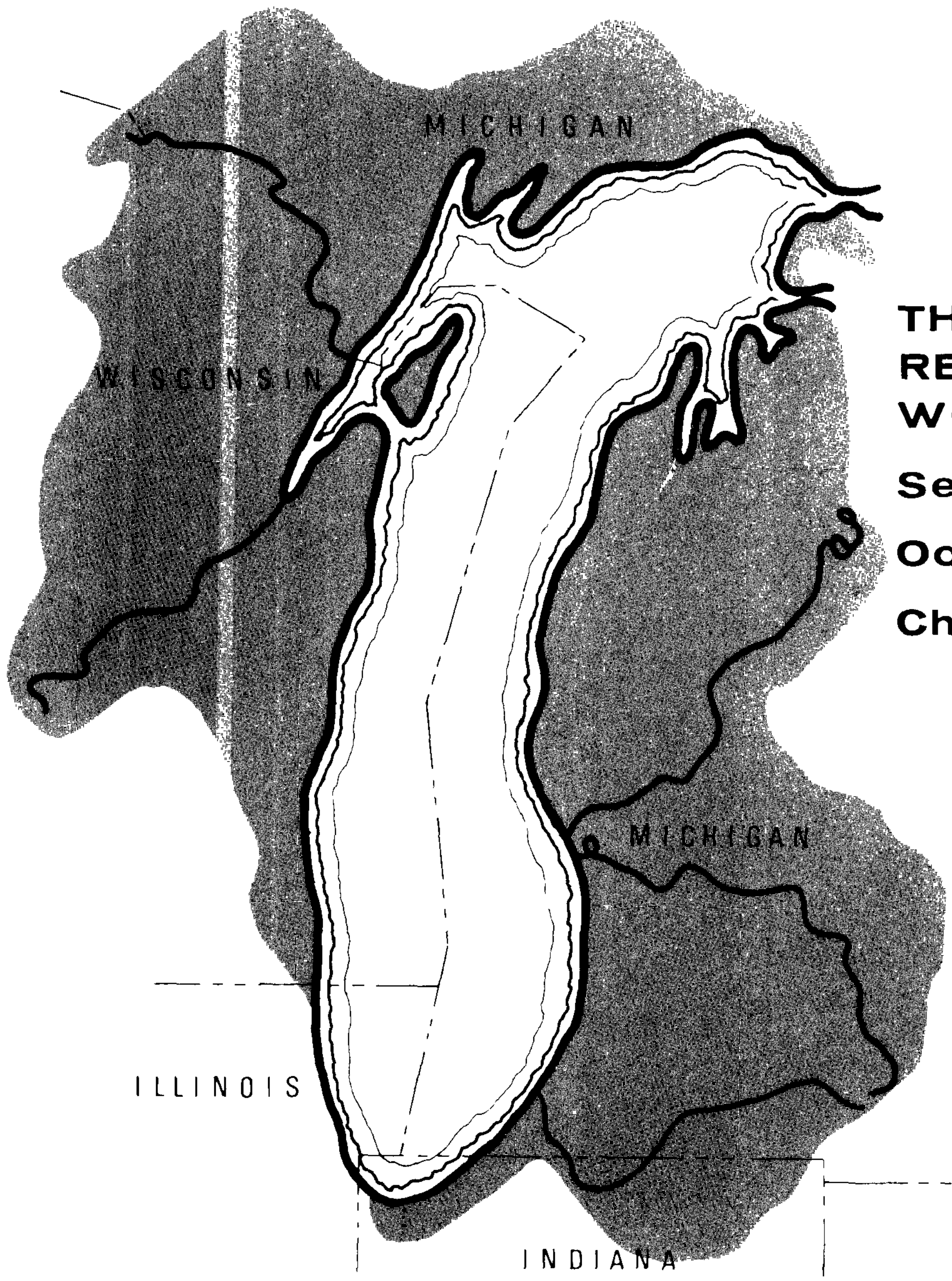
PROCEEDINGS



THIRD SESSION
RECONVENED IN
WORKSHOP SESSIONS

September 28, 29, 30,

October 1, 2, 1970.

Chicago, Illinois

Vol. 4,

CONFERENCE

Pollution of Lake Michigan and Its Tributary Basin

U.S. DEPARTMENT OF THE INTERIOR . . . FEDERAL WATER QUALITY ADMINISTRATION

WORKSHOP SESSION FOR THE THIRD SESSION OF THE CONFERENCE IN THE MATTER OF POLLUTION OF LAKE MICHIGAN AND ITS TRIBUTARY BASIN IN THE STATES OF WISCONSIN, ILLINOIS, INDIANA, AND MICHIGAN - - - VOLUME IV

Bal Tabarin Room
Sherman House
Chicago, Illinois
October 1, 1970

C O N T E N T S

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Workshop Session for the Third Session of the Conference in the Matter of Pollution of Lake Michigan and Its Tributary Basin, in the States of Wisconsin, Illinois, Indiana, and Michigan, held in the Bal Tabarin Room of the Sherman House, Chicago, Illinois, on Thursday, October 1, 1970, at 9:00 a.m.

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PRESIDING:

MURRAY STEIN, Assistant Commissioner for Enforcement and Standards Compliance, Federal Water Quality Administration, U.S. Department of the Interior, Washington, D.C.

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CONFEREES:

CLARENCE W. KLASSEN, Director, Illinois Environmental Protection Agency, Springfield, Illinois.

BLUCHER A. POOLE, Technical Secretary, Stream Pollution Control Board, Indiana State Board of Health, Indianapolis, Indiana.

PERRY E. MILLER, Assistant Director, Stream Pollution Control Board, Indiana State Board of Health, Indianapolis, Indiana.

CONFEREES (Continued):

RALPH W. PURDY, Executive Secretary, Michigan Water Resources Commission, Lansing, Michigan.

THOMAS J. FRANGOS, Administrator, Division of Environmental Protection, Wisconsin Department of Natural Resources, Madison, Wisconsin.

FRANCIS T. MAYO, Regional Director, Federal Water Quality Administration, U.S. Department of Interior, Chicago, Illinois.

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ALTERNATE CONFEREES:

RICHARD NELLE, State Sanitary Engineer, Illinois Environmental Protection Association, Springfield, Illinois.

DAVID P. CURRIE, Chairman, Illinois Pollution Control Board, Chicago, Illinois.

CARLOS FETTEROLF, Supervisor, Water Quality Standards Appraisal, Michigan Water Resources Commission, Lansing, Michigan.

DONALD J. MACKIE, Assistant Secretary, Division of Environmental Protection, Wisconsin Department of Natural Resources, Madison, Wisconsin.

ALTERNATE CONFEREES (Continued):

JEROME McKERSIE, Acting Chief, Water Quality Evaluation Section, Division of Environmental Protection, Wisconsin Department of Natural Resources, Madison, Wisconsin.

ROBERT P. HARTLEY, Director, Office of Enforcement and Cooperative Programs, Federal Water Quality Administration, U.S. Department of Interior, Chicago, Illinois.

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PARTICIPANTS:

John R. Brough, Director, Air and Water Control, Inland Steel Company, East Chicago, Illinois.

John T. Dunn, Pollution Control Engineer, Bethlehem Steel Corporation, Chesterton, Indiana.

Winfred L. Ettesvold, Chairman, Michigan Grand River Watershed Council, Lansing, Michigan.

Philip F. Gustafson, Coordinator, Argonne Great Lakes Research Program, Argonne National Laboratory, Argonne, Illinois.

Ewald L. Moerke, Jr., Attorney, Milwaukee, Wisconsin.

PARTICIPANTS (Continued):

Chester Grobschmidt, Mayor, South Milwaukee, Wisconsin.

H. W. Poston, Commissioner, Department of Environmental Control, Chicago, Illinois.

James C. Vaughn, Engineer of Water Purification, Chicago, Illinois.

Benjamin F. Willey, Director, Water Purification Laboratory, Chicago, Illinois.

Jacob D. Dumelle, Member, Illinois Pollution Control Board, Chicago, Illinois.

Robert V. Bowden, Sanitary Engineer, Federal Water Quality Administration, Chicago, Illinois.

Frank Harangody, Mayor, Whiting, Indiana.

Raymond E. Anderson, General Manager, North Shore Sanitary District, Waukegan Sewage Treatment Plant, Waukegan, Illinois (by Paul A. Kuhn).

David Schwarz, Director, Corporate Environmental Control, Abbott Laboratories, North Chicago, Illinois.

Charles F. Riefstahl, Skokie, Illinois.

Byrd F. Parmelee, Sales Engineer, Technicon Industrial Systems, Tarrytown, New York.

Virginia F. Hubbard, City Clerk, Petoskey, Michigan.

Russell C. Mallatt, Lake Michigan Thermal Study Committee.

Murray Stein

PROCEEDINGS

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MR. STEIN: Let's reconvene and start with Mr. John R. Brough's statement.

May I ask the conferees if they see anyone coming in who they want to put on, who is ready to make statements to let the Chair know and we will get these statements moving as rapidly as we can. I know a lot of people have indicated they wanted to make statements.

Our original announcement was that the meeting was to start at 9:30. The municipal and industrial people may not have been here late last night when we announced we were going to reconvene at 9:00, so I suspect that they may be in here later.

Now, again, in the field of water pollution control, I think this is really an historic occasion this morning, and I guess we don't pause in our business for these historical occasions, but today is the day when the gentleman on my right, Mr. Perry Miller, takes over as Executive Secretary of the Indiana Commission. Since I have been in the business -- and this has been a long time -- we have been dealing with Blucher Poole, and this is a very, very significant personnel change, and I might say that I have known Mr. Miller about the same time as we all have and, Perry, congratulations. I think the best indication is the way Perry is spending his first day in office and that is working on one of the most difficult problems we have. Thank you very much.

Mr. Brough.

STATEMENT OF JOHN R. BROUGH, DIRECTOR OF AIR AND WATER CONTROL, INLAND STEEL COMPANY, EAST CHICAGO, INDIANA

MR. BROUGH: Thank you, Mr. Stein.

Mr. Chairman, honored conferees, ladies and gentlemen. I am John R. Brough, Director of Air and Water Control for Inland Steel Company.

Inland Steel Company has a vital interest in the protection of Lake Michigan for a variety of uses, including swimming, boating, fishing, and public water supply. We recognize our responsibility to do our part in preserving the lake for these uses by protecting the lake from damage which may be caused by the use of the lake for industrial processing, cooling, and transportation.

Certainly the use of the lake for recreation, commercial fishing, and public water supply is in the public interest. The industrial use of Lake Michigan is also in the public interest.

The proposal of the FWQA to prohibit any discharge to the lake which is more than 1 degree above ambient would, in its effect, prohibit the use of Lake Michigan water for industrial purposes, for the only way to comply with such a restriction is to discharge no water to the lake.

I agree with the following statement contained in the Fish and Wildlife Service publication, "Physical and Ecological Effects of Waste Heat on Lake Michigan."

"Everyone concerned with the problem agrees that not enough is known about the ecological effects of massive heated effluents and that a great deal of research is needed on this problem. Unfortunately, the information is needed now. Since it is not available however, interim standards must be set for Lake Michigan on the basis of existing knowledge."

I do not agree, however, that it is necessary to establish standards that are so restrictive that they prohibit the use of the lake for all uses other than aquatic life, recreation, and public water supply.

The arguments for no significant heat additions contained in the Fish and Wildlife Service publication are heavily dependent upon a projection of waste heat input into the lake in the year 2000. The predicted level of waste heat 30 years from now cannot logically justify the elimination of effluents which have long existed without any known adverse effects due to heat.

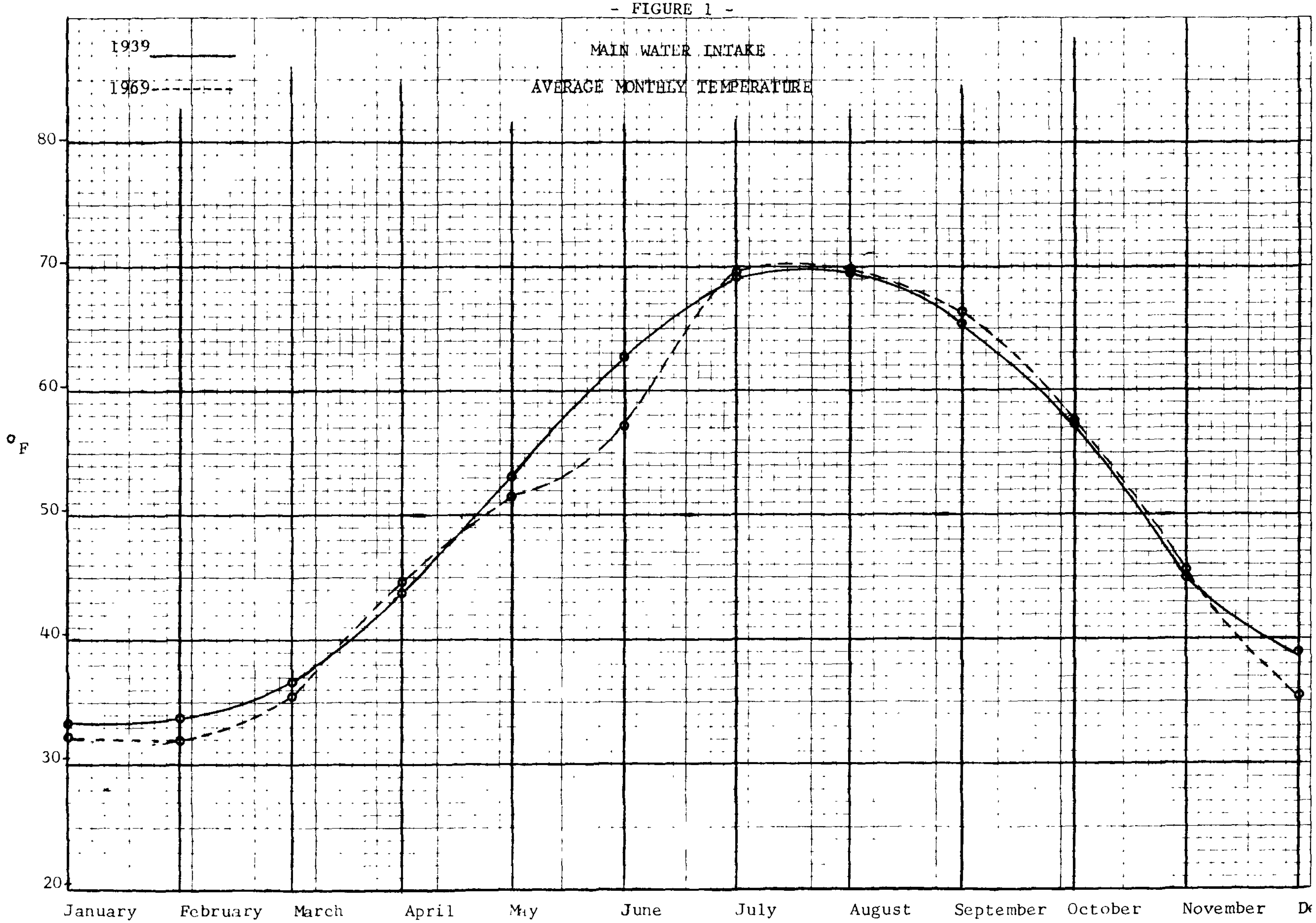
The projection of waste heat discharges for the steel industry in the next 30 years contained in the Fish and Wildlife publication is inconsistent with our recent experience at Inland. New steelmaking processes, as well as processes for converting molten steel into solid semi-finished products, require far less water than the older processes which they replace. As a result, additions in steelmaking and steelrolling facilities which have been made in our plant since 1966 have not resulted in any increase in the quantity of waste heat discharged.

The publication on "Physical and Ecological Effects" indicates that even though present and projected waste heat discharges have a small impact upon the average temperature of the lake as a whole, there is a great impact from heated effluents in the beachwater zone. If this were true, then surely it would be apparent at the Inland Steel Company main water intake. This intake receives water from the surface adjacent to the plant in that portion of the lake classified as the beachwater zone. To the west of this intake is the Indiana Harbor Ship Canal which undoubtedly carries a significant portion of the waste heat entering the lake from Indiana. Further west, but still within 6 miles, are heated effluent discharges from oil refineries, chemical plants, powerplants, and steel mills. To the east, within 6 miles, is a large powerplant as well as a large steel plant and other plants which discharge heated effluents. For many years, we have recorded the temperature every 8 hours at this intake. We have retained these records for several of the past 36 years. In figure 1 (See P. 1395), the average monthly temperatures of our intake water for the year 1969 are plotted together with the same data for 1939. In figure 2 (See P. 1396), the monthly maximum and minimum temperatures recorded in these years are plotted.

