, it is obvious that if a current of $2\frac{1}{2}$ miles per hour can be established between Bridgeport and Joliet, and a permanent flow of lake water of considerable quantity be established, the water would reach Joliet, not only in a condition to be wholly inoffensive, but comparatively clear. The reader will remember the forcible statement of Dr. Tidy, quoted by Capt. Galton, to the effect that with one-seventh of sewage and six-sevenths of clear water, and a current of two miles per hour, not a trace of noxious matter would be found at the distance of five miles. The researches of Baumeister and of the Royal Commission on Water Supply (of London) are, as has been shown, to the same general effect, as are also the statements of Dr. Rauch, above quoted, where he says: "Over one-half the

“sewage pollution disappears before reaching Lockport, twenty-nine miles below Bridgeport, and nearly one-third of the “remainder is lost in the next four miles.” This loss between Bridgeport and Lockport, occurs in a canal with a current of less than a mile an hour. Naturally the more volatile elements of pollution would disappear first, and one-third of the more stubborn remainder disappears between Lockport and Joliet, a distance of four miles, over one-fourth of which is occupied by the still waters of the two basins. The activity and energy of self-purification of Chicago sewage, even when diluted by the inadequate supply furnished by the present pumping works, is therefore an established fact. It will further be borne in mind that the pumping works now take all the sewage with some additional quantity of lake water, and that any additional supply furnished will come from the lake; and further, that under present conditions, the output of the stock yards, as indeed also that of the entire city, is in a state of advanced putrefaction before it reaches the canal, and is much less amenable to the influence of self-purification than is fresh sewage.

The average daily sewage of Chicago for the year 1891 was 157,000,000 gallons. The addition of 100,000 cubic feet of water per minute, will reduce it to the proportions of 1 of sewage to $7\frac{1}{2}$ of clear water. If the sewage be taken while fresh, and a current of $2\frac{1}{2}$ miles an hour be established for forty miles, the conditions essential to the complete purification of the water will have been far more than complied with. It may be said that this is only a temporary expedient, and that the city will soon outgrow these provisions. The reply is:

1st. That the quantity of water, velocity of current, and distance, are an ample guaranty that at least double the present quantity of sewage would be purified by the means suggested.

2d. That the facts and figures of Dr. Tidy and others mentioned, refer to European sewage, which is rated at from thirty to forty gallons per capita daily, while the sewage of Chicago is diluted to three or four times that amount, so that it may fairly be concluded that the provision mentioned will be ample for the city of Chicago, long after it has passed the 2,500,000 line of population.

The output of sewage for 1891 was at the rate of about 14,000 cubic feet per minute; provision for 16,000 feet of sewage per minute additional, or, including the contemplated supply of lake

water, of 130,000 cubic feet per minute, would seem to be ample for any future requirements necessary to be provided for. With a flow of $2\frac{1}{2}$ miles per hour this body of water will require a channel with a cross section of 600 feet, or, say, a channel with a flow of water sixty feet wide and ten feet deep.

There are three plans which may be suggested for conducting this stream to Joliet:

1st. To utilize the entire route of the present canal from Bridgeport to Lockport, sink the bed of the canal ten feet below Chicago datum, and give it the requisite incline to secure a current with the velocity specified above, abolishing the locks on the route, and leave the current unobstructed. This plan would probably meet with objection from those interested in the maintenance of the canal in its present condition, as a means of navigation—its value as such, has been sufficiently considered.

As to the cost of deepening the canal, if we assume \$11,000,000, as the cost of excavating a new channel 160 feet wide and eighteen feet in depth below water level, from Willow Springs to Lockport, it would seem as though one-third of that amount would do the requisite work on the canal to secure the proposed channel.

2d. Another location for the channel would be to utilize the bed of the Des Plaines River from the summit to Lockport. This could be done in two ways: convey the water by open channels or subterranean conduits from both branches of the south fork, and pump it up into the Des Plaines, or sink the bed of the Des Plaines low enough to have a gravity flow of the required velocity from Bridgeport to Lockport. This latter method would be more expensive than the use of the canal, as it would require conduits or an open channel from the two branches of the river to the summit. The water, however, from the west fork could be taken at a point three or four miles above the pumping works at Bridgeport. Two sewers nine feet in diameter and about one mile and a half long, to a junction with the west branch, would probably suffice for the east branch. The cost of excavating the bed of the Des Plaines would be greater than that of deepening the canal, as that river is eight feet above datum at the summit, and the line is not so direct, but it would have the advantage over the use of the canal, or of pumping the water up into the present bed of the Des Plaines, in that the bed of the Des Plaines being so much lower, there would be little or no

likelihood of its flood-waters rushing down the Ogden ditch and sweeping the contents of the South Branch and its thirteen slips, out into the lake to contaminate the water supply.

The cost of either method of using the Des Plaines is not entered upon, but it is obvious that it would not exceed one-fourth to one-third of the proposed water-way from Bridgeport to Lockport; it would seem as though two nine-foot sewers from the east fork to the west fork, and a sufficient channel excavated up and beyond the present terminus of the west fork, to the summit, and the channel of the Des Plaines deepened, all at an expense not exceeding \$5,000,000 to \$6,000,000.

To this system should be added the expense of intersecting the sewers along the lake front to conduct all the sewage now emptied into the lake, into the east fork, but these details are of minor importance when considered in comparison with the expenditures which the proposed water-way would require.

This use of the Des Plaines River will render it unnecessary to do further pumping into the canal. What the latter will be worth when the city ceases to supply it with water, may be left to conjecture.

3d. There is practicable, a combination of these two plans, that is to say, the city might enlarge its plant at Bridgeport and pump seventy or eighty thousand cubic feet per minute, and subterranean conduits be extended from the east fork to the west fork, the latter continued on to the summit, and some forty or fifty thousand cubic feet of water per minute pumped into the Des Plaines at that point.

The objection to this plan is, that the water of the South Branch, as a source of supply to the canal, and kept at the sluggish motion necessary to a canal, will not become purified as it would with a more rapid current, and is likely to leave open a chance for complaint by the people of Joliet. Whether they would find sufficient advantage in the continued existence of the canal, to compensate them for any unpleasantness arising from its polluted water, is a matter upon which they will perhaps have an opportunity to express an opinion.

DISPOSAL OF CHICAGO SEWAGE BY PRECIPITATION.

While it seems to be established that the presence of excrementitious matter in sewage does not affect the general character

of the sewage of a city, there can be no doubt that, quantity considered, it is one of the most potent elements of pollution.

The first ward of Chicago comprises all that portion of the south side of the city lying north of Twelfth Street, and in 1890 contained a population of 24,000. In addition to its resident population, the great hotels, restaurants, office buildings of the city, and various minor industries are located in that ward. Three sewers empty into the main stem of the river, and there is a sewer emptying into the South Branch at nearly every street running toward the river, from Lake Street up to Halsted Street bridge, a distance of about three miles. It may be fairly estimated that including the traveling public stopping at the hotels, the first ward has a population during the day of 400,000 people, and the excrementitious matter of that population, contributing to the sewage of the first ward, with the other sources of pollution, may be said to constitute a volume of polluting matter in excess of that of any six residence wards in the city.

It must not be understood, however, that the volume of sewage from the first ward is increased in any proportion to the number of people to be found there during the day. Ten gallons per capita daily, would probably cover the average amount of sewage of the transitory population. The character of the sewage from the stock yards has already been sufficiently described.

If, then, a system of sewers be constructed by which the sewage of the South Side, and of the stock yards can be collected and disposed of without entering the river or canal, it is obvious that the sewage question of Chicago will be disposed of for an indefinite time to come.

Such a system is entirely practicable. An intersecting sewer starting from the corner of Michigan Avenue and South Water Street, and thence west to the river at the foot of Market Street, and thence along Market Street and up the river as near its bank as practicable to Halsted Street, taking up the contents of all the sewers in its course; extending thence along Halsted Street due south to Fortieth Street, taking up at this point the entire sewage discharge of the stock yards, thence east to the Fort Wayne tracks, thence along said tracks to their crossing of Stony Island Avenue, with another trunk sewer commencing at Twelfth Street, and thence south to Madison Park Station, and thence down along Stony Island Avenue, taking up the outputs

of the various sewers now emptying into Lake Michigan, would accomplish the desired result. At Stony Island Avenue, the two systems would join and be extended south to some of the sandy lands lying east of Lake Calumet, where precipitating works might be erected, from whence the effluent could flow into the Calumet River.