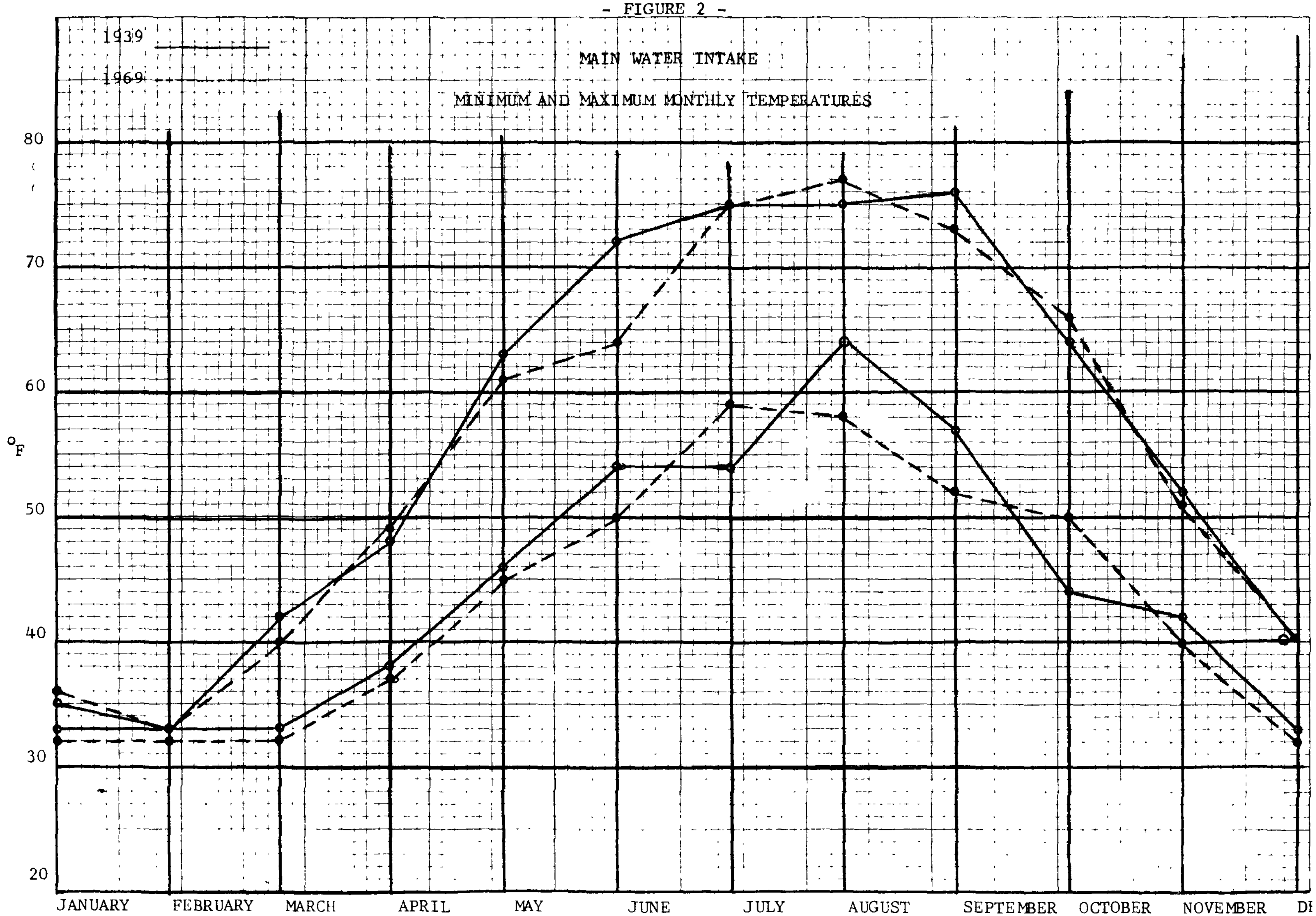
You will note from figure 2 that the maximum temperature measured at Inland's main intake did not exceed the maximum temperature of 82 degrees which the Fish and Wildlife publication indicates may be expected from natural forces in inshore water.

You will note from these figures that in 30 years there has been no noticeable change in temperature

- FIGURE 1 -


1939
1969
MAIN WATER INTAKE
AVERAGE MONTHLY TEMPERATURE
°F
80
70
60
50
40
30
20
January
February
March
April
May
June
July
August
September
October
November
De

- FIGURE 2 -


1939
1969
MAIN WATER INTAKE
MINIMUM AND MAXIMUM MONTHLY TEMPERATURES
80
70
60
50
40
30
20
°F
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DE

patterns even though the growth rate in waste heat additions in this area was probably as great during the past 30 years as has been projected for the entire lake in the next 30 years. These data appear to be in conflict with the assumption made by the Fish and Wildlife publication that waste heat is retained in the beachwater zone.

As I said before, I agree that a great deal of research is needed in order to enable a better understanding of the ecological effects of massive heated effluents. I agree that interim standards must be set for Lake Michigan on the basis of existing knowledge.

Existing knowledge does not indicate measurable impact upon water quality or the general aquatic life of Lake Michigan from the existing discharges of heated effluents; and, therefore, does not indicate that prohibition of present and planned additional discharges will be beneficial.

Existing knowledge does indicate that there are many known causes of pollution of the lake which are correctable with known technology. There are many opportunities for expenditure of funds for furthering the cause of pollution abatement which do have measurable benefit. We should direct our resources to those areas which we know will produce benefits and continue our research and study to establish an intelligent plan for the regulation of lake water uses including its use for receiving waste heat.

I suggest that a technical committee be established to evaluate existing knowledge with regard to the effects of heated discharges and to recommend reasonable interim standards which will assure the preservation of the lake for all legitimate uses. The technical committee should include competent technical personnel representing a broad range of water users and interested citizens' groups.

Thank you, Mr. Stein.

MR. STEIN: Thank you, Mr. Brough.

Are there any comments or questions?

Mr. Brough, do you really believe that if we establish the technical committee now -- let's suppose we are going for this -- and adopted your suggestion on interim requirements, that a technical committee would be able to give us any more information than we are adducing at this workshop?

MR. BROUGH: Mr. Stein, you have a great deal of information except that you have this information, as I see it, represented at widely differing positions. I am not suggesting that this conference isn't capable of sifting this information and of reaching a reasonable position. However, I think their efforts might be facilitated if you did have this committee get together who represented a broad range of interest and who could then make recommendations which would assist you in this effort.

The idea for this, I think, came from the 1965 conference on Lake Michigan between Illinois and Indiana and the Federal Government. A technical committee was used at that time to recommend standards, and these standards were adopted by the States of Illinois and the State of Indiana. They were approved by the Federal Government, and I have heard of no challenge to these standards with the exception of the one, and that is the one pertaining to temperature criteria which is under challenge today.

MR. STEIN: Mr. Brough, I think you have raised a point, a very interesting point. As you know, I have pushed that technical committee. As a matter of fact, I was chairman of the panel that was responsible for appointing that committee, encouraged and made the funds available for them for the secretarial and other travel services, clerical services, and was instrumental in getting the report published, etc.

But here was one difference, and this is an essential difference. In order to get a committee that you say we should have, we have to have a real support in working at least on some basic assumptions by the governmental agencies, municipalities, and industries involved.

I think the governmental agencies all agreed there was a problem on pollution of Lake Michigan. I think the reason we are at this meeting is we -- at least the governmental agencies agree that there is a problem possibly of heat coming into the lake; and the municipalities agreed there was a problem before we set up the technical committee, and the two major industries concerned -- the oil and the steel industry -- both agreed there was a problem. They never contended that they weren't contributing a pollutant into the lake. They never suggested the material they were putting there was not causing harm.

However, as I understood the power companies' view they contend what they are doing is fine and we just go ahead.

Now, I think we have to assume that if we are going to set up a technical committee to set up a standard, we have to get this on the assumption that all of the parties to it agree there is a problem and something has to be done. This is not meant to be criticism of the power industry, because certainly under our form of government and under our Constitution and under both State and Federal law, we have every right to say that they are not causing the problem, and they have every right to handle this by the process of confrontation rather than adjustment to the technical committee. But until we get that I don't know that we have a basis for moving forward in that direction.

MR. BROUGH: Yes, Mr. Stein, I am well aware of the things that you pointed out particularly with regard to the 1965 conference and your being the leader in getting this technical committee formed and all that.

J. R. Brough

I am sure that I agree with you that if the power companies won't participate in such an activity, then the technical committee would serve no useful purpose. However, although I didn't hear all the testimony that was given in the last three days, I did hear a great deal of it, and it seemed to me that there was a middle ground that represented a place that a compromise could be worked out.

For example, the gentleman from the Fish and Wildlife Service -- and I don't recall who made the statement -- but they made the statement that the reason we used the year 2000 for estimating the impact on Lake Michigan is that we were sure that we could establish that damage would be done in the year 2000.

So that would indicate to me that between now and the year 2000 there might be some point at which you might say that we had reached a level that we couldn't tolerate.

Now, this may be true. I am not saying it is and I don't want to misquote anybody. I do understand that nearly everyone in the Fish and Wildlife Service said that there would be some harm to some organisms, but I didn't hear anyone from the Fish and Wildlife Service say that there would be intolerable harm from one nuclear power station or from one powerplant or anything like this.

What I am saying is that there is some point where you would do substantial damage to the lake and some point where you perhaps would do insignificant damage to the lake.

MR. STEIN: I am not arguing with you on the theoretical position, but I think we have a very practical position the way the conference proceeds to work it.

As you know, there is a little time differential between here and Washington, and during lunch time and in the morning we have other duties out here to perform. Just this morning before I came down here I was on the phone with the offices back East. We have cases involving power companies and heated water. We are in court. The question was whether we could work out a stipulation and an order to work our way out of that.

The difficulty was we couldn't do that, as we are here when we sit down with the power company. We had to go to court first. Then the problem is that you don't have the flexibility. Once you are in court, you don't have the flexibility in the sense that we had in that technical committee.

I don't know that we can get an agreement. But if we are going to do this at all, it looks as if we are going to have to get a precisely developed stipulation that will be entered as an order by the Federal Court.

J. R. Brough

This, it seems to me, may be the hard way to do this. But I, again, want to make this clear, that it takes two parties at least to make the bargain. If anyone considered by some governmental agency to be a polluter feels that way, it is his absolute right and privilege to do this through the judicial process.

Now, your judgment may be that we are not circumscribe, but I did not get the feeling from the presentations I heard from the power industry that they were ready to utilize any other process, other than this, to come to this agreement.

Now, if we have to get the people together, I think, Mr. Brough, your approach might be a feasible one. Now, I am not sure we are going to get any more information under this technical committee than we have here. But we may get a feeling in dealing with people from say the steel industry, the oil industry -- and I know Mr. Mallatt had to leave but he was here with a statement yesterday -- and possibly the power industry, as well as the cities and States here if we are going to take an interim step of what we all might agree to.

But I think we have to have the major industries ready to sit down, and recognize there is a problem that we have to face in order to do that, because without that assumption all we are going to have is a disagreement.

MR. BROUGH: Well, I think, Mr. Stein, in order to get into that sort of thing, you have to have an agreement among the parties involved that there is room for compromise. If either one of the parties feels that we have a position and we are going to stick with it -- in other words, we know the solution and we will compromise with you as long as you come all of the way to my position, then there isn't any point. I agree with you that the only way to settle this sort of issue is to go to court.

MR. STEIN: I didn't see a scintilla of evidence in the past several days that anyone had the position that: We have the position and ours is right. If there was an indication of that -- maybe there were a few -- maybe Dr. Ayers indicated that -- but I didn't see much else.

Are there any other comments or questions?

If not, thank you very much, Mr. Brough.

MR. BROUGH: Thank you very much.

MR. STEIN: Is anyone else here now who is ready to make a statement?

Yes, would you come up?

J. T. Dunn

STATEMENT OF JOHN T. DUNN, POLLUTION CONTROL ENGINEER, BETHLEHEM STEEL CORPORATION, CHESTERTON, INDIANA

MR. DUNN: Mr. Chairman, ladies and gentlemen, my name is John Dunn. I am the Pollution Control Engineer for the Burns Harbor Plant of the Bethlehem Steel Corporation which is located in Chesterton, Indiana. I am speaking on behalf of the corporation.

Since the start of construction of our Burns Harbor Plant, Bethlehem Steel has been a leader in providing the most advanced pollution control systems available for the protection of Lake Michigan. The corporation has cooperated with the regulatory agencies to the fullest extent, both with respect to operational matters and by supporting reasonable legislation in all areas of environmental control. Over $50 million has been spent to install pollution control facilities at Burns Harbor and additional millions are being spent yearly for the operation and maintenance of these systems. This money was spent with a purpose, that is, it was spent to protect our environment from the effects of toxic or nuisance substances in the waste products generated in our steelmaking processes. The benefits to Lake Michigan, as a result of proper treatment of these wastes, is clearly defined and it was in this light that Bethlehem Steel committed itself to such a comprehensive control program.

Bethlehem Steel supports reasonable and necessary standards to protect water quality; however, we oppose the promulgation of what we believe to be needlessly stringent effluent temperature standards for the following reasons:

1) The effect of thermal discharges is not fully understood at this time.

2) Thermal pollution is not a problem in Lake Michigan at this time nor is it expected to be within the period of time that would be required to complete field research into this matter.

3) The personnel, equipment and the technology are available for comprehensive research into the ecological effects of thermal discharges.

4) The technology and equipment for the control of thermal discharges are presently available, thus, if research indicates the need for such control, reasonable standards could be implemented in a short period of time.

5) It is unreasonable to demand immediate

adoption of standards designed to adequately protect the lake against a projected thermal input of 431 billion B.t.u./hr. in the year 2000 when the 1980 projected heat load is only 105 billion B.t.u./hr.

6) To attempt to halt eutrophication of Lake Michigan by the control of temperature without proper control of nutrients, which is now the more critical and proven problem, is a backdoor approach that is destined to fail regardless of the control of thermal discharges.

7) To spend the amount of money required to achieve the stringent "interim standards" that are being proposed without the proof of need or benefit would detract money from other more beneficial pollution control projects.

In the "white paper" entitled "Physical and Ecological Effects of Waste Heat on Lake Michigan," released by the Department of the Interior, an attempt is made to establish a case for "interim standards" for thermal discharges to Lake Michigan. Yet the paper notes on the first page that: "Not enough is known about the ecological effects of massive heated effluents and that a great deal of research is needed on this problem." In addition, this paper extrapolates the heat input to the year 2000 and uses this figure to predict the direst results in statements that are qualified with words such as "may," "could," and "possibly." It then takes these questionable predictions for the year 2000 and implies that these consequences of thermal discharge to Lake Michigan are just a few years away. Previous statements by respected members of the academic community before this conference indicate that the question of thermal discharges and its effect on the ecology of Lake Michigan is not as clearly defined as the Department of the Interior would imply. To review these items would be redundant, but it must be stressed that much work must be done in this area before reasonable legislation can be written.

Bethlehem Steel Corporation would propose the following approach to the development of thermal discharge standards:

1) Interim standards should be developed in conjunction with the State regulatory agencies that reflect the presently defined need for control.

2) A Federally-sponsored research project investigating both the ecological effects of various levels of temperature increase and the factors of heat plume dispersion and other physical factors should be initiated immediately. This work would be field-oriented

J. T. Dunn

with a minimum dependence on mathematical models, etc., and should be conducted over a period of at least 2 years to properly evaluate the effects of the winter freeze.

3) Maintain a policy of continuing field research and evaluation of the acquired data to provide for the periodic revision of thermal discharge standards if the need is so indicated.

4) Continue the established program to reduce the nutrient discharge to the lake especially in the area of municipal treatment plants.

It is only through a comprehensive program such as this that the people of the Lake Michigan area will receive the proper return on the dollars spent for environmental control. It is a mistake to develop regulations on the premise that the amount of money available for pollution control is unlimited just as it is a mistake not to get the maximum benefit from the dollars spent. To promulgate an "interim regulation" that is, in effect, as stringent a regulation as could be written is totally irresponsible in light of the existing situation. I thank you for your consideration and hope that this conference can lead to realistic legislation with respect to this aspect of our environment.

MR. STEIN: Thank you very much, Mr. Dunn.

Any comments?

As I sense it, I think your suggestion, at least your recommendations are probably what the conferees may want to very seriously consider. I am not sure we would have any problem in a philosophic sense with any of your approaches. You raise several points. One I am not sure of -- do you think that the suggestion of the Fish and Wildlife people in their paper was the most stringent regulation that could be written? I don't think they would be the most rigid ones if I were writing them. How about a completely closed system, no discharge?

MR. DUNN: In effect, a thermal heat input is a closed system. I don't see --

MR. STEIN: Well, I don't know that that could be equated. But if you wanted to be more stringent you just would put that out as a closed system.

MR. DUNN: Well, that may be, but we were referring strictly to the thermal aspect of the thing.

MR. STEIN: Right, and I am not sure, as I pointed out, that that isn't an aspect which we may not have to consider.

But there is one other question that you raise here. I would like to go over this with you because on page 2 of your report, No. 6, you say -- and I read this: "To attempt to halt eutrophication of Lake Michigan by the control of temperature without proper control of nutrients, which is now the more critical and proven problem, is a back door approach that is destined to fail regardless of the control of thermal discharges."

Then you refer to this again. I remember when we first embarked on that program and we had a conference such as this. There were the same kinds of allegations and there was improvement, then, just as we are getting now on heat, because you get that all of the time.

The question I have: We have a program for reduction of phosphates on an 80 percent basis, on a State-wide basis. Now, do you believe -- are you implying that this isn't enough, we have got to do some more on nutrients and we have to put extra restrictions on cities?

MR. DUNN: The reason this was put in the paper was because the paper tends to imply that it is easier to control the heat than it is to control the nutrients, and maybe we should not place as much stress on the nutrients. If there are two sides to the see-saw let's attack one side. We think it has to be a balanced approach.

I can't say from my position that 80 percent is or is not enough. What we are trying to bring out here is that it has to be a whole attack on the thing.

MR. STEIN: I understand that, but we do have a program and a pretty significant program, a new one and a pretty drastic one for the cities to put in phosphate control.

Now, as one from industry are you suggesting that we take another look at our municipal control program and probably put more restrictive requirements on the cities?