The district of territory drained by this system comprises the first, second, third, fourth, fifth and all that portion of the sixth ward lying east of Halsted Street, all of the thirty-second ward, and the north half of the thirty-fourth ward—a district of territory which contained in 1890 about 200,000 people.

Such a system of sewers constructed with reference to the wants of a population of 500,000, can probably be built for \$2,500,000. That portion of the system for taking up the sewage now emptying into the lake, or some equivalent for it, must be constructed in any event.

The quantity of land necessary would depend upon whether the sludge was pressed, or was dried out sufficiently in sludge beds. In the former case forty acres of land would be sufficient. By the latter method, probably some 300 acres would be necessary. Land in that neighborhood is said to have a value of from \$1,500 to \$2,000 per acre.

Tank capacity could be added as occasion required, but undertaking, in the first instance, to make provision for the disposition of the sewage of a population of 300,000 at the estimated rate of 120 gallons of sewage per capita daily, we have 36,000,000 gallons of sewage. The works at Worcester, Mass., cost about \$56,000 and are adequate to the treatment of 4,000,000 gallons of sewage daily. Roughly estimating the cost of the works to be built at nine times the cost of those at Worcester, we may place their cost at \$500,000.

The necessary incline of the proposed system of sewers, if continuous from the corner of Michigan Avenue and South Water Street, will bring the discharge outlet some thirty to thirty-five feet below datum, and the sewage will have to be raised at least ten feet above that level. It is probable that it would be found advantageous to erect a small pumping-station at the corner of Halsted and Fortieth streets, to raise the sewage at that point to a higher level, in which event the discharge outlet of the system would not be more than twenty to twenty-five

feet below datum. The expense of the two pumping plants is estimated as not exceeding \$300,000.

Recapitulating, we have then for cost of the entire works:

Sewers	\$2,500,000
Forty acres of land at \$1,750 per acre....	70,000
Construction of precipitating works....	500,000
Engines, pumps, etc.....	300,000
	<hr/>
Total.....	\$3,370,000

The expense of operating the precipitating plant is found to be about 40 cents per capita per annum at Worcester, and the expense would probably not be greater for the treatment of Chicago sewage, which for a population of 300,000 would make the

Annual expense.....	\$120,000
The annual expense of pumping the sewage to the level of the precipitation tanks may be put at.....	50,000
	<hr/>
Making the annual expenses.....	\$170,000

There can be no possible question as to the adaptation of the system of sewage disposal by precipitation to the necessities of the South Town and of the stock yards, and that with its adoption, in connection with the operation of the canal pumping works as now existing at Bridgeport, all ground for complaint at Joliet, or elsewhere down the river, would be obviated for an indefinite period in the future, if not for all time.

If, however, there should be reason for complaint at some remote period in the future, a remedy could be immediately found at a moderate expense, by either of the methods mentioned under the title of Dilution and Self-purification, or a portion of the sewage of the west side of the city be taken to the Des Plaines and purified at that point by precipitation.

It has been repeatedly urged that the polluting element of Chicago sewage, arising from the stock yards, packing houses, etc., should be cared for by those making it, as it is caused by purely private enterprises. There is certainly force in the suggestion, but after all, Chicago owes its growth and development to private enterprises, and if the principle is a correct one, there seems no reason why it should not be applied to every manufacturing establishment in the city. It is apparent that the principle is not one of universal application to its fullest extent, but it may be

urged with reason, that the stock yards and the industries located there, should contribute more than their quota, as raised by taxation, to do away with the evil. Some years ago, the people interested there, signified their willingness to contribute liberally to aid in carrying out a satisfactory system; it is not probable that there has been any change in their views on that subject; at any rate, the justice of such action on their part is so obvious, that their co-operation, both as to the construction of the plant and in the cost of its maintenance, may be reasonably expected.

The adoption of any system other than that of deepening the Des Plaines from the summit to Lockport, leaves the water supply of the city subject to contamination whenever the Des Plaines pours over the dam and down through the Ogden ditch. The scheme of the great water-way does not obviate this difficulty. It may be said, however, that with the removal of the sewage of the South Town and of the stock yards, that the waters of the South Branch would be comparatively clear.

Recent experiences of the freshets of May and June, 1892, indicate strongly enough, however, that even under such improved conditions, the water supply of Chicago will be unfit to drink, whenever the surface waters of the territory drained by the Des Plaines River, carry the contents of the Chicago River out into the lake. To what extent this might be obviated by the construction of such works along the bank of the Des Plaines opposite the south end of the Ogden ditch as would prevent, or at least hinder such overflow, is worth serious consideration.

It is within the observation of every one, however, that our water supply becomes polluted by the agitation of the waters of the lake when there is no discharge from the Chicago River. The causes of such contamination have heretofore been indicated, a very material one being the dumping of scows, loaded with sludge taken from the bottom of the river, into the lake.

There is an ordinance prohibiting such work within what is supposed to be a safe distance from any of the intakes of the water supply, but when it is understood that this dredging work is done by private contract; that the city supervision over the dumping of sewage has not been very stringent; that the cost of towing mud-laden scows is very considerable, the probabilities in favor of a violation of the ordinance are not very remote. The present arrangement is unsatisfactory, because, first, it is doubtful whether a city ordinance would be operative on the

lake; second, whether the dumping ground is far enough away, and third, the penalty should be greater than the city can inflict.

The possibility that the water supply of Chicago may be contaminated through such means, ought not to exist. The contents of those scows, if taken to the lake at all, should be taken far enough away to remove all possibility of affecting the water supply of Chicago.

It is not necessary that any opinion should be expressed as to which of the foregoing methods for the disposition of Chicago sewage should be adopted. The method by use of the canal is the cheapest; that by deepening the bed of the Des Plaines is the most effective, while that by precipitation is the most independent. The last method requires an annual expenditure, but is, perhaps, on the whole as desirable as either of the plans that have been suggested. Now that the idea has been suggested of the city of Chicago paying for property destroyed by floods in the Illinois River Valley; it will not be readily given up by the people down there, and the same reasons which have been urged against creating a flow of 300,000 cubic feet per minute operate, though of course in a much less degree, against the creation of an additional flow of 100,000 cubic feet a minute, and is a cogent reason why the system of sewage disposal by precipitation above suggested, is the most desirable.

CONCLUSION.

The subject of the drainage and water supply of Chicago has been reviewed at very considerable, and what to many will even appear unnecessary length. It must be borne in mind, however, that as the matter now stands, the people of the State of Illinois must understand it. Those among them who will consider these questions, and be called upon to act, are not so engrossed in politics, market reports, base-ball and horse-racing news, or domestic scandals, as not to be anxious to examine carefully everything which will throw light on this grave subject, and they are neither unwilling to make the necessary effort, nor incapable of so doing. It is hoped that it has been presented with sufficient clearness to be understood by any man of ordinary understanding.

It has been shown that it is entirely practicable to do away with the sewage nuisance, both as to the water supply and

to the people down the river, at what is, relatively speaking, a trifling expense. If the matter had been approached intelligently in 1887 the correction of existing evils would have been long since accomplished. The matter was placed in the hands of charlatans, empirics, and self-seekers, and we find ourselves at the end of 5½ years, and after the expenditure of \$500,000, vastly worse off than when we started. We find ourselves hampered by the provisions of an atrocious law, and threatened not only with the burden of taxation arising from the useless expenditure of thirty to forty millions of dollars, but with annual liabilities for damages which no man can estimate, and for law-suits without number.

The outlook is not pleasant, but it is not desperate. The presentation of this matter to the people of the State of Illinois in its true light will insure relief. They are too intelligent and too just to insist that Chicago shall carry out the provisions of the Drainage Act; it is only necessary that the people of Chicago shall take a decided stand in the matter.