MR. DUNN: No, I am not saying that. This wasn't the intent. The intent here was to say -- or at least referring back to the "white paper," was that -- the "white paper" attacks it from the point of view that there are two problems: nutrients and temperature. It gives no credit for the fact that we are in a nutrient control program, and it tends to gloss over the fact that we are in this nutrient control program, and in this area in 5 or 10 years we hope to be in a lot better position than we are now. This is the one thing we were intending to bring out here.

MR. STEIN: I am glad to have that clarified because the way it was written one would think you were implying that the industry was trying to turn it toward the municipalities so we would let up on the industry.

MR. DUNN: No, but at the same time we do think that the municipalities are the biggest source of nutrients.

MR. STEIN: Right.

MR. DUNN: We don't mean to be beating them with a club.

MR. STEIN: As I say, we all recognize the deficiency in our program of not really coming to grips with the nutrients going into the water from municipalities.

Mr. Mayo.

MR. MAYO: Mr. Dunn, Mr. Lee of Commonwealth Edison, I think, in substance suggested that if we permit power companies to go ahead with the plants, at least those presently under construction, that the power industry would go along with something in the form of "a moratorium", I suppose might be a good word, with respect to any additional new plants and related waste heat discharges for some reasonable period of study.

Do you have any idea how the steel industry or any of the other industrial people would feel about a so-called moratorium on heated waste discharges into Lake Michigan for a period of serveral years perhaps?

MR. DUNN: Well, first let me say that I do not speak for the industry in general. Our position is kind of particular. We are in kind of a crossfire in that we don't discharge all of our waste directly to Lake Michigan; we do discharge some of our waste to the Little Calumet River which, of course, runs into Burns Ditch and then into Lake Michigan.

Mr. Miller is aware of the problems that we are having there where we are talking about bringing relatively cold water from Lake Michigan at certain times of the year, running it through our system and discharging it to the Sound, to the Little Calumet River.

So what happens here is that the Department of Natural Resources in Indiana is attempting to control the thermal shock to the stream both from high temperature and low temperature, and here we are working toward the end now of being able to discharge this effluent at a temperature that is comparable with the conditions existing in the Little Calumet River. So we may at times be attempting to hold the temperature of our effluent up, which is what seemed to be in direct opposition to what we are talking about here. But this situation exists, and the thing is pretty complex. It is not a clearcut attack on the thing. From our point of view, it would just really be hard to say.

J. T. Dunn

The second thing is with respect to our discharges, as opposed to the utilities, one, we do not normally have as large a temperature pickup through our cooling systems. Quite often in, say, furnace cooling application we may have no more than a 1-degree rise across the furnace. Some application some places it is higher. We do generate up to 80 megawatts in the plant now and we also have high pressure turbines that we use for supplying power to the blast furnace so we do have some conditioning application. But a lot of our applications are strictly once-through cooling on a rather low temperature rise across the cooling member.

As far as waging a moratorium on this, I really don't know. I just couldn't say offhand. It would require a great deal of studies, and I think as a result of the increased activity in this area, we are surely looking at everything with this in mind, but I could not make a statement of corporate policy on this.

MR. STEIN: Are there any other comments and questions?

Any public questions?

If not, thank you very much.

May we have Winfred Ettesvold? Mr. Ettesvold, before you begin, I would like to remind you that we try to emphasize thermal application here, and while we don't want to cut anyone off, our main thrust at this workshop session is to consider the question of thermal pollution.

MR. ETTESVOLD: Thank you, Mr. Chairman.

I am afraid that this statement which I have, which is fairly brief, is on the general subject of pollution rather than specifically on thermal pollution.

MR. STEIN: All right.

Continue.

W. L. Ettesvold

STATEMENT OF WINFRED L. ETTESVOLD,
CHAIRMAN, MICHIGAN GRAND RIVER
WATERSHED COUNCIL, LANSING, MICHIGAN

MR. ETTESVOLD: I am Winfred Ettesvold. My profession is as Director of Environmental Health of the Kent County Health Department, Grand Rapids, Michigan. I also serve as chairman of the Grand River Watershed Council, and I appreciate the opportunity to make a brief statement to the assembled conferees about what we believe to be a very unique organization which is attempting to bring the local units of government together on this broad problem of pollution.

The Michigan Grand River Watershed Council is a statutory entity composed of, and representing the local government units in the Grand River basin. According to the Local River Management Act, its functions are: "To enable local units of government to cooperate in planning and carrying out a coordinated water management program in the watershed."

The Watershed Council is comprised of the grassroot elements of the communities including townships, villages, cities and counties. Through the Council, the representatives have the opportunity to become involved in the planning aspects of a water management program and to continue their involvement by assisting the communities in the implementation of the programs.

The key role of the Council is to coordinate the concerns and efforts of the communities to develop programs on a regional basis. This is particularly important to the million people in the basin because of the multiplicity of governmental units. In an area exceeding 5,500 square miles there are 19 counties, 29 cities, 43 villages and 158 townships that have all or part of their respective areas in the Grand River basin.

The abatement of water pollution is a police power of the State. However, the State of Michigan strongly endorses the right of home rule by the communities, and encourages them to exercise police powers at the local level. The State further encourages local government to provide preventive measures before the necessity of enforcement occurs.

The Grand River Watershed Council is actively involved in assisting local communities in the development of pollution abatement programs. The following programs demonstrate the emphasis on regional promotion and development of water and land management programs, to enhance and preserve the quality of the water.

First is the stream monitoring program.

A major emphasis of the Watershed Council has been the implementation of a systematic stream monitoring program. This program started in June 1968. Today the following communities are voluntarily working together in this effort: Grand Haven, Coopersville, Grandville, Grand Rapids, Lowell, Ionia, Portland, Grand Ledge, Lansing, East Lansing, Eaton Rapids, Jackson, Hastings, Nashville, Belding.

The Center of Environmental Studies, Jackson Community College is also participating in the program by testing specific locations on the streams and lakes in Jackson County. Approximately one hundred stations are sampled monthly by the waste water treatment plant technicians. The basic parameter at all stations include temperature, dissolved oxygen, biochemical oxygen demand, pH and total coliforms. In addition to the basic parameters, the larger cities also test for one or more of the following: chlorides, total phosphate ortho phosphate, total soluble phosphate, total chromium, cyanide, nickel, ammonia nitrogen, copper, zinc and suspended solids.

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I might add in addition to my prepared statement that the work that we have accomplished through the Grand River Watershed Council and this procedure has resulted in a much more uniform approach on the part of the laboratory technicians at various wastewater treatment plants. We feel that this has been a very significant contribution to developing a pattern for the entire river.

In addition to the cooperative efforts of the local governmental units, the Institute of Water Research, Michigan State University, performs all data card punching for storing the data in the Storet computer, available through the services of the Federal Water Quality Administration. Retrieval and analysis assistance is provided by the Water Resources Commission, Michigan Department of Natural Resources.

Some of the benefits of the stream monitoring program include: standard methods for testing, centralized storage of data, convenient retrieval of data, and a regional analysis of the water quality characteristics.

It is becoming apparent a more intensive program is necessary to assure that the water quality standards of the State are being satisfied. This can be accomplished through expansion of the present program by

W. L. Ettesvold

increasing the number of parameters being tested and the frequency of these tests, or to consider a more sophisticated testing program with automatic sensoring units connected to a centralized storage center such as has been developed by the Ohio River Sanitary Commission.

The Watershed Council is endeavoring to expand its monitoring program by encouraging other local units to participate. The attached paper "Monitoring Streams and Lakes" has been developed to show the value of the program and the possibilities for involvement.

(The paper above referred to follows in its entirety.)

MONITORING STREAMS AND LAKES

MICHIGAN GRAND RIVER WATERSHED COUNCIL

609 Prudden Building

Lansing, Michigan 48933

JOHN H. KENNAUGH
Executive Secretary

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MONITORING STREAMS AND LAKES

INTRODUCTION

Availability of water is a major problem in many parts of the country; but in Michigan, water pollution is the critical issue. Large quantities of water seem to be our richest resource. However, with the limitation of approximately thirty (30) inches of precipitation each year, and the increasing and multiple demands on this resource, water quality controls become necessary to preserve its continued use.

Domestic demands on water have increased from five (5) gallons per person per day in 1900 compared to one hundred fifty (150) gallons per person per day in 1960. During this same period, the population has increased three (3) fold. Between 1960 and 2000, the population is projected to double in numbers and the water demand will triple. During the same period, the recreational demand on the water resources will also triple. These geometric trends are signals that effective management programs to preserve and develop our water resources are essential to satisfy our own foreseeable needs and the needs of future generations.

Assured water quality is essential to long range planning of water use, both for the public and private sectors. Adoption and enforcement of water quality standards are the key factors to provide this assurance. Enforcement of water quality standards can be best approached with a continuous surveillance of the streams and lakes to observe trends that may occur as a result of increasing intensified use and changing demands on the water resource.

Water quality preservation is not simply a local issue, but rather, is a regional concern including all the area within the hydrologic boundary of the river basin.

It becomes essential for the multiple governments in the basin including counties, cities, villages and townships to work with the state in a coordinated and continuous program.

WATER QUALITY STANDARDS

STATE PROGRAM - Preservation and enhancement of the water resources results from adoption and effective enforcement of water quality standards. Water quality standards for all surface waters of the state were established by the Michigan Water Resources Commission for the following uses:

- Water Supply
  - Domestic
  - Industrial
- Recreation
  - Total Body Contact
  - Partial Body Contact
- Fish, Wildlife and Other Aquatic Life
- Agricultural Use
- Commercial and Other Uses

For each of these uses, eleven (11) standards (parameters) were established to designate the maximum and/or minimum level of acceptance. These parameters are:

- Coliform
- Dissolved Oxygen
- Suspended, Colloidal & Settleable Materials
- Residues
- Toxics & Deleterious Substances
- Total Dissolved Solids
- Nutrients
- Taste& Odor Producing Substances
- Temperature
- Hydrogen Ion
- Radioactive Materials

The water use designations with the standards for each were then applied to all the surface waters of the state.

LOCAL PROGRAM - Local governmental units may also adopt water quality regulations to protect the receiving waters in their area providing the standards are equal or higher than the standards adopted by the State.

The City of Grand Rapids has adopted an ordinance to regulate the discharge of wastes into sanitary and combined sewers. Section 2.66 identifies fifteen (15) categories of wastes that are being regulated. One of these sections specifies maximum quantities of discharge for zinc, chromium, cadmium, copper, cyanide, nickel and phenol.

Through this type of local effort the water resources within the enforcement area are protected, the downstream waters are enhanced, and the need for state agency enforcement has been minimized.

STREAM AND LAKE MONITORING

PURPOSE - Monitoring the water resources is an action program involving a systematic surveillance of the water characteristics to observe conditions and detect changes. The program should be continuous and each phase of the program should be conducted in a consistant manner in order to develop valid conclusions.

PROCEDURES - Standard procedures are essential to effective monitoring. Location, frequency and methods of sampling are key elements to a monitoring program. Documentation of the sampling site, and the water quality data is important. When the documentation is accomplished through the computerized program sponsored by the Federal Water Quality Administration, convenient and efficient retrieval is possible for review and analysis.

The data collected has value only if it is used. Following the retrieval, review and analysis, periodic reports to the governmental units and the general public are necessary to assure them that the water quality is consistent with the standards that have been adopted. If the standards are not being satisfied, each governmental unit will need to determine what type of water and/or land management programs are needed to upgrade the quality of the water.

WATER PARAMETERS

The Storet computer program operated under the auspices of the Federal Water Quality Administration identifies over seven hundred (700) parameters for water analysis. It is not practical, or possible for a single governmental unit to test for each of these parameters. Less than five per cent (5%) of these parameters are used to study the characteristics of surface waters and many communities have the capability to test only about one per cent (1%).

The Grand River Basin Stream Monitoring Program will be used as a basis for suggesting the parameters that can be tested by communities. The parameters will be grouped according to standard equipment and capability of the community depending on its respective physical and technical resources.

GROUP I - Communities that do not have testing laboratories, or organizations that would like to participate in a continuous monitoring program, can acquire portable testing equipment to test basin parameters of a stream or lake. Portable test kits can be purchased to examine various combinations of parameters. The Hach Chemical Company has a Fish and Stream Kit that will test for carbon dioxide (CO_2), dissolved oxygen (DO), free and total acidity, phenolphthalein and total alkalinity, hardness and hydrogen ion (pH). The equipment is contained in a solid oak carrying case (12 x 6 x 8), weighs 8 lbs. and costs about fifty dollars ($50). These tests can be incorporated in a monitoring program providing it follows the standard operating procedures. The tests have accuracy limitations but they can be used in the Storet Computer Program with qualifications.

GROUP II - Fourteen (14) governmental units in the Grand River Basin are participating in the stream monitoring program. The basic parameters tested by these units are temperature (F^{O}), dissolved oxygen (DO), biochemical oxygen demand (BOD), hydrogen Ion (pH) and one of the coliform (Coli) parameters. All governmental units with a population exceeding 2,000 people, and discharging treated wastes into the streams will also be testing for phosphate (PO_4), by 1972 according to the water quality enforcement program of the State.

GROUP III - Communities that provide secondary waste treatment or have testing capabilities in their laboratories, include additional parameters in their testing program. These tests are chloride (Cl), ammonia (NH_3-N), nitrate (NO_3-N), residue and turbidity.

GROUP IV - Some laboratories are also able to test for toxic materials and heavy metals. Parameters being tested in this category by Grand River Basin communities are cyanide (CN), chromium (Cr), copper (Cu), iron (Fe), nickel (Ni), and zinc (Zn).

Table I lists all the parameters in their respective groupings for convenient review.

TABLE I

PARAMETER CHECK LIST

FOR GOVERNMENTAL UNITS

PARAMETER	CODE	GROUPS I	II	III	IV
Carbon Dioxide (CO_2)	00405	X			
Dissolved Oxygen (DO)	00300	X			
Free Acidity	00436	X			
Total Acidity	99435	X			
Phenophthalein	00415	X			
Total Alkalinity	00410	X			
Hardness	00900	X			
Hydrogen Ion (pH)	00400	X			
Temperature (F^o)	00011	X			
Bio-Chemical Oxygen Demand (BOD)	00310		X		
Coliform Imedendo	31501		X		
Coliform Les-Agar	31504		X		
Coliform MPN Conf.	31505		X		
Coliform Fecal	31614		X		
Coliform MPN Pres.	71205		X		
Chloride (Cl)	00940		X		
Turbidity	00700			X	
Residue Total	00530			X	
Residue Volatile	00535			X	
Ammonia (NH_3-N)	00610			X	
Nitrate (NO_3-N)	00620			X	
Phosphate (PO_4) Total	00650			X	
Phosphate (PO_4) Soluble	00653			X	
Phosphate (PO_4) Poly	00655			X	
Phosphate (PO_4) Ortho	00660			X	
Cyanide (CN)	00720				X
Chromium (Cr)	01030				X
Chromium (Cr) Hex	01032				X
Copper (Cu)	01040				X
Iron (Fe) Total	01045				X
Nickel (Ni)	01065				X
Zinc (Zn)	01090				X

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4. The Storage and Retrieval of Data for Water Quality Control, U. S. Department of Interior, Federal Water Quality Administration, Washington, D. C. 20242.

5. Use Designation Areas for Michigans' Intra-state Water Quality Standards, Water Resources Commission, Department of Natural Resources, Lansing, Michigan 48926.

6. Water Analysis Catalogue, Hach Chemical Company, P. O. Box 907, Ames, Iowa.

W. L. Ettesvold

Soil Erosion Guidelines

One of the most critical pollution problems of the Grand River and its tributaries is sedimentation caused by soil erosion. An accelerated land treatment program in rural and urban areas is essential. To this date there is no governmental unit in the basin that can claim it has an effective soil erosion control program. The Watershed Council has accepted the leadership role to encourage local governmental units to incorporate soil erosion control measures in their local regulations. A technical committee was created to develop an informational booklet for public officials and the general public. The booklet "Soil Erosion and Sedimentation Control Program" is attached as a part of this report.

(The paper above referred to follows in its entirety.)

MICHIGAN GRAND RIVER WATERSHED COUNCIL

SOIL EROSION & SEDIMENTATION

Control Program

609 PRUDDEN BUILDING • LANSING, MICHIGAN 48933 • PHONE: 517 489-0552

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MEMBERS, SOIL EROSION CONTROL COMMITTEE

James Biener	Michigan Grand River Watershed Council
Richard Drullinger	Soil Conservation Service
Frank Evans	Ingham County Road Commission
Raymond Guernsey	City of Lansing
Robert Halstead	Soil Conservation Service
John H. Kennaugh	Michigan Grand River Watershed Council
Paul Koch	Soil Conservation Service
A. E Matthews	Michigan State Highway Department
Bill G Rowden	Tri-County Regional Planning Commission
Palmer Skalland	Soil Conservation Service
Ralph Sweinberger	Michigan Grand River Watershed Council
William Walsh	Michigan Walter Resources Commission

"The fourteen Soil Conservation Districts in the Grand River Basin are legal units of government charged to assist landowners in the control of soil erosion and sedimentation problems. The districts are committed to be of service to the people and communities of the basin "

R G Hill

"Photos Courtesy of U S D A. Soil Conservation Service"

I. INTRODUCTION

The Problem

It seems incredible that Michigan, the Water Wonderland State, should have a water problem. To some extent the problem is one of quantity,–but more importantly, one of quality. Michigan citizens are becoming sensitive to the fact that pollution in some of our lakes and streams is limiting the human use and enjoyment of our most valuable resource. It is a serious problem. It deserves our careful consideration.