Years ago, when Tweed was stealing millions of dollars annually from New York City, the New York *Times* came into possession of the accounts, and published them. While the publication was going on, some of Tweed's guilty associates rushed to him in consternation, and asked what should be done. Tweed treated the matter lightly, declared that nothing would come of it, and said: "The people of New York will never pay any attention to it, as long as they've got a dollar." They did pay attention to it. Tweed died in the penitentiary, some of his associates went with him to prison, others fled into exile.

Shall Tweed's estimate of the people of New York prove true when applied to the people of Chicago?

INDEX.

	Page
AIR IN WATER.....	112
Report of London Commission on effect of.....	113
ALLEN, CHARLES A., city engineer of Worcester, Mass., is sent to Europe.....	105
Report of, on irrigation works at Pullman, Ill.....	103
Report of, on foreign sewage disposal works.....	104
Report of, on results at Worcester, Mass.....	106
Letters of, on disposal of sludge.....	104
Letters of, on construction of works.....	107
ANALYSIS of polluted water useless.....	98
English scientists on.....	99
Of waters of Illinois for State Board of Health.....	97
ATTORNEYS' FEES to be paid by Drainage Board.....	73
BAUMEISTER, work of, praised by Herring.....	4
On quantity of sewage in cities.....	13
On quantity of rainfall entering sewers.....	14
On elements of sewage.....	17
On self-purification of rivers.....	113
BAZALGETTE, SIR J., on effect of storm water.....	15
BERLIN, amount of sewage from different districts in.....	13
Irrigation works of.....	102
BIRMINGHAM, precipitating works at.....	104
BRADFORD, ENGLAND, precipitating works at.....	104, 108
CANALS, in Ohio and Indiana.....	80
CANAL, New York and Erie, unprofitable.....	80
CANAL, Illinois and Michigan, history of.....	21
Deepened by city of Chicago.....	22
Pumping works for at Bridgeport.....	23
Neglect to keep the channel clear.....	25
Not to be used outside of Cook County.....	36
As a regulator of rates.....	81
Financial history of, for eleven years.....	117
Use of by Chicago for drainage purposes.....	118
Is maintained by the State.....	119

	Page
CHICAGO CITY, map of	8
Boundaries of	9
Sewage system of	10
Water supply, quantity of	12
Sewage, quantity of	12
Rainfall, amount of in	13
Sewage of, character of	15
Canal deepened by	22
Pumping works at Bridgeport built by	23
Efforts of to dispose of sewage	25
Distances from by rail and river	87
CHICAGO RIVER, description of	19
Only source of supply to water-way	63
Capacity of	64
Engineer Williams on current in	66
Capt. Dunham on current in	67
Lake line agents on current in	68
Artingstall on capacity of	68
Capt. Marshall on current in	69
Radical changes in to supply water-way	70
CHICAGO SEWAGE, quantity of	12
Character of	15
Elimination of question as to	97
Methods for disposal of	120
COOLEY, L. E., assistant engineer to Herring	28
On cost of Herring's commission	30
February 1, 1890, elected chief engineer of Drainage Board	44
February 6, 1890, directed to collect information	44
February 8, 1890, states that two years will be neces- sary for engineering work before actual work can begin	44
February 15, 1890, desires this position embodied in the minutes of the Board	45
February 15, 1890, is directed to procure staff for work	45
February 15, 1890, states difficulties and "continues at large"	45
March 1, 1890, is instructed to report	45
March 1, 1890, asks for time	46
June 18, 1890, is directed to make certain surveys	46
July 26, 1890, committee appointed to supervise	46

	Page
COOLEY, L. E., September 9, 1890, is directed to report in thirty days.....	46, 47
October 15, 1890, singular letter from.....	47
November 7, 1890, report of committee censuring his delay.....	47-49
November 26, 1890, directed to confine his work....	49, 50
November 26, 1890, directed to surrender papers....	50
November 26, 1890, is discharged.....	51
Fritters away time in useless detail.....	51
Has a "policy" not in harmony with the trustees....	52
Opposes amendment of Drainage Act.....	53
Proposed to spend \$5,000 or \$6,000 for analysis of water of the South Branch.....	98
CRIMP, extracts from work of.....	100, 108
DATUM, Chicago, what is.....	93
DES PLAINES RIVER, effect of overflow of on Chicago River	11
Effect of overflow of at Joliet.....	61
Description of from Summit to Joliet.....	93
DRAINAGE wanted, not a water-way, by the people.....	95
The real question involved in.....	97
DRAINAGE ACT, authors of.....	34
Various provisions examined.....	34 to 43
A law for a water-way only.....	43
Effort to amend.....	53
Reasons of failure to amend.....	54
DRAINAGE BOARD.	
Members of have no personal responsibility.....	35
A secret body.....	35
An extravagant body.....	35
Expenditures of to August 1, 1892.....	35
Should be abolished.....	35
Not to use the canal outside of Cook County.....	36
May be harassed with suits in unfriendly localities..	37
Efforts to carry out the law.....	44 to 50
Cooley constantly urged to greater activity by..	44 to 50
Appoints a committee to see that the engineer obeys the orders of the Board.....	46
Directs the engineer to confine his labors.....	49, 50
Directs engineer to deliver up documents.....	50
Apprehensions of as to property.....	49, 52
Changes in membership of.....	54, 55

	Page
DRAINAGE BOARD.	
Reasons for present hurried movement of.....	55, 56
Deceptive propositions of for drainage work.....	57
Must pay plaintiffs' attorney fees	73
DUNHAM, CAPT., on river navigation.....	67
ENGINEERING PROBLEM, simplicity of.....	
Great amount expended on by Drainage Board.....	94
Amount expended on by Capt. Marshall.....	94
Befogged intentionally.....	29, 51, 99
Williams has six routes for channel.....	65
FLOODS in Illinois River Valley.....	74
FULLERTON AVENUE CONDUIT, length and cost of.....	62
HEALTH OF PUBLIC.	
Not affected by sewage in neighboring rivers	100
HERRING, RUDOLPH.	
Employment of by city on the drainage question ...	27
Directions to as to scope of investigations.....	27
Employer and assistants water-way men	28
His report a water-way report.....	28 to 30
Report of worthless as a discussion of the drainage question.....	28 to 30
HURD, HARVEY B., residence at Evanston.....	34
Opposes amendment of the Drainage Act.....	53
ILLINOIS RIVER, description of by Capt. Marshall.....	72
Length and width of.....	37, 73
Tributaries of	73
Quantity of land overflowed by	73, 86
Accounts of damage by floods of.....	74 to 79
INDIANA, damage to lands in by dam in Calumet River....	22
IRRIGATION, disposal of sewage by works of, where.....	
Effects of cold weather on works at Pullman, Ill....	103
JOLIET, necessity of protecting walls at.....	60 to 62
JURIES, in damage cases.....	37
LAKES, transportation on, size of vessels, etc.....	83
LAKE LINE AGENTS, on navigation of Chicago River.....	68
LAKE MICHIGAN, contamination of.....	10
LAKE VESSELS, capacity of	83
LEEDS, precipitating works at.....	104
LEGISLATIVE COMMISSION OF 1887	
Scope of the commission, make no report.....	32
Do not examine questions committed to them.....	32

	Page
LEGISLATIVE COMMISSION OF 1887, attend meeting at Peoria,	32
Meeting at City Hall and character of	33
LEGISLATURE, Act of 1865	22
Joint resolutions of	23
LIME, quantity of necessary for precipitation of sewage. 107,	109
LONDON, sewage of empties into the Thames	98
Water supply of	98
Commission to examine water supply of	98
MARSHALL, CAPT. W. L., career of	4
On allowable current in Chicago River	69
Description of Illinois River by	72
Upon flooding Illinois River bottom lands	86
Reports against action by the United States	85
Time and cost of survey of water-way by	94
MISSISSIPPI RIVER, character of boats on	85, 87
Decline of traffic on, as shown by letters	88
Report of United States Commissioner of Navigation showing decline in boat building	89
NEW YORK AND ERIE CANAL, decline of traffic on	80
PRECIPITATION OF SEWAGE	103
Works for in England	104
Results from in England	105 to 112
Works for at Worcester, Mass.	106
Cost per capita per annum in England	104
Cost per capita per annum in Worcester	107
Societies of Arts upon	108
Report of Royal Commission on	108
PULLMAN, irrigation works at in cold weather.	103
RAILROADS, transportation by	81
RAINFALL, quantity of in Chicago	13
Effect of on sewers	14
ROCK-CUT, useless requirement of in the Drainage Act.	40
SELF-PURIFICATION OF WATER	112
London Commission on	113
Baumeister on	114
Dr. Tidy on	115
Dr. Rauch on	115
Of the River Nebel	115
Retarded by putrefaction of sewage	114
SEWAGE, quantity of Chicago	12
In European cities	13