Pollution by sewage and human waste, industrial waste, chemicals and toxic materials are sources which are readily discernable to the average citizen. What is probably less understood is the fact that soil erosion and sedimentation contribute to, and are equally a part of the pollution problem. And indeed, it is so recognized by experts.

The Michigan Water Resources Commission classify suspended, colloidal or settleable material as a pollutant and in their "Water Quality Standards for Michigan Waters" state that such materials "shall not be present in sufficient concentration to be objectionable or to interfere with normal treatment processes."

Source and Causes of Erosion

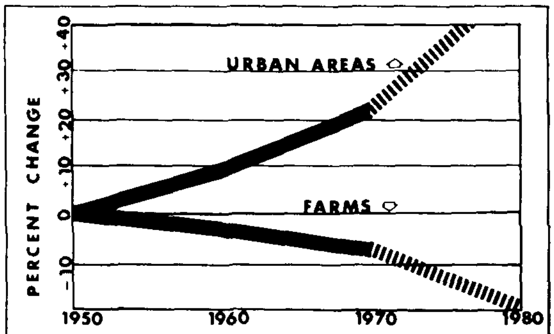
Farms and rural areas, while large in acreage, open in character and potentially vulnerable to erosion, do not pose as great a problem as the expanding urban areas. There are two significant reasons rural erosion is less critical than urban erosion. Firstly, the private farmer or land holder has an economic interest in the proper management of his own land. Secondly, there are public agencies (Soil Conservation Service of the U.S.D.A., Michigan Department of Natural Resources, Soil Conservation Districts, State Soil Conservation Committee, Michigan Department of Agriculture, etc.) who care for and are responsible for good management of open public lands. For many years these agencies have offered their technical skills and expertise to private farmers. There is common interest in a common cause by people who care. No such situation exists in our exploding urban areas. The private capital which makes a city grow has but little regard for the natural resources it destroys. At the same time, regrettable to say, our public official until now has displayed a similar lack of interest, despite a high degree of organization existing in many of our forms of municipal and county governments.

The Result

Massive urbanization creates untold damage through soil erosion and sedimentation. The deposition of sediment obstructs sewers and ditches, silts valley land and reduces the capacities of our streams and lakes. It blocks and eventually closes navigation channels, limits recreational opportunities and contributes greatly to the general unsightliness of our streams.

The Future

The rapid land use transition from a tranquil setting to that of a highly specialized urban atmosphere does not augur well for the future. A glance at the land use trends in the Grand River Basin shows that urbanization with its exploitation of natural resources will continue at accelerating rates.



MICHIGAN LAND USE TRENDS

What We Can Do

Erosion and sediment control measures are relatively simple and inexpensive. Conceived and developed within the framework of the U.S.D.A. Soil Conservation Service with the technical assistance of the state agencies, Agricultural Research Program and Cooperative Extension Program of Michigan State University, the measures as outlined in this report can be readily adapted to the urbanizing areas of Michigan.

While the responsibility for controlling erosion lies clearly with individual units of government, the Grand River Watershed Council as an agency concerned with water management within the Grand River Basin proposes to coordinate erosion control on a regional basis.

Responsible governmental officials within the Grand River Basin are urged to review the material herein presented and to follow through with an erosion control program designed for their own particular area. The Grand River Watershed Council and associated agencies listed in this booklet stand ready to assist governmental units in developing effective soil erosion control programs.

II. STATEMENT OF POLICY

In view of the need for erosion and sediment control measures, the attached model resolution (page 15) to be adopted by individual units of government within the Grand River Basin area states its support of the program of the Grand River Watershed Council in providing a regional soil erosion and sediment control program for this part of the state.

Farmland loses top soil.

III. SEDIMENT - DAMAGE - THE PRICE WE PAY

Soil erosion affects everyone. But many city dwellers give it little thought because it appears to them to be a problem only for farmers. Not so. And to illustrate, let's take a close look at one of the results of soil erosion—sediment or "silt."

Crops and Cropland Suffer

Some sediment affects the farmer directly and the city dweller only indirectly. Rain and wind spread sediment over farmland, not only destroying crops but also making the land less suitable for crops. Drainage and irrigation ditches quickly silt up. Stream channels clog and soon swamp productive farmland. The result is that more and more farmland is abandoned. Sediment damage to farmland in this country adds up to many millions of dollars every year.

Temporary erosion control measures during construction can avoid damage like this.

Road, Railroads, and River Channels are Silted

You have probably seen road graders scraping out roadside ditches. But did you realize that most of this work would not be necessary if soil erosion was controlled? Sediment fills ditches along roads and railroads and plugs culverts; it clogs stream channels so badly that some bridges have to be raised.

The sediment dredged each year from streams, navigation channels, estuaries, and harbors is estimated to exceed one-half billion cubic yards. The cost of removing this sediment is tremendous. This cost is paid for largely through Federal taxes.

Sediment damage to all our transportation facilities, including roads, railroads, and navigation channels, amounts to many millions of dollars every year.

Floods are More Frequent

More rivers are flooding more frequently each year because stream channels are choking with sediment. Also, many streams are carrying increasingly heavier loads of sediment. In the Los Angeles area, flows from newly burned-over hillsides consist of as much as 85 percent mud by volume and only 15 percent water.

So, in addition to the damage by floodwater there is the damage by sediment to streets, houses, machinery, automobiles, sewer lines, and wells.


Floods causes damage and inconvenience.

Sediment Hurts Recreation and Public Health

Sediment greatly reduces the attraction of many lakes and reservoirs for swimming, boating, fishing and other water-based recreational activities.

It destroys the spawning beds of game fish, ruins their eggs, and reduces their food supply. Fish eat the worms, insect larvae, and other small aquatic animals that feed on microscopic plants, but muddy water shades out light, interfering with the growth of the microscopic plants.

In many small streams, sediment fills the deep pools that provide a refuge for fish during the dry season.


Sedimentation destroys recreational value.

Most streams and lakes no longer have as many game fish as they once had. Less desirable species, such as carp that thrive in turbid waters are replacing the game fish. An attempt is being made to implant game fish in the Grand River, but results so far are inconclusive. Sedimentation is a difficult obstacle to overcome.

Commercial fisheries also have been affected. In the broad, shallow bays of western Lake Erie, fishing for yellow perch, cisco and whitefish was an important industry when clean, gravelly bottoms and abundant vegetation favored spawning and early growth. Today, sediment from nearby Ohio, Michigan and Indiana farms, urbanizing areas and channel dredging have contributed to the greatly reduced number of these fish.


Shopping plaza drainage causes bank erosion.

Sediment is a National Problem

Thus it is apparent that sediment affects every citizen. To every citizen it means higher taxes, railway fares, electricity and water bills; higher food and clothing prices; and more frequent requests for disaster funds.

IV. WHERE DOES SEDIMENT COME FROM

FARMLAND

Erosion on farmlands in the Grand River Basin does not pose as serious a problem as the urban areas. Nevertheless, cultivated land is still a source of much sediment. This erosion usually results from growing crops on steep land, from straight-row farming areas which should be contour-farmed or terraced, and from too frequent cultivation of land that needs alternating row crops and grass crops.

Pastures may be eroded due to overgrazing and farm woodlands may be eroded due to over cutting.

Wheat field could have been protected by strip cropping.

URBANIZATION

By far the largest contributors to the problems of erosion in the Grand River Basin are the rapidly expanding urban areas. In the process of converting farmland to highly developed urban areas, the land is exposed to erosion hazards during the process of construction.

Construction sites are highly susceptible to erosion. Roadways, subdivisions, shopping centers and large housing developments may keep an area bare and vulnerable for one to three years. Trees and natural vegetative cover along the riverbanks are frequently torn up, and gouged out to permit installation of storm sewer interceptors with no provisions for repairing the damage or maintaining stability.

Contractors and builders have not been required to provide erosion control measures in the performance of their work. As a result, relatively small areas of land under construction are causing massive erosion problems affecting the entire area.

Urbanized areas create erosion hazards.

RIVERBANKS

The first white settlers in this country cleared the bottom land along rivers. With no trees to offer resistance, rivers and streams began to erode their banks and to meander with a freedom never known before. When the waters overflowed onto the flood plains, the freshly plowed fields were easy marks for floodwater erosion.

Storm sewer placed with no regard for erosion.

V. WHAT CAN WE DO?

Control Measures and Community Planning

Any disturbance of ground cover and soil will give opportunity for erosion. Vegetation of any kind should be left until just before construction begins, and only the minimum area required for operations should be disturbed at one time. Bare spots need to be covered as soon as possible.

When extended periods of exposure are unavoidable, temporary cover should be provided. Annual grasses, small grains, or sod make a quick cover. Mulch, burlap, and plastic also protect the soil.

Contour diversions can be used to intercept runoff and channel it to waterways that lead it by means of meanders or drop structures to safe outlets.

Some erosion is inevitable during periods of active disturbance. Dams or basins can prevent sediment damage.

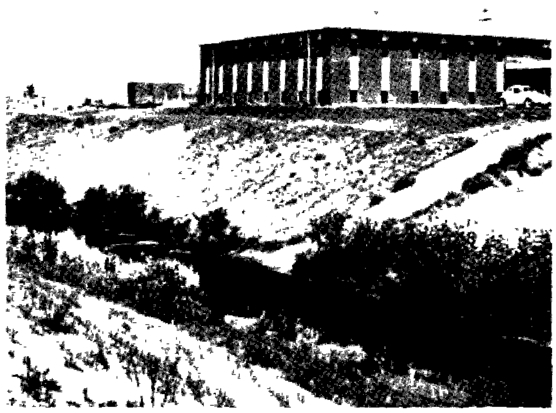
Communities—towns, townships, cities, and counties—can help prevent erosion and sediment damage by planning the development of their land and water resources and making their plans binding through zoning regulations. Already many communities require that builders and planners adhere to specific regulations in clearing an area for building. Some require that urban planning be based on a scientific soil survey.

Community land use plans need to suggest how private and public improvements and land uses can be carried out in the best interests of all the people.

Raw streambanks can be managed by sloping and shaping, establishing vegetation, or the use of rock or other stablizing materials. Flood plains subject to scouring by floodwater can be protected by grass or other means.

Erosion can be stopped by dams or drop structures. Such structures usually require action by a group of landowners. Downstream interests, dependent on sediment-free water, may assist with these structures as may the State and Federal governments.

Contour farming, as compared to straight-row farming, sharply reduces soil loss. Terracing does also. Experiments have shown that terracing cropland will reduce soil loss as much as 85 percent as compared to straight-row farming. These concepts can also be used in community layout and development. Technical assistance is available from the Soil Conservation Service through locally organized soil and water conservation districts.



Controlling run-off in urbanizing area—seeding, sodding,ditching—paved flume

Farming the conservation way—terracing, strip crops, contour cultivation.

Controlling Other Sediment Sources

Many highway departments and railroads are finding it pays to plan road cuts and fills so that erosion will be minimal and, further, to protect them with grass, vines, or shrubs.

Wind erosion can be controlled by such farming methods as stubble mulching, improved cropping systems, wind stripcropping, and shelterbelts. Severe "blow" areas may need to be planted by trees or dune grasses.

VI. BASIC PRINCIPLES

The sediment control program for the urbanizing area will involve the following basic principles:

A. Sediment Control in the urbanizing area should become a stated policy of the county government and all concerned public agencies operating in or having jurisdiction in the county. All departments and divisions should cooperate in implementing the program.

B. Sediment control provisions should be incorporated in the planning stage for most effective application in the construction stage of development.

C Competent technical personnel, workable procedures and regulations, and enforcement are essential for successful sediment control.

D. Practical combinations of the following technical principles will provide effective sediment control when skillfully planned and applied:

1. The smallest practical area of land should be exposed at any one time during development.
2. When land is exposed during development, the exposure should be kept to the shortest practical period of time.
3. Temporary vegetation and/or mulching should be used to protect critical areas exposed during development
4. Sediment basins (debris basins, desilting basins, or silt traps) should be installed and maintained to remove sediment from run-off waters from land undergoing development.
5. Provisions should be made to effectively accommodate the increased run-off caused by changed soil and surface conditions during and after development.
6. The permanent final vegetation and structures should be installed as soon as practical in the development.
7. The development plan should be fitted to the topography and soils so as to create the least erosion potential.
8 Wherever feasible, natural vegetation should be retained and protected.

E. A public information and education program on sediment control is necessary to obtain public and industry support.

F Research, evaluation studies, and observations should be conducted to provide needed information for improvement of the program.

VII. EROSION AND SEDIMENT CONTROL MEASURES

Rainfall and run-off travelling over inadequately protected land causes erosion The amount of damage depends on three variables 1) the quantity and velocity of run-off 2) the nature of soil and 3) the slope of the ground.

The illustration below shows how these variables affect erosion under a wide range of differing conditions.

The example shows that the same amount of run-off will erode a rather flat slope on barren soil, but will cause no damage on a much steeper slope providing the ground is covered with grass.

Let us consider how we may control each one of these three variables; run-off quantity, character of ground, slope of ground.

1. Controlling Quantity of Run-Off

In any given drainage area, while we have no control of the total rainfall discharged upon that ground, we can, indeed, control its distribution and disposal. In so doing we can protect the most vulnerable areas from damage. Following are some of the techniques which have proven to be effective:

a) *Diversions* - Diversions are intercepting ditches and berms or ridges placed laterally along the contour on sloping ground to divert water before scouring can occur. Their spacing depends upon slope, soil, and run-off. The water is collected and conveyed laterally at slow velocity and discharged into a protected area or outlet channel.

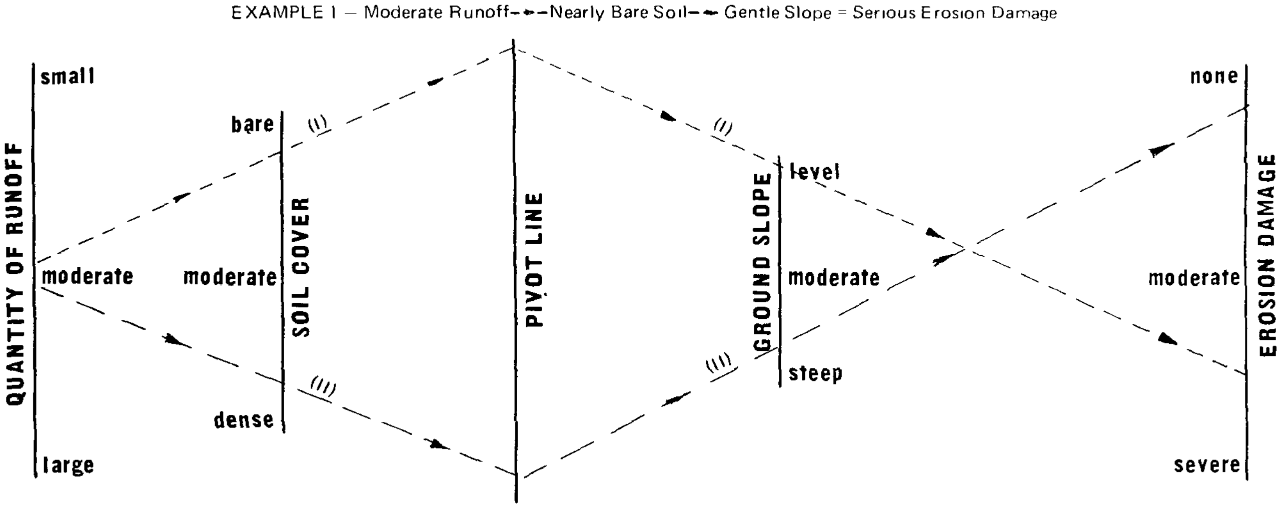
THIS?

Wheat field erosion on long slope

OR THIS?

Successful farming on long moderate slope

EXAMPLE I – Moderate Runoff→Nearly Bare Soil→ Gentle Slope = Serious Erosion Damage



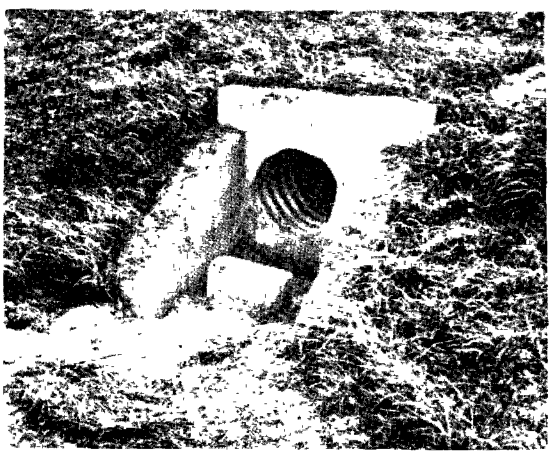
EXAMPLE II – Moderate Runoff→Dense Soil Cover→Moderate Ground Slope = Very Slight Erosion Damage

b) *Bench Terraces* - Bench terraces are relatively flat areas constructed on sloping land to planned dimensions and grades. These areas are applied along the contour with the length and width controlled by the natural terrain and the required erosion limitations.

Contour benches may be installed across the slope and designed for widths which will permit construction of a row or tier of housing units on flat areas which generally follow natural contours. Diversions may be used to transport water to a designed outlet.

Diversion under construction

c) *Outlet Channels* - This measure consists of the construction of designed channels for the disposal of storm run-off from diversions, bench terraces and other structures. The design is based on the run-off from predicted storms and includes the vegetative or structural measures required to protect the channel from erosion.