	Page
SEWAGE, effect of storm water on	13
Character of Chicago	15
From the stock yards, nature of	16
Effect of excrementitious matter on	17
Of Chicago collected in South Branch	20
Putrefaction of	20
Effect of putrefaction of	114
Disposal of by irrigation	102
Disposal of by precipitation	103
Disposal of by water-way requires no study	120
Dilution and self-purification of	121
Precipitation of Chicago sewage	124
System of intersecting sewers for	125
SEWAGE OF CHICAGO, quantity of	12
Quantity per capita daily	12
Character of	15
Effect of on public health	97
Methods of disposing of	120
SEWERS, system of in Chicago	10
Size of in Europe	13
Intersecting system proposed	125
SLUDGE, dumped into Lake Michigan	11, 128
Wash of into the lake	11
Deposit of in the canal	22
Value of as a fertilizer	104, 111
STATE BOARD OF HEALTH, preliminary report of	97
Useless analysis of polluted waters by	78, 99
STEAMBOATS ON THE MISSISSIPPI, character of	85, 87, 89
Decline in traffic by	88
Decline in building of	89
Capacity of lake	83
STOCK YARDS, sewage from	16
Contribution by to abate nuisance	128
SUITS, where may be brought	37, 73
Character of juries to try	37
Attorneys fees recovered from Drainage Board	73
THAMES RIVER, district drained by	98
Commission to examine waters of	98
Analysis of waters of valueless	99
Sewage discharge into no effect upon health	100
TRANSPORTATION, State aid for, when justifiable	90

	Page
WATER-POWER FROM WATER-WAY, useless.....	42
Drainage Board can not build works for.....	42
WATER SUPPLY OF CHICAGO.....	12
Contamination of.....	10, 128
WATER-WAYS, artificial, in general, value of.....	80
As regulators of rates.....	81
WATER-WAYS, DEEP WATER NATURAL.....	83
WATER-WAY, under the Drainage Act, canal not to be used for.....	36
Unnecessary size of.....	38
Sewage may not be allowed in.....	39
Useless rock-cut for.....	40
Prejudiced commissioners to decide upon.....	41
Ends in a tail-race.....	42, 58
Willow Springs to Section 14, cost of.....	57
Work on not all submitted to bids.....	59
Underestimate of cost of by engineers.....	57
specifications for bids, character of.....	57
Subsidiary works, list of.....	60
Summary of cost of.....	71
Capt. Marshall on cost of.....	85
Surveyed by Capt. Marshall.....	94
Capt. Marshall on flooding to be caused by.....	72, 86
Effect of on Chicago as a grain market.....	84
Engineering problem of.....	93, 94
WENTER, drainage commissioner, member of committee on engineering.....	46
September 9, 1890, votes against resolution that engi- neer file report in thirty days.....	47
November 7, 1890, votes against adoption of report on Cooley.....	49
November 26, 1890, votes against order for engineer to confine his work.....	49, 50
December 10, 1890, votes against order for engineer to surrender documents.....	50
July 22, 1891, votes against employment of men to locate route.....	56
WILLIAMS, BENZETTE, on Chicago sewage.....	15
Report of on Bridgeport pumps.....	24
Appointed consulting engineer on Herring commis- sion.....	27

	Page
WILLIAMS, BENZETTE, has a "policy"	31
Opposes amendment of Drainage Act	53
Resides on Salt Creek	34
Appointed chief engineer	55
Inadequate estimates of	57, 62
Has six routes for channel	65
On navigation of Chicago River	66
WORCESTER, MASS., precipitating works at	106
WORTHEN, made chief engineer	52
Reports of	52
Recommends thirty-six foot iron cylinder at Joliet..	62

TD
525
C5
J33
1892
RARE
AK RM