Channel outlet protected by vegetation and control structure.

THIS?

Farmland at 2% gradient is subject to erosion.

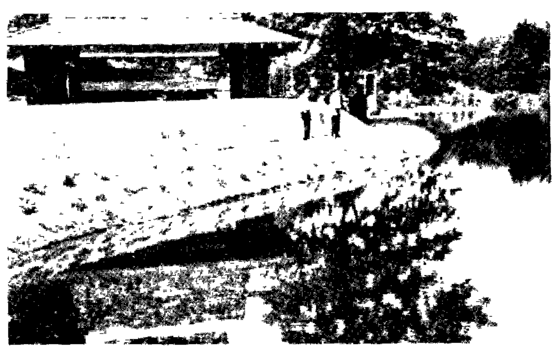
OR THIS?

But not with contour farming

THIS?

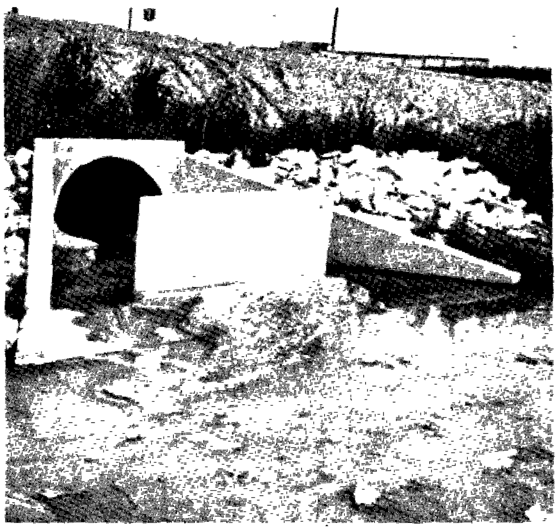
Unregulated, unprotected water channel

OR THIS?



Controlled protected channel.

d) *Waterway Stablization Structures*
Erosion control methods include structural devices to dissipate the energy of flowing water by holding the waterway slopes and velocities within non-scouring limits. Drop structures, concrete or other lining could be utilized in an open waterway.

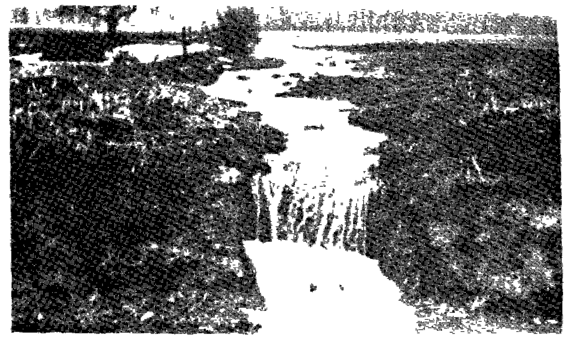


Structural devices dissipate the energy of flowing water.

e) *Bank Erosion Structures* - The control of bank erosion in main stream channels can be accomplished by riprap, rock cribs, groins, jetties, fencing, piling, etc. The purpose of bank control measures is to install a barrier that will withstand the erosive forces exerted by flowing water or create a bank roughness that will reduce the erosive power by dissipating energy of the water as it moves along the bank line.

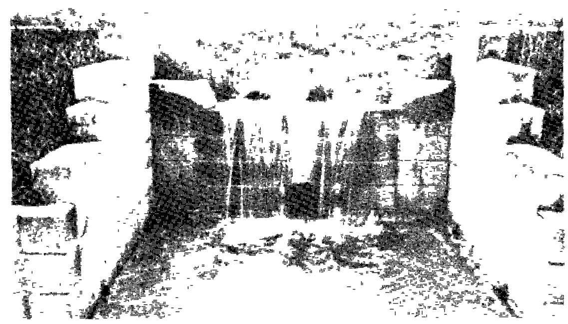
Steel jacks used to prevent further bank erosion

THIS?



Uncontrolled run-off.

OR THIS?

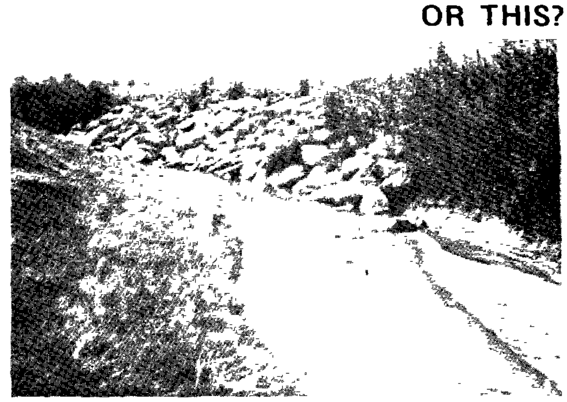


Device for controlling run-off.

THIS?

Showing bank erosion uncontrolled.

OR THIS?



Sodding and rip-rap prevent erosion

River bank erosion control.

Cribbing, planting make steep slopes erosion free

f) *Sediment Basins* - The sediment basin may be considered as a safety valve. It is an admission that the mechanics and scheduling of new construction cannot possibly eliminate a certain amount of erosion during the period of construction. Strategically placed, a temporary earth fill type dam downstream from a development area serves to regulate run-off and trap sediment. The sediment can be removed mechanically as the storage space behind the dam becomes filled. The whole structure can be removed after stability is reached in the development area or it can be retained and maintained to enhance the area.

Sodding, seeding, mulching, blends with natural vegetation.

g) *Stream Channel Construction* - To relieve flooding or poor drainage conditions, it may be necessary to enlarge, deepen or reconstruct existing channels to designed cross section and grades. In doing this, however, the danger exists of creating a new erosion cycle. The design must include considerations regarding the stability of the bed and banks of the proposed channel under the predicted run-off conditions.

Portion of sediment control basin.

2. Controlling Ground Area Subject to Erosion

As seen on the diagram, the nature of the soil cover is tremendously important in controlling erosion. Overland flow is most destructive on barren soils, less destructive on soils covered with vegetation. In most cases vegetation can be established quickly and inexpensively. Nowhere does the erosion control dollar go further than with the prompt and careful covering of open soil with natural vegetation.

Following are some of the methods recommended to control ground areas subject to erosion:

a) *Limit Extent and Duration of Exposure* - Where new construction occurs, every attempt should be made to reduce the size of the area and the duration of exposure.

Asphalt-Straw Mulching Provides Temporary Protection.

b) *Protecting Soils with Vegetative Cover* - In areas of good soils on moderate slopes, the establishment and maintenance of good vegetative cover are relatively simple as compared to "critical areas." The non-critical areas can usually be stablized by utilizing standard plants and seed mixtures recommended by local agencies or landscaping services. Soil tests should be made as a basis for adding the plant food necessary for plant establishment and maintenance.

Critical Area Stablization - In addition to the disruption due to heavy equipment on construction sites, there are other conditions which may be equally as "Critical." Acidity, low fertility, compactness, dryness or wetness often prevail and are unfavorable to plant growth. Excessively long slopes and steep grades may be encountered or created. Water disposal structures are normally subjected to hydraulic forces requiring special techniques and grasses resistant to scouring. Information to handle these difficult sites is readily available.

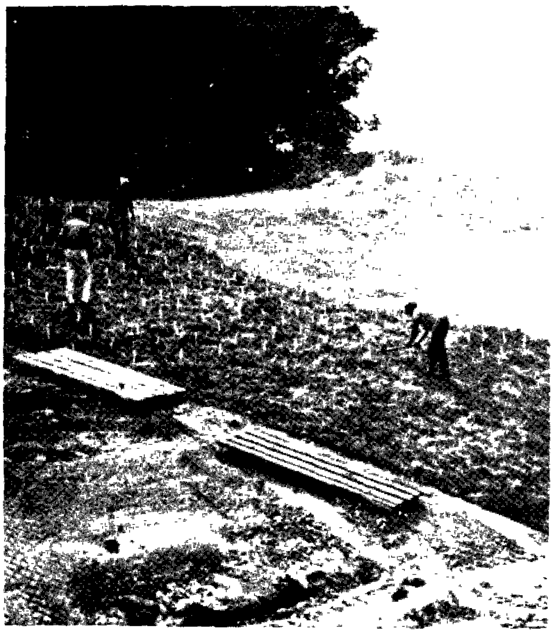
Steep critical slopes at bridges require special attention.

Temporary Measures - Where the life of a construction contract extends over a considerable period of time, it is highly desirable to establish a temporary cover with annual rye or sudan grass. This technique can also be used where jobs are completed at a season not favorable for permanent vegetation. The temporary grass is later worked into the soil when it is prepared for permanent seeding.

An alternative method is the application of mulch for immediate protection. Areas brought to final grade whatever the season should be mulched and then overseeded at the proper season with permanent grass and legume species.

Mechanical Method of Applying Mulch.

Permanent Vegetation - For both sodding and seeding, there is a fairly wide choice of grasses, legumes, and other plants for use on critical areas. The final choice of species should be determined by weighing such factors as adaptability, use, aesthetic requirements, degree of maintenance that can be expected and other special considerations.



Slope protected by sodding

Plants should be selected that will provide long-lived stabilization with little subsequent management where a "manicured" look is not required. Some species provide excellent protection against scour in waterways and outlets, but most require periodic mowing and fertilization. Where a reasonably high level of management can be expected, the choice of plants is broader. Often, techniques of seedbed preparation and establishment are as important as the selection of the species.

Seeded Banks Protect This Channel.

3. Controlling Slope of Ground.

Areas which are excessively steep, where the topography is rugged or where unusual conditions suggest that the land is "unbuildable," should not be intensively developed. The land use master plan should specify proper restrictions, and no ambitious entrepreneur should be encouraged to develop a site where erosion is sure to be a problem.

Some land should be classified as "unbuildable."

This is not to suggest that critical areas are to be avoided. Huge areas cannot be, and should not be leveled. Steep slopes in localized areas may be reduced by retaining walls, terracing and channeling as previously described, but such development should be carried out with adequate planning and careful supervision.

Steep slopes localized and well handled on residential lot.

Technical references and sources for assistance in planning for erosion control are listed on page 16 of this bulletin.

VIII. MODEL SOIL EROSION AND SEDIMENT CONTROL RESOLUTION

The following model resolution, when adopted by all authorized planning bodies within the Grand River Basin, can lay the ground work for easier control on a regional basis. Precise working may be altered to meet local conditions.

WHEREAS, the Grand River Watershed Council has been authorized by act of the Michigan State Legislature to conduct water resource studies in the Grand River Watershed, and to advise local governments of the Council's view of the problems, and

WHEREAS, the shifting of land use in the watershed basin from agriculture to urban and suburban developments has substantially increased silt and sediment problems on the lands and in the streams and lakes in the region, and

WHEREAS, the people of the State of Michigan have indicated by popular vote their approval of the Clean Water Bond Issue proposal in 1968, and

WHEREAS, sediment from developments has been declared a pollutant by the Water Resources Commission of the Michigan Department of Natural Resources, and is recognized under the adopted Water Quality Standards for Michigan Waters, and

WHEREAS, soil erosion and sedimentation cause unreasonable damage to private and public property and diminish the public use and enjoyment of our streams and lakes,

NOW THEREFORE BE IT RESOLVED:

1. The Legislative body of (township, city, county) endorses and supports the Grand River Watershed Council Soil Erosion and Sediment Control Program,
2. That it is a policy of the (township, city, county) to provide control of soil erosion and resulting transported sedimentation, through its exercise of the review and approval authority for subdivision and commercial developments or any development where such control is considered proper and relevant,
3. That the same policy shall be implemented through the Public Works Departments (township, city, county) in development and maintenance of park lands, recreation sites, streets, and other Public owned properties,
4. That it shall be the policy of the authorized planning body of the (township, city, county) to seek comments and/or recommendations from the Grand River Watershed Council, the Michigan Water Resources Commission, the U.S.D.A. Soil Conservation Service, the Soil Conservation District, or other agencies recommended by the Council with respect to processing of any preliminary developmental plans as in the judgement of the authorized planning body of the (township, city, county) that will require soil erosion measures to be carried out by public and private interests during the construction of such developments.

IX. INFORMATIONAL AND EDUCATIONAL PROGRAM

To enlist public awareness and support, an informational program will be conducted by the Grand River Watershed Council, Soil Conservation Districts, Soil Conservation Service and the Cooperative Extension Service.

Included in the program will be:

1. Publications - such as an illustrated issuance of this Soil Erosion Control Booklet, copies of standards and specifications for urban and rural soil erosion control practices, suggested ordinance for municipal adoption, etc.
2. Publicity about the program.
3. Informational program for developers and engineers.
4. Recognition of outstanding soil erosion control work by individual developers and engineers.
5. Preparation and distribution of study reports.
6. Assistance to local communities in the implementation and management of a soil erosion program.

X. TECHNICAL REFERENCES AND SOURCES

Technical Guide (Standards and Specifications)—U.S.D.A. Soil Conservation Service

Standard Specifications For Road and Bridge Construction—Michigan Department of State Highways

Community Action Program For Sediment Control—National Association of Counties

Sediment Is Your Problem—U.S.D.A. Soil Conservation Service Bulletin A1B 174

Additional technical data as well as complete information for specific problems are available from the U.S.D.A. Soil Conservation Service through the Soil Conservation District. Other sources of information are available from:

Bureau of Water Management,
Department of Natural Resources
Cooperative Extension Service
Grand River Watershed Council
Michigan Department of State Highways

OTHER WATER MANAGEMENT PROGRAMS BY THE MICHIGAN GRAND RIVER WATERSHED COUNCIL

Stream Monitoring Program
Stream Appreciation Month
Water Supply Study
Implementation of Flood Plains Study
Preservation and Utilization of Flood Plain Areas
Grand River Basin Federal Comprehensive Water Resources Planning Study

The Watershed Council provided one of the two participants to review the "Community Action Guidebook for Soil Erosion and Sediment Control" developed by the National Association of Counties Research Foundation.

Neither of these booklets will have any value unless the recommendations are implemented. The best way to assure their use is to conduct seminars, conferences or other types of informational meetings to identify the problems, present the tools for solutions, and assist the local governmental units in the implementation of proper guidelines and control measures. To accomplish this end, the Watershed Council is again accepting the leadership role by coordinating the interests and concerns of the local Soil Conservation Districts and the Michigan Association of Counties to co-sponsor with the Michigan Grand River Watershed Council a series of conferences for public officials. Through these efforts we expect to reduce one of our most critical pollution problems in the basin.

Flood Plain Control Regulations

Development of flood plain areas is another pollution factor that can be controlled through local police powers. Installation of septic tanks and drain fields, open storage of solid wastes, and the open storage of usable materials in the flood plain can all have a deleterious effect on the stream during flooding periods.

Zoning laws, health codes, building codes and subdivision control regulations are all tools that can be used to protect the flood plain. Adoption and effective enforcement of these regulations will require technical studies to accurately identify the flood plain.

Flood Plain Information Studies conducted by the Corps of Engineers, and Flood Plain Hazard Studies conducted by the Soil Conservation Service are designed to provide the technical data for ordinance enforcement. Unfortunately, these programs are inadequately funded to conduct the necessary studies in the rapidly urbanizing areas.

The Watershed Council has initiated action for studies along fourteen stream stretches in the basin. Two of these streams are scheduled for completion this winter. The need for these studies in our basin only partially represent the need for studies across the state. When a stream study has been completed, the Watershed Council presents its publication, "Preservation and Utilization of Plain Areas" to each governmental unit to encourage adoption of local regulatory measures.

W. L. Ettesvold

Local Water Quality Control Regulations

The State has the responsibility of water quality enforcement. However, funding of the enforcement agencies is not adequate for the State to enforce the comprehensive programs needed. Cities and counties need to become more actively involved to supplement the State's efforts and to retain the home rule philosophy. An example of local enforcement is an ordinance adopted by the city of Grand Rapids. Through this ordinance regulatory limits have been placed on industrial waste discharges to protect the stream quality. These limits are being enforced by the city to protect their wastewater treatment plant and to reduce pollution of the Grand River.

The Michigan Grand River Watershed Council is serving the regional interests of the governmental units in the Grand River Basin. Several programs have been initiated that will benefit, not only the local unit and the State, but will also result in a national benefit.

The following suggestions are offered for your attention, your consideration and hopefully, your endorsement:

1) Greater assistance to local communities

W. L. Ettesvold

for developing adequate stream monitoring programs.

2) Funding to regional governmental entities for conducting information and educational programs on needed water and soil management programs.

3) Additional funding for hydrological studies to assist local communities in developing proper land use for protection of flood plain areas.

4) Provide funding to local communities to enable them to determine the method and cost for removing stream-laden sediment to renew the streams for more effective use.

The Watershed Council is organized to serve its constituent governmental units. We also stand ready to serve our State and the Federal Government in whatever way we can. We realize our problems are not unique to our area. We believe if we can solve our problems we will be helping other governmental units by establishing guidelines which they may follow to achieve success.

P. F. Gustafson

Thank you, Mr. Chairman.

MR. STEIN: Thank you. Are there any questions or comments? If not, thank you very much.

Philip F. Gustafson.

May I suggest that those making statements, that we are largely interested in the thermal problem. We would appreciate any other aspects of pollution either submit a statement for the record or summarize it, if possible.

STATEMENT OF PHILIP F. GUSTAFSON,
COORDINATOR ARGONNE GREAT LAKES
RESEARCH PROGRAM, ARGONNE NATIONAL
LABORATORY, ARGONNE, ILLINOIS

MR. GUSTAFSON: Mr. Stein, conferees, ladies and gentlemen, I am Philip F. Gustafson, Coordinator of the Argonne Great Lakes Research Program, Argonne National Laboratory here in Argonne, Illinois, just outside of Chicago.

I might just make a couple of statements as to what Argonne is and why we are interested and concerned with Lake Michigan problems. Argonne, as many of you may know, is subcontracted with the Atomic Energy Commission by the University of Chicago and some 31 other universities in the midwest area, and has been the center of research and development over the years and has also been a center for the study of radiation problems. Since reactors emit also thermal discharges as well as radioactive ones, it is not totally unreasonable that the laboratory was requested by the Atomic Energy Commission to look at the influence of thermal discharges.

I do have a statement which I have handed to the workshop, and I would like to read just a few portions of it and make a few comments, if I may, at the end.

MR. STEIN: Mr. Gustafson.

MR. GUSTAFSON: Yes.

MR. STEIN: If you wish, we will put the entire statement in the record as if read, even though you summarize it.

MR. GUSTAFSON: I would appreciate that very much.

MR. STEIN: Without objection, that will be done.

(Whereupon, the paper above referred to follows in its entirety.)

P. F. Gustafson

MR. GUSTAFSON: At the present time the States bordering upon Lake Michigan and the Federal Government are wrestling with the questions raised by discharging waste heat into the lake. The deliberate release of wastewaters at temperatures above that of the lake at the point of input is not a new practice; it has been part and parcel of human occupation of the land along the lake and has increased at a rate commensurate to or exceeding that of population growth. What is new, however, is the fact that the wisdom of this practice is now being questioned, and indeed being subject to regulation by the appropriate agencies. This questioning and probing is a healthy sign, a further indication of the awareness on the part of a growing number of citizens that our resources are not endless; that the natural environment, be it air, land, or water, does not have a limitless capacity to absorb wastes and other forms of insult and assault.

The matter of thermal discharges into Lake Michigan has been brought to the fore by the construction of six large nuclear powerplants (a total of ten individual reactors to be in operation by 1978) which intend to use Lake Michigan water for condenser cooling, and discharging this water directly back into the lake.

P. F. Gustafson

The sheer magnitude (volume) of water involved, coupled with the rise in temperature over the condenser, tends to stagger the imagination and perhaps to blur reason.

About 4,600,000 gallons per minute or 10,000 cubic feet per second will be required for cooling purposes by the nuclear plants now under construction. This figure does not include the Bailly nuclear units now being considered. The cooling water will gain an average of 20.5 degrees F. across the condenser. Cooling water for the nuclear plants will be taken from some distance offshore, and in most cases from near the lake bottom. Hence, the cooling water will usually be below the ambient temperature of the surface waters when it enters the plant, and as a result the temperature difference between discharge water and lake surface temperature will be significantly less than the Delta T across the condenser. The objective of this statement is to attempt to place the cooling water discharged from nuclear powerplants in a reasonable perspective, to discuss what is known and what is unknown concerning thermal parameters in Lake Michigan, to explore the alternatives to direct lake discharge, and finally, to suggest a course of action to answer pertinent scientific questions, to alleviate economic and operational stress, and to provide adequate electric power to residents of the Lake Michigan region.

Perspective

Lake Michigan is the fifth largest body of freshwater in the world. It is of sufficient depth that it is thermally stratified during the summer (roughly May to November), and is thermally mixed from top to bottom each spring and fall. The primary source of heating of the lake is direct solar and atmospheric radiation, with river and surface water runoff providing a relatively minor additional natural heat input to the lake proper. Major manmade sources of warm water discharges include industrial discharges, municipal sewage treatment plant effluent, and cooling water from steam generating facilities.

The waste heat from this latter category is most readily documented because of the rather direct relationship between electrical output and heat loss across the condenser. In addition, detailed records of power generation make it possible to determine not only annual heat discharge but to break it down into daily or even hourly segments. The present electrical generating capacity situated on Lake Michigan, and using lake water for cooling is about 8,000 MWe* Except

* 8,000 megawatts electrical, term describing generating capacity.

for 75 MWe which comes from the Big Rock nuclear plant at Charlevoix, Michigan, all this power comes from coal- or oil-burning plants. Older fossil fuel plants such as these have an efficiency of about 30 to 35 percent (although fossil fuel plants built recently achieve about 40 percent efficiency) for converting heat into electrical energy. Of the 65 to 70 percent waste energy, as it were, about 15 percent is lost up the stack. Thus, from the 8,000 MWe from fossil fueled power generation, there is between 17,000 and 19,000 MW of waste heat produced, of which 13,000 to 15,000 MW is released to the condenser cooling water.

The present type of nuclear power reactors have a conversion efficiency of about 33 percent (heat to electrical energy), and effectively (a few percent may be lost directly to the atmosphere in the plant) all of the waste heat (67 percent) is released to water across the condenser system. Therefore, we see that for each unit of electricity actually generated (per kilowatt, for example), 20 to 35 percent more heat (50 percent more when compared to the most modern fossil plants) is discharged to cooling water from a nuclear plant than from a conventional fossil fuel installation.

It is also true that the present trend in powerplant construction is in terms of blocks of 500 to 1,000 MWe per generating unit. This means that the heat released is concentrated in a localized area and is somewhat more aggravated in the case of nuclear plants because of the greater aqueous heat loss per unit of power produced as discussed above.

In terms of heating of the entire lake, the discharge from generating plants makes an insignificant input. Calculations show that if none of the heat from present powerplants and those proposed through 1978 were to leave the lake over an annual cycle, the temperature increase would be a few hundredths of a degree centigrade throughout the entire lake. Of course, such a situation does not exist in nature, as there is continual heat loss to the atmosphere by evaporation and nonevaporative processes. It is also true that the discrete thermal discharges from powerplants do not mix throughout the entire lake, but are essentially localized entities of warm water. It is because of this phenomenon of relatively restricted volumes of warm water, present in one general location near shore, that raises questions about biological effects and other aspects relating to water quality.

Except at times during fall and spring when the lake is thermally mixed, the temperature is not uniform throughout the lake. In summer, the mixed surface layer (which may extend down to depths of 60 to 70 feet) is appreciably warmer (10 to 25 degrees F.) than the underlying waters. Conversely, in the winter, surface waters may actually be colder than those at greater depths. Furthermore, there are variations in surface water temperatures over fairly short distances (less than a mile) and/or short time intervals (less than an hour.) These variations are particularly evident near the shore, and are due to the upwelling of cooler water, warm surface water being blown onto the shore, and other wind and current phenomena. These variations make the term ambient temperature somewhat ambiguous other than in a general or average sense.

As mentioned earlier, there are already a number of generating plants situated on Lake Michigan which draw cooling water from the lake and return the heated effluent to the lake. Three of these begin to approximate the generating capacity and thermal discharge of the nuclear stations now under construction. These larger plants now in operation are Waukegan (1108 MWe), Oak Creek (1670 MWe), and State Line (964 MWe). A feeling for the magnitude and the environmental effects of thermal discharges may be obtained by looking at and around these plants which have been in operation for a number of years. The initial impression is that these plants have not had a very profound or obvious effect on the lake, certainly not an adverse effect as appears to have been the case with some other discharges such as sewage and chemical discharges.

Determinations of the lateral extent and the depth of the warm water discharges (called thermal plumes in analogy to smoke plumes) have been made by infrared over-flight techniques and by making direct temperature measurements in the water. A thermal discharge is warmer than ambient lake water and tends to float because it is less dense, spreading out as it floats in a manner dictated by wind, current, and the velocity of the discharge itself.

The lake thermal plumes studies are a few feet (6 to 8 maximum) thick and have temperatures which are measurable above ambient (about 1 degree centigrade) out to a mile or so from the discharge point. The initial decrease in water temperature from the outfall to the measurable edge of the plume occurs primarily through mixing with the cooler water surrounding the plume, with some loss directly to the atmosphere as well. Over a matter of a day or so the bulk of the heat is lost to the atmosphere. Other than providing a warmer region for swimming, and a more ice-free region of limited extent during the winter, and occasional periods of local fog, there are no obvious physical effects from the thermal discharge.

Biological effects are equally hard to discern. Fish are noted to congregate near the outfall, particularly in wintertime, but increased algal blooms, differences (or lack of) in bottom organisms and other indications of biological change have not been documented. Bottom organisms probably are not truly good indicators of the thermal situation because of the surface-floating character of the warm water. The fact that changes have not been documented in part implies they are difficult to see, or are slight if not nonexistent. On the other hand, it must be said that not a great deal of research has been devoted to looking for thermally-induced changes. So we are faced with a situation in which obvious changes have not been observed, but secondary, more subtle, effects at some distance from the point of input may take place.

Additional information as to possible thermal effects can be obtained from examining stream and river plumes in the lake. The prime example as far as Lake Michigan is concerned is the Grand River which has an average flow of between 1,500 and 7,700 c.f.s. depending upon the time of year. This compares with the flow rates of 3,260 and 3,500 c.f.s. specified for the Zion and Donald C. Cook plants, respectively. The Grand River is also warmer than the average surface temperature of the lake, varying from 5 degrees F. above lake surface temperature in March and September to as much as 19 degrees F. in July. During part of the year the actual heat carried into the lake by the Grand River in B.t.u./day, for example, closely approximates that which would be released from the largest nuclear plants now under construction on the lake. From March through July the Grand River dumps between 200 and 340 billion B.t.u./day into the lake, whereas if run at peak capacity for 24 hours a day the Donald C. Cook and Zion plants would discharge 390 and 340 billion B.t.u./day respectively. It is interesting to observe that the Grand River is not generally thought of as a source of thermal pollution.

Alternatives

On the basis that adverse effects may be taking place now from the presence of thermal inputs or the mode of introduction, or that such changes may occur if the inputs increase, one must consider other means of disposing of waste heat. This can be done in several ways; through increased volume of cooling water, diffuser systems which increase mixing, cooling ponds, cooling towers, or combinations of these. It is also apparent that in the main the summer months are the more critical time; hence the time when more elaborate cooling measures should be taken.

There is, of course, a further option open and that is not to site powerplants or other heat sources along the lake at all. This is a solution for future siting, but hardly helps in present circumstances. From a strict economic sense, direct cooling is least expensive in terms of initial investment and annual operating costs. It may, in fact, turn out in the end to be the most reasonable use of a natural resource, namely the Great Lakes.

Each of the various alternatives will be considered in terms of their advantages and disadvantages.

1) The condenser discharge could be mixed with additional water before entering the lake. This would serve to reduce the difference in temperature between the plant discharge and the lake itself; however, it would not reduce the total heat input to the lake. Such

a procedure involves the expenditure of energy in pumping, and the larger volume of relatively high velocity water might produce both physical and biological effects such as scouring of the lake bottom, or influencing fish movements. The advantage would be that modifications to present facilities could be done at or near the lake shore in most instances, and would not require the use of additional land.

2) Diffuser systems. Multiple nozzle or aspirator systems will allow rapid mixing with cooler surrounding water, and when spray devices are used, direct heat loss by evaporation is achieved. Such systems will represent some expense, and the durability and maintenance of such devices has not been field tested on a large scale. Where actual sprays are involved the water loss from the lake system will increase due to evaporation.

3) Cooling ponds. These would require considerable land adjacent to the plant to be used for this purpose, approximately 2 acres per MWe is a rough figure for cooling pond size. The loss of water from evaporation would be comparable to or somewhat greater than if the heat were put directly into the lake itself. Confined bodies of warm water such as this may become algal beds, and require attention to prevent their being

a source of odors. The quality of cooling pond water will decrease with time as solids left behind by evaporation accumulate.

4) Cooling towers. Wet or dry cooling towers for powerplants in the 500-1,000 MWe range represent a sizeable capital investment. The Davis-Besse Plant in Ohio is spending $9 million on cooling towers for a 872 MWe facility. They will also consume power in their operation, and require periodic maintenance.

Such towers are faily large in size, both height and base area. Wet towers will be more wasteful of water in that they depend heavily upon evaporation for heat removal. Solids left behind in evaporation must be removed, as must slime and algal growths, usually by back-flushing into the lake. Such a procedure will produce periodic inputs of concentrated chemicals into the lake. The evaporation may lead to fog and icing under appropriate meteorological conditions. Dry cooling towers do not waste water, but are limited in their cooling abilities by the ambient air temperature as cooling is done by exchange to the air passing over the cooling coils. Experience with dry towers is limited to fairly small (200-300 MWe) installations. In some locations, objections have been raised concerning the appearance of cooling towers and their effect on the landscape.

Combinations

A combination of methods might prove most acceptable in the long run. Direct discharge except in warm seasons, when cooling towers could be used, is one possibility. This would also avoid the fog and ice problem during the winter months. A cooling pond-direct discharge is also in this category.

It should be emphasized that from the standpoint of water conservation, direct discharge of heat in the lake is most conservative of this resource. As demands for lake water increase, the diversion of water for cooling towers and ponds may be regarded as an unacceptable use of water.

Field Program to Determine Best Options

Two things seem apparent:

1) That demonstrable physical and/or biological effects from present thermal discharges are hard to find on the Great Lakes or elsewhere.

2) There is a need for well-planned intensive and extensive field work to determine what effects, if any, do exist. It would also seem reasonable to not be overly restrictive on thermal discharges in light of present observations. In reality we will never know

what reasonable thermal standards are until adequate field work is done, and to do this it will be necessary to have thermal discharges to study. Otherwise an unwise alternate, the consequences of which are, in fact, less clearly understood, may be chosen. There are environmental costs to be borne in any event, and what must be done is to minimize these costs in conjunction with their socio-economic impact. This should be the prime objective of regulation.

There is a conservation principle involved here related to the conservation of energy principle. In fact, energy is the real culprit. Feasible methods of steam electrical generation are inherently limited to maximum efficiencies of the order of 40 to 50 percent. This means that half or more of the heat produced must be discarded, and the name of the game is to discard this heat in the manner least offensive to the environment or to use it beneficially in some manner. There is a feeling, based upon plenty of evidence to be sure, that whatever man does in terms of waste disposal is probably wrong. It is possible that in the case of heat, discharge to Lake Michigan is an appropriate, and acceptable use of a natural resource. It remains to be proven, however, and the natural capacity of the lake to receive and to eliminate heat must be determined.

The source of support to do the necessary research is always a problem. But consider the manner in which moneys are now being spent. For example, the Davis-Besse nuclear plant on Lake Erie is going to spend $9 million on cooling towers, plus operating and maintenance expenses annually. This exceeds the total amount spent annually on research in the Great Lakes which is at all relevant to the pollution question, and greatly exceeds the annual support of thermal research on the Great Lakes. The point is that more money could be reasonably spent to determine whether or not cooling towers are a) necessary and b) desirable, rather than going ahead and building them without further consideration. The money involved could go a long way toward answering some of the uncertainties, without irreversibly harming the lakes, and perhaps would even save expenditures in the long run.

Lake Michigan Plan

A suggested plan for determining thermal effects and thermal capacity is to allow present facilities and those under construction to operate, but to conduct sound scientific investigations of the environmental effects of such operation. At present, theory is inadequate to predict the consequences; only experiments will do. This does not mean a license to operate indefinitely in the face of evidence of deleterious effects. If such effects manifest themselves, corrective action must be taken. Such a procedure could be conducted under a Lake Michigan Environmental Agreement between the public (through their representatives) on the one hand and thermal dischargees on the other. The results of field investigations should be reviewed by a commission composed of Federal, State, and local representatives, industrial representatives, and members of the concerned public such as conservation groups, environmental committees and the like. If the findings indicate environmental change, the commission must make a judgment as to its seriousness and recommend that corrective action be taken promptly, and may even recommend what corrective action be taken. The details of this approach must, of course, be worked out. The main point is, however, that some reasonable course be followed which does not blindly trade one environmental situation for another which is even worse.

MR. STEIN: Thank you.

Are there any comments or questions?

Mr. Gustafson, thank you for your paper.

MR. GUSTAFSON: You are welcome.

MR. STEIN: You know, in a way, you are one firm -- I have a little principle here, the Stein Principle of Presentations of Papers. When on the second or third page we get into a discussion of all of the alternatives including dilution, I can predict that when we get to the conclusions we are going to come in with a recommendation for further study.

MR. GUSTAFSON: Well, I guess a research organization has to be that way.

MR. STEIN: By the way, this isn't a criticism. You know, in your field, you try to be objective about looking for things -- the indicators of what is going to happen in prediction.

MR. GUSTAFSON: Right.

MR. STEIN: And in this field, I think we have a few indicators.

MR. GUSTAFSON: Indicators, yes.

MR. STEIN: Mr. Mayo.

MR. MAYO: You have indicated that the Argonne National Laboratory has done some plume studies --

MR. GUSTAFSON: That is correct.

MR. MAYO: -- on Lake Michigan.

MR. GUSTAFSON: On Lake Michigan.

MR. MAYO: Which plumes specifically have you worked with?

MR. GUSTAFSON: The Waukegan plume and the plume at Big Rock.

MR. MAYO: Is this part of a current cooperative study effort at Waukegan?

MR. GUSTAFSON: Well, we are indeed a part of the group consisting of EPRO from DePaul, the Bio-Test Laboratory of Commonwealth Edison, the Metropolitan Sanitary District and ourselves. But this was really instigated quite independently of these people. It happens that we are all working with the same area so that we have been exchanging data, yes.

MR. MAYO: In connection with the studies that you have conducted so far, do you have any feel for the conclusions that were expressed yesterday, I believe, by Dr. Pritchard? Were you here at the time?

MR. GUSTAFSON: No, unfortunately I was at the laboratory yesterday.

MR. MAYO: Perhaps much of the gist of Dr. Pritchard's statement was that if properly defined in terms of an outlet facility, both in terms of placement, configuration, and I think also the velocity, that the heated water would essentially remain at the surface.

MR. GUSTAFSON: Yes.

MR. MAYO: And if the depth was in excess of 10 or 15 feet, that little or no heat would be available to impact the lake bottom.

MR. GUSTAFSON: Yes.

MR. MAYO: How does this square with the findings that you folks have so far?

MR. GUSTAFSON: This certainly is the sort of thing that we have observed, Mr. Mayo. We have made some 15 or 16 surveys at the Waukegan plant under various circumstances, and I believe that the discharge canal depth is something on the order of 8 to 10 feet at the mouth and we have not seen demonstrably warm water below a 9-foot depth. But this I worry about, and really the purpose of our field measurements is so that we may plug them into models which now exist and which the laboratory is working on, including those of Pritchard and some of the people who have been in this for a long time. We are trying to get field data to verify these models.

But one problem which bothers us is that you have a natural bias in the days when you do get data because you don't go out when the lake is too rough because it is hazardous to the people involved, and what really happens when there is a lot of turbulence and upwelling and down-welling, we don't know ourselves, and I have a hunch that there aren't many people who go out in that kind of weather either, so that unfortunately the field data suffer a bias in that sense.

MR. STEIN: Thank you.

Are there any further questions?

MR. CURRIE: Yes, Mr. Chairman, one.

MR. STEIN: Yes, Mr. Currie.

MR. CURRIE: Mr. Gustafson, there were predictions in Dr. Pritchard's paper regarding the residence time of any particular molecule or organism at elevated temperatures inside of a plume. I take it you haven't attempted to evaluate his particular calculations, but have you calculations of your own on the same subject?

MR. GUSTAFSON: We do have some calculations of, say, the time course of temperature in a body of water that has gone through the condenser and out into the plume, and what we are now doing is integrating the total temperature that this thing says, say, in degrees, ourselves and we really don't have this thing completed yet. But it certainly gets down to within a degree centigrade of ambient, within a matter of a few hours.

MR. CURRIE: Thank you.

MR. STEIN: Thank you.

Any other questions?

If not, thank you very much, Mr. Gustafson.

May we have Mr. Moerke of the city of Milwaukee?

STATEMENT OF EWALD L. MOERKE, Jr.,

ATTORNEY, MILWAUKEE, WISCONSIN

MR. MOERKE: Thank you, Mr. Chairman, and members of the Great Lakes Water Conference.

My name is Ewald L. Moerke, Jr., and I am associated with the law firm of Schroeder, Gedlen, Riester and Moerke with offices at 108 West Wells Street, Milwaukee, Wisconsin. I am here representing the Metropolitan Sewerage District of the County of Milwaukee and its two component agencies, the Sewerage Commission of the city of Milwaukee and the Metropolitan Sewerage Commission of the county of Milwaukee.

I appreciate the opportunity afforded me to present, on behalf of the district, the views of the Commissioners of the Metropolitan Sewerage District with respect to the application of the city of South Milwaukee for approval of plans for secondary treatment for their sewage treatment plant. My commissioners feel that this is a matter of great importance not only to the citizens living in the Greater Milwaukee area but to all persons who value the continued high purity of the waters of Lake Michigan and its tributary streams. We are very concerned

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about the continuation of a potable water supply for all users on Lake Michigan. We are afraid that events which have recently transpired may impair the quality of Lake Michigan water.

As many of you know, the city of South Milwaukee, a community of approximately 23,286 people located on the shores of Lake Michigan, has for many years operated a primary treatment plant for the citizens of that community. The city of South Milwaukee elected in 1960 not to come into the Metropolitan Sewerage District and now is the only community in the county of Milwaukee which is not a part of the district.

Here may I state the city of South Milwaukee is completely surrounded by property under district control.

Within the last few years, the city of South Milwaukee has seen fit to prepare plans for secondary treatment of their facilities and has forwarded such plans to the Department of Natural Resources of the State of Wisconsin, together with an application for Federal and State assistance. Such plans involved an expenditure based on 1968 figures of about $1.6 million. If Federal and State grants were approved to the fullest extent possible, the city of South Milwaukee would recover about

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$1.2 million. These plans were approved by the Department of Natural Resources of the State of Wisconsin early in 1970, but, as we understand it, the State grant under the ORAP 200 program of the State of Wisconsin has not, as yet, been approved. Recently, however, the FWQA did approve the granting of Federal funds for the project in South Milwaukee.

The city of South Milwaukee lies immediately north of and its boundaries adjoin the district property upon which the district's new South Shore Treatment Plant has been built and recently placed in operation. The city of South Milwaukee could be served by this plant with the construction of a sewer down South Fifth Avenue to the main interceptor leading to this plant. A stub has already been built into our main interceptor to provide for the South Milwaukee flow. It is estimated by our engineer that this main sewer would cost approximately $1.7 million and if the city of South Milwaukee would elect to be served by the district, the cost to South Milwaukee for their share of this main would be approximately $34,000.

This, however, does not tell the whole story. The Metropolitan Sewerage District, through its two component commissions, has the power to improve water-courses within the district. The commissions' attorneys

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have advised the commissions that there is no duty to improve any stream outside of the district.

There is a watercourse which originates in the cities of Milwaukee and Franklin known as Oak Creek which has been partially widened, deepened and enlarged in the city of Milwaukee to carry away storm drainage from that watershed. However, the outlet of Oak Creek into Lake Michigan is in the city of South Milwaukee.

It is estimated by the district engineers that it would cost $2.8 million to widen, deepen, and enlarge Oak Creek in the city of South Milwaukee so as to provide an adequate outlet for this watershed. Thus, any reckoning of total costs must involve the watercourse improvement cost for, if the city of South Milwaukee should come into the district, the district would absorb this charge as well as the charge for the main sewer. If the city of South Milwaukee stays out of the district and is permitted to build its own secondary treatment plant, then the taxpayers of the city of South Milwaukee will have to shoulder this cost alone. The two commissions have jointly adopted a resolution following their counsels' advice that they would not entertain a request from the city of South Milwaukee to improve Oak Creek in the city of South Milwaukee.

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The Metropolitan Sewerage District of the county of Milwaukee now serves the entire county of Milwaukee except the city of South Milwaukee, and by contract serves many adjacent municipalities within the same watershed. This includes the city of New Berlin, the village of Elm Grove, the city of Brookfield, the village of Menomonee Falls, the village of Butler, city of Muskego, and the city of Mequon. In addition, we are now engaged in discussions with a sanitary district in the county of Racine for the reception of their sewage into our system.

The district serves its customers through a system of main and intercepting sewers which, between the two commissions at the end of 1969, totaled 216.7 miles. The treatment of sewage is carried on at two plants: one located at Jones Island, which is the older plant; and the other one is located in the city of Oak Creek on Lake Michigan at the foot of East Puetz Road. The latter plant has just been recently completed and put into operation and is probably the most modern plant in operation to date in the United States if not in the world.

In our plants, the effluent is constantly monitored to determine the quality and effectiveness of our treatment plants and we believe that we have achieved operating results as good as any plant in existence. The Jones Island plant is a full treatment plant consisting of coarse screening, grit chambers, fine screening, aeration tanks, settling basins, and we are now planning and have under contract post chlorination of all effluent. The South Shore Treatment Plant, at the present time, is a primary treatment plant with chlorination, but we are planning and have under contract the installation of secondary treatment.

The laboratory facilities maintained by the district consist of a staff of approximately twenty people and all of the latest and most modern facilities are provided.

The dry weather flow through the Jones Island plant results in a purity of effluent of 96 percent to 98 percent (coliform removal). Chlorination should bring the quality even higher. We fully expect that our South Shore wastewater treatment plant, when secondary and full chlorination is applied, will achieve the same excellent results.

The Jones Island plant has in the past achieved spectacular results with regard to the removal of phosphates. As a matter of fact, the United States Government has given us a grant to study the removal of phosphates that we achieved and we have a second grant to assist in the process of running plant scale tests to see whether we cannot achieve even better results.

MR. MAYO: Excuse me. You make a comment that the South Milwaukee construction grant has been approved by FWQA. I think you are advised that it has not been approved.

MR. MOERKE: In a phone conversation I had with you, that is correct, Mr. Mayo, you so advised me. But I am informed that in a previous conversation we were told that it had been approved. Now, I stand corrected if I am wrong on that.

MR. MAYO: You are wrong.

MR. MOERKE: All right.

We submitted a report to this body on March 31, 1970, relating to the removal of phosphates and we have some additional data to submit with respect to this matter.

(The reports above referred to follow in their entirety.)

Proposed addition #1 to follow summary of the "Statement for March 31, 1970 Lake Michigan Conference"

(copy included)

Additional data collected since completion of the statement for the 3-31-70 Lake Michigan Conference indicates that the use of iron from waste pickle liquor continues to enhance phosphate removal without adversely affecting purification or plant equipment.

On July 30, 1970 Mr. R. D. Leary advised the F.W.Q.A. project officer that the Commission was therefore ready to proceed with iron addition to the 85 M.G.D. West Plant as soon as formal F.W.Q.A. approval was obtained in conformance with the original grant approval dated December 13, 1969. We understand that the project officer has recommended approval of the project extension and forwarded the material to the Washington Office of the F.W.Q.A.

Lawrence A. Ernest

Lawrence A. Ernest
Director of Laboratory

March 24, 1970

Statement for March 31, 1970

Lake Michigan Conference

The Sewerage Commission of the City of Milwaukee, the A. O. Smith Corporation and the F. W. P. C. A. have a joint demonstration project underway to demonstrate the removal of phosphorus from sewage utilizing the iron in waste pickle liquor from the sulfuric acid pickling of steel as the cation source. The project was proposed in late 1969 and placed on stream on January 5, 1970.

Waste pickle liquor is being added to the 115 mgd East plant while the 85 mgd West Plant receives the same screened sewage and acts as the control.

Two 30,000 gallon waste pickle storage tanks have been installed and the instrumentation required to automatically provide constant iron addition to the mixed liquor is being installed by the A. O. Smith Corporation. The automatic system will monitor mixed liquor flow and waste pickle liquor iron concentration and adjust the waste pickle liquor flow to maintain the desired rate of iron addition.

The major objective of the iron addition to the East Plant is to maintain an effluent total phosphorus concentration of 0.5 mg/liter (as P.) or less. Other objectives include:

A. A comparison of the efficiency of the two plants in removing BOD, COD, nitrogen and suspended solids.

B. Determination of optimum iron requirement to maximize phosphorus removal.

C. Determination of the effects of iron addition on the mixed liquor biota and its settling characteristics.

D. Observation of possible effect of iron addition on the plant physical facilities

E. Determine the effect of iron addition on waste sludge conditioning requirements.

At the present time the spent pickle liquor is being trucked from the A. O. Smith Corporation and added to the raw sewage at a rate that is manually varied asto iron concentration determined by specific gravity. The iron is added 24 hours a day and five days a week.

During the first week of the project (January 5th through January 12th) problems with waste pickle liquor handling were encountered due to cold weather and the subsequent crystallization of Ferrous Sulfate in trucks and feeding equipment.

The following total phosphorus data has been accumulated for the period from January 12, 1970 through February 28, 1970.

Total Phosphorus in mg/l-P

Screened Sewage	10.1
East Plant Effluent	0.77
West Plant Effluent	2.7
% Removal East Plant	92.4
% Removal West Plant	73.3

Iron Addition Data

Average lbs. iron/day	=	11,004
Average iron concentration in mixed liquor due to addition in mg/l	=	12.5

The range of total phosphorus concentration in the East Plant effluent was 0.35 to 1.9 mg/l-P with the high value occuring on a Sunday and Monday. (no iron was added on Saturdays and Sundays) Of the 48 days in the period, 15 days had East Plant total phosphorus residues of 0.50 mg/l-P or less.

In closing I would like to point out the substantial contributions of the A. O. Smith Corporation in both money and engineering expertise. The A. O. Smith Corporation has been responsible for the supply and addition of the waste pickle liquor and in spite of weather and equipment problems, they have met their difficult assignments. In addition to the day to day iron addition, they are proceeding to provide the storage and handling facilities needed to maintain and control continuous iron addition.

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In order to understand the cost to South Milwaukee to provide its own secondary treatment as opposed to coming into the district, it is necessary to understand the basic financing of the district. The district has two budgets: one is a capital budget, and the other is an operating budget. Let me first discuss the capital budget and how it operates.

The two commissions each year meet jointly and prepare a district budget for capital improvements. This budget is transmitted to the County Board of Milwaukee County and under the law, the county must approve such budget. The county, however, has the option to decide whether to provide the money by a general tax levy payable in the next year or whether they will bond for all or part of the cost. Generally speaking, the county outlay for district purposes averaged about $10 million per year since 1960, which includes financing of the current budget by bonds and cash and debt service and bond retirement from previous years' budgets. This, then, is distributed to the towns, cities and villages lying within the county, except for the city of South Milwaukee, on the basis of the equalized valuation of all assessable property within such town, city or village. Thus, for example, the taxpayers of the city of Milwaukee bear about 75 percent of the capital budget and the city of South Milwaukee, if they were in the district, would bear 1.9315 percent.

The second budget prepared is the operating budget. This budget is certified to the towns, cities, and villages directly by the district, based on the sewage contribution of each town, city, and village. If South Milwaukee came into the district, they would annually provide about 1.3 billion gallons of sewage out of a total estimated gallonage of 70 billion gallons put through our two treatment plants, or roughly 2 percent.

We would now like to give you our analysis of the relative costs between South Milwaukee coming into the district and South Milwaukee staying out of the district and providing its own secondary treatment. We have included the cost of watercourse improvement because we feel that this must enter into the total picture since it will be a cost which is either assumed by the district or assumed by South Milwaukee.

If South Milwaukee should come into the district and no Federal or State grants would be given, then the cost breakdown would be as follows:

Cost of sewer	$1.7 million
Watercourse improvement	$2.8 million

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Total costs of the sewer and watercourse improvements	$4.5 million
South Milwaukee's share of the sewer and watercourse improvement at 2 percent	$90,000
Operating costs annually	$100,000

However, the expense to South Milwaukee in the first year they would be in the district would be approximately $200,000 on the capital budget and $100,000 on the operating budget for a total of $300,000.

If South Milwaukee stays out of the district and receives maximum Federal and State grants, the cost breakdown would be as follows:

Cost of secondary treatment	$1.6 million
Recovery of State and Federal grants totaling 75 percent	$1.2 million
Net cost to South Milwaukee for secondary treatment	$400,000
Watercourse improvement	$2.8 million
Total cost to South Milwaukee for watercourse improvements and secondary treatment	$3.2 million
Operating costs	$100,000
Total costs to South Milwaukee	$3.3 million

These figures speak for themselves and it is obvious that the cost of providing treatment and improving Oak Creek in South Milwaukee could be better achieved if

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South Milwaukee came into the Metropolitan Sewerage District. We are here talking about taxpayers' dollars from whatever source and if South Milwaukee came into the district, the costs of providing service would be underwritten by the taxpayers of the district and no Federal or State grant money, which also comes from taxpayers, would be required. Let me add: If South Milwaukee should come into the district, there would be no back charge or entrance fee of any kind for South Milwaukee.

While we have not analyzed the plans of the city of South Milwaukee, because they have not been submitted to us, we seriously question the ability of the city to keep their operating costs under $100,000. They have estimated their operating costs at $94,000 in the application submitted. However, one process control engineer or chemist will cost between $12,000 and $15,000 a year and they will need at least five operators to operate this plant and supervise its operation. We estimate that for the five men this will cost at least $10,000 per man per year. Then there is the question of maintenance, repairs, and chemicals needed to keep this plant operating at top efficiency. Therefore, we question, without even examining the plans, the operating budget of $94,000 per year.

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Costs, however, are not the only criteria for judging the wisdom and feasibility of the plans of the city of South Milwaukee. We believe that good municipal waste control can only be acquired with large sewage treatment facilities and an adequate transmission system which serves all or a large portion of an entire watershed. This idea is not of our origination and we do not wish to take credit for it, for it has been made the policy of the Great Lakes Water Conference.

When you contrast what South Milwaukee proposes to do with the limited personnel available to them to that which is provided by the district, it is readily apparent that better service can be provided by a metropolitan district as opposed to a small plant which cannot economically afford the type of treatment facilities and laboratory control that we provide. We believe that the actions of the Department of Natural Resources of the State of Wisconsin and the proposed action, if I might say, of the Federal Water Quality Administration are contradictory to the policy of nonproliferation, which policy is for the purpose of improving and protecting the quality of the waters of Lake Michigan and its tributary areas and for the purpose of ensuring a potable water supply for all water users of the highest maximum quality possible.

You should also be made aware of the fact that the SEWRPC is studying and preparing a regional sanitary sewer plan for the seven southeastern counties of the State of Wisconsin. These counties are Walworth, Kenosha, Racine, Milwaukee, Waukesha, Ozaukee, and Washington. We expect that this study will be forthcoming in the near future and that it will lay the groundwork for many policy determinations by the Department of Natural Resources and the legislature of the State of Wisconsin in dealing with the ever-growing problem of the reduction of municipal waste and the preservation of our natural water resources. We envision this report to deal with the problem of sewage treatment on the basis of natural watershed boundaries rather than artificial political boundaries which bear no relationship to the direction in which waters flow.

This indepth study, which has not as yet been presented to the public, will undoubtedly precipitate new legislative considerations due to the fact that this study was not in existence at the time the city of South Milwaukee made its application. The SEWRPC had no power to interject itself into this controversy because their authority is based only on an interference with an adopted overall regional plan of which there was none at that time. We are sure, however, that if the plans of the city of South Milwaukee were presented to the SEWRPC after their intensive study becomes public, that that agency would disapprove of such plans.

Gentlemen, I know that this discussion has been long and in some cases very detailed. I have prepared my remarks and reproduced them so that you may have them and read them at your leisure. We would ask that you use your best efforts to reverse some of the decisions that have been referred to with respect to the city of South Milwaukee's plans for secondary treatment and we are sure that you will agree with us that those plans are not in the public interest. We are certain that there are better methods for handling the problems of the city of South Milwaukee with respect to sewage treatment. Again, I wish to state that I appreciate the time you have given me and the kind and courteous attention you have rendered to my discussion. If there are any questions I can answer, I will be happy to do so.

MR. STEIN: Thank you very much, Mr. Moerke.

I guess this shows that the problem which you have described, which we are finding all over the

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country -- and that is the determination of how the political subdivisions can best handle their wastes in either a coordinatored or separate effort -- is one that probably at least produces as much heat as the discharge from a powerplant.

Any comments or questions?

MR. MAYO: Mr. Moerke, I have just a couple of brief questions with regard to the South Milwaukee Sanitary District situation.

As I understand, at least the brief financial comparison that you made here, from the standpoint of cost to the Federal Government, whether it was in the form of a $1.5 million grant to South Milwaukee for a sewage treatment plant englargement, or whether it was a grant to the Milwaukee Sanitary District for roughly $1.5 million for an interceptor line, it would be essentially the same.

MR. MOERKE: I don't know what the Federal grant would be, or what a State grant would be for the sewer. I have been told that the chances of getting a Federal or a State grant would be good for that sewer.

MR. MAYO: Well, the percentage of Federal participation would be the same whether it was a treatment plant or whether it was an interceptor.

MR. MOERKE: I am not familiar with the details of that. You would be the judge of that, but I assume you are correct.

MR. MAYO: I think another couple of problems that we are obliged to address ourselves to -- perhaps we will have an opportunity to discuss these in more length this evening -- is the question of whether or not the South Milwaukee discharge, as it is contemplated in its current plans, will in fact meet water quality standards. And, as I understand the State position, at this time, the discharge would be expected to meet water quality standards, and whether or not the general impact upon the environment would be the same or essentially the same, whether the discharge goes through the Milwaukee Sanitary District facilities, or whether South Milwaukee went it alone. So these are fairly important considerations for us to keep in mind.

One of the hazards that we are faced with in the Federal Government review of these construction grant applications, when there is a controversy between a municipality and a district as to who should provide the service, is the degree to which we permit ourselves to become embroiled in the question of the appropriateness of the costs that a municipality chooses to assume for itself by following a preferred method of doing something, and whether we should or can really judge it is appropriate for a municipality to do under those circumstances, when, in fact, there is the element of self-determination.

So I would just offer those as some observations in connection with the problems we are faced with as we review construction grant applications when this kind of a controversy surfaces.

MR. STEIN: Any other questions?

MR. GROBSCHMIDT: I wonder if I could make --

MR. STEIN: I am sorry. You will have to come up to the microphone and identify yourself.

MR. GROBSCHMIDT: Mr. Chairman, members of the conference who are in attendance this afternoon and this morning. Thank you for the opportunity to be able to say a few words here.

My name is Chester Grobschmidt, and I presently serve as the Mayor of South Milwaukee. Now, I appreciate the remarks as stated by the attorney for the Metropolitan Sewerage System. We have not, at this particular time, a prepared statement to release to you, but I do have with me the technical and legal people of our community who are attending this conference here this morning and today for the purpose of wanting to be apprised of our commitment to quality.

The city of South Milwaukee's plant is not a small plant; it is not a proliferated plant. We advanced the detail plans for our plant from its infancy to every proper agency -- to the State and to the Federal water quality people. We had an opportunity to meet with the Washington officials to explain to them the plight that the city of South Milwaukee had been faced with.

What Mr. Moerke alludes to in his report contains several discrepancies, and I think the first and foremost which your group should take into consideration is that the $2.8 million costs which reflect channel improvement actually have nothing to do with the application as submitted by the city of South Milwaukee. These costs should not be part of any sewage treatment and commitment to quality that the city of South Milwaukee is expected to have.

The watercourse that Mr. Moerke alludes to happens to fall under the jurisdiction of the Milwaukee County Park Commission. We have, through the years, given up lands which were on our tax base. We have removed our utility, sewer, and water lines to allow for the eventual widening and deepening of that channel. We have no jurisdiction whatsoever of that channel course. This falls entirely within the responsibility of the Milwaukee County Parks Commission of which we share in a budget which is annually assessed to each municipality and Milwaukee County.

At this particular time, I would like to ask that your group give me an opportunity to formulate a rebuttal to the Metropolitan Sewerage Commission's remarks, sir.

MR. STEIN: Yes. Well, do you want to submit it for the record?

MR. GROBSCHMIDT: I do not have the remarks prepared. I do have a group with me -- the knowledgeable people.

MR. STEIN: When can it come in because -- you know, I am involved in innumerable controversies such as this, and you certainly will have this, and this forum is open, and I have one observation to make and I ask both groups to consider this.

I understand you are meeting with Mr. Mayo and the State officials this evening. You have this kind of judgment to make on this whether a resolution of this problem can best be served by utilizing a forum such as this, to put yourselves on record, or whether you want to sit down and try to negotiate this without the various parties concerned.

But certainly the record is open to do whatever you wish.

MR. GROBSCHMIDT: Sir, I would rather sit down and talk to responsible parties and resolve this as we have in the past.

MR. STEIN: Right. But if you want to put rebuttal in or any other statement, we will keep the record open for a week and you can put it in.

MR. GROBSCHMIDT: I made my initial remarks for the benefit of those of the audience who will not be able to be in attendance at that particular meeting, so I want to see that the people in the audience are not disillusioned as to the plant as it exists in the city of South Milwaukee and the inferences made.

I will accept your suggestion to reasonably iron this out at a meeting set forth by Mr. Mayo.

Thank you, sir.

MR. STEIN: Thank you very much.

Mr. H. W. Poston, Commissioner of the Department of Environmental Control, city of Chicago.

STATEMENT OF H. W. POSTON, COMMISSIONER,
DEPARTMENT OF ENVIRONMENTAL CONTROL,
CHICAGO, ILLINOIS

MR. POSTON: Mr. Stein and members -- conferees. I am very happy to appear before you today. I note that Perry Miller now has taken over for the State of Indiana, and I wanted to congratulate Perry in his new position.

MR. STEIN: I made that announcement, Wally, before when we had a large group here, but this is the first day that Mr. Miller, on my right, has assumed the job and office of Executive Secretary of the Indiana Commission, and he is replacing Mr. Blucher Poole, who we all know and have worked with through the years. We all would like to give our best to Perry and well appreciate the fact that he is spending his first day in office with us here.

Wally.

MR. POSTON: There is an ever-increasing concern for the conditions of our lakes and waterways. We in Chicago are especially concerned about the condition of our closest and greatest body of water -- Lake Michigan.

Although the primary concern of this conference

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is focused upon the problems related to thermal discharges in surface waters, I think it appropriate to cite two other problem areas in which the city of Chicago is taking positive action on behalf of the environment.

Mr. Vaughn of the Chicago Water Department, will add to the information from the city of Chicago in a presentation of chemical data resulting from numerous studies which the Department has made -- that is, the Water Department -- and it will serve as a continuation of previous reports which he has given to this Board.

During the past boating season Chicago enforced the harbor pollution control ordinance of the municipal code which prohibits the discharge of all forms of sewage into the lake and surrounding waterways. This code further states that all vessels with toilets must be equipped with a waste retention tank or incineration device. Fines ranging from $100 to $500 can be levied against offenders.

The continued discharge of nutrients, especially phosphates, into our lakes and waterways causes massive algal blooms. These growths can contribute substantially to the degradation of our lakes and other surface waters.

Although the city of Chicago discharges no sewage -- treated or otherwise -- into Lake Michigan, masses

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of decaying algae whose growth was stimulated by nutrients in sewage from neighboring communities in Illinois and the States of Michigan, Indiana, and Wisconsin are adding greatly to the eutrophication of the lake.

A recent conference such as this one called attention to the need for reducing the amount of phosphorus reaching our surface waters. To this end, the city of Chicago has proposed legislation limiting the phosphorus in detergents by weight to 8.7 percent effective February 1, 1971. It further proposes that phosphorus be reduced to zero by June 30, 1972.

This ordinance now pending before the city council would eliminate about 60 percent of the phosphates in municipal sewage and should bring about an immediate and substantial reduction in the phosphorus discharged to the surface waters downstream from Chicago. We think this action is warranted for the following reasons:

1) Chicago's primary objective is to protect Lake Michigan by maintaining the highest level of water quality, keeping it available for the full complement of uses for this land and future generations.

2) Chicago desires to improve its rivers and to be a good neighbor to downstream communities on the Illinois River system. Chicago wants to limit additions

of phosphates to its rivers, thus minimizing water quality problems now. We do not want to put unnecessary phosphates in surface waters, and we do not want other communities to put unnecessary phosphates into Lake Michigan.

3) The aesthetic quality of Chicago's water supply is at times adversely affected by the presence of tastes and odors due to algae and diatoms in the raw lake waters. In addition, these organisms increase Chicago's water treatment costs. The growth of these algae and diatoms is stimulated by the presence of phosphates in the lake.

4) To remove phosphates by advanced waste treatment methods would mean an additional cost to the Chicago area residents estimated to be in excess of $20 million per year. These are figures from the Metropolitan Sanitary District.

In recent years the calefaction or warming of bodies of water has posed a possible threat to the populations of fish and other aquatic life now in existence. There is no doubt that the balance of aquatic life will be harmed when water temperatures are raised to limits beyond a certain toleration level.

Great concern has been expressed by competent persons in their statements before this conference and the recent hearings of the Illinois Environmental

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Control Board regarding the magnitude of the problem and how it may be effectively controlled. Numerous investigations now in progress are aimed at assessing the effects of thermal discharges into Lake Michigan. One significant achievement concerning calefaction is the attention being focused on the problem in its infancy rather than waiting until a crisis proportion has been reached.

The major problem is not that all of Lake Michigan will be affected by heat but rather that the shoreline would become the prime victim of thermal discharges; thus destroying the values now present -- fish and other aquatic life, recreational resources for our citizens and a general source of beauty for all of us.

Waste heat addition in coming decades could significantly raise the temperature in extensive areas of the inshore waters, particularly the beach water zone. Waste heat from individual shore discharges are capable of thermally influencing many miles of lake shore. If the frequency of discharges along the shore increased, many heat plumes would eventually be so close together that their effects would merge. With the magnitude of projected waste heat, it is not difficult to envision a very sizeable portion of the beach water zone and certain

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adjacent waters physically affected by artificial temperature increases.

The aggregate influence of waste heat from increasing numbers of plants around the perimeter of the lake would proportionately magnify the unnatural effects on fish and other aquatic organisms caused by a single plume. Where several powerplants would exist close together, ecological problems would be intensified because of the proximity of their thermal zones of influence.

Under such warmed conditions and in those areas where nutrients are approaching critical levels, changes toward increased eutrophication would be expected. The increased eutrophication would be evidenced by dramatic increases in blue-green algae.

We think it is possible to realize the full range of uses of Lake Michigan as a natural resource by employing imaginative technology to serve human beings living in an urban setting, whereby the quality of life is enhanced aesthetically and the functiona, practical needs are met as well.

Rather than thinking in terms of having to dissipate the heat developed during the production of electric power, perhaps we should think in positive terms

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and find means to utilize this heat. For example:

Heated effluents from nuclear power stations could be used to some extent to improve the operation of domestic waste treatment facilities.

Other uses to which the low-grade heat in effluents might be put include providing irrigation for fruit orchards, for the raising of fish, keeping the Great Lakes-St. Lawrence Seaway open longer during the year, extending the swimming season at public beaches, for heating buildings in high density areas, for the distillation of salt water or sewage, and using canals to transport heated water to new, self-supporting metropolitan areas.

As Commissioner of the Department of Environmental Control, one of our concerns is the quality of our lakes and waterways. We are noting closely the current research efforts being conducted by various agencies and individuals. Wherever possible, my cooperation and that of my staff is available to prevent any deterioration of Lake Michigan.

Thank you.

MR. STEIN: Thank you, Mr. Poston.

Any comments or questions?

Mr. Poston, I note that you talked about "... warmed conditions and in those areas where nutrients are approaching critical levels, changes toward increased eutrophication would be expected."

I think the record will show that you were a member of this group when determinations were made in Lake Michigan that nutrients were placed on the critical list, isn't that correct?

MR. POSTON: That is correct.

MR. STEIN: And that your program presumably in Chicago limiting phosphorus and detergents, by the way, to 8.7 percent, effective February 1, 1971, is to implement this. It is designed to help reduce the nutrient discharge impact on Lake Michigan, is that correct?

MR. POSTON: The impact of this ordinance would have the effect of encouraging similar ordinances in other cities that are around the lake. The city of Chicago itself discharges its waste to the Metropolitan Sanitary District system, which goes down to the Illinois River.

MR. STEIN: That is correct. But you are talking in terms of reducing the nutrient problem wherever it exists, and that Illinois waterway is a slack water course where you are apt to have these nutrient problems, too.

MR. POSTON: Where they do have these nutrient problems, too.

MR. STEIN: I didn't want to talk that definitively about an intrastate situation.

Now, what I am saying is: Given these factors or these positions you have, if you believe that warming the nutrients can create eutrophication, would you think a suggestion would be in order to the conferees -- and I know, as I read your recommendations, you have been elevated to a statesman status now -- to adopt the specific figure of 8.7 on the phosphates that you, in your role in Chicago came up with.

MR. POSTON: This is a steep increase, Mr. Stein, in that by June in 1972 it would be down to zero.

MR. STEIN: Now, what do you think -- what would you suggest to the conferees on temperature? Do you think we have an obligation to get a specific on temperature increases as you have on phosphates?

MR. POSTON: I would like to very much, Mr. Stein. I am not privy to all of the information which has been used in granting permits for construction of these new works. I haven't been able to digest all of the information that you, as a conference here, have had presented to you.

I am sure of a couple of things, and one is that

Lake Michigan should not be permitted to depreciate its quality in any extent and the city of Chicago, I think, is firm in this conviction. I also am of the decided opinion that the degradation of Lake Michigan should not be permitted. As to the exact figure, I am not ready at this moment to tell you.

MR. STEIN: No, I am not asking you for an exact figure, but you did come up with a specific program and a specific figure on phosphates. You have come up with a specific program and a specific figure on discharge of various substances into Lake Michigan in your capacity in the past.

Now, as you view the question of the heat problem in Lake Michigan, do you think that this panel has an obligation to come up with specifics, as you have had in the past with other substances in Lake Michigan, and specifics as you have in dealing with your phosphate problem in Chicago?

MR. POSTON: Well, I think certainly that this would be very desirable and I think that you should. I think this is a problem that is going to be increasing rather than decreasing, and I would like to see this panel come forth with a decision.

MR. STEIN: Are there any other comments?

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Mr. Miller.

MR. MILLER: Mr. Poston, I have a question that relates to your ordinance, and my concern is how this ordinance may speak to substitutes that may replace the phosphorus and whether they may have just as much or more of a deleterious effect than phosphorous compounds, and does your ordinance speak to this?

MR. POSTON: We do not say what the content of any detergent should be or any soap should be. We are concerned with the phosphate that we know is deleterious. We have Carson Pirie Scott, Sears and Roebuck, Marshall Fields, all advertising and selling detergents which have low phosphate and zero phosphate. They are national companies which indicate that they can supply adequate quantities of phosphate to meet the demand, and some of those with the same ingredients that are already in -- or some of the ingredients that are already in the detergents.

I recognize that one of the milder substitutes for phosphates is NTA and I recognize that there have been clouds cast on the effect that NTA may have. I know that studies are going on relative to what these effects are. But I feel that we can come up with substitutes that do not have to have this nutrient which is the only nutrient, we feel, that can be controlled, and which does provide a stimulus or a stimulant to algal growths and eutrophication of our lake.

MR. MILLER: I don't disagree. I think that we need to come up with substitutes. But I wonder if there isn't a need also for showing that the substitutes are safe and aren't going to have a deleterious effect, and just limiting the phosphorus may not accomplish this. And this was my concern, whether you were also in the ordinance requiring a showing that the milder or the substitutes would not cause any deleterious effects.

MR. POSTON: We have not stipulated this in the ordinance. I would be glad to send you a copy of the proposed ordinance.

MR. STEIN: Mr. Miller, who do you think should show that the substance is safe, the public agency or the manufacturer?

MR. MILLER: I think the manufacturer should show it is safe.

MR. POSTON: I would agree with that.

MR. STEIN: Would you apply the same principle to every industry, including the power industry?

MR. MILLER: Well, I think this is really a question, and it comes down to one that you know -- of the many toxic compounds that you deal with, I think there is an incumbent responsibility on the manufacturer in the production of products to show that it does not have an adverse effect.

MR. STEIN: Are there any --

MR. POSTON: I think that when you know that something is harmful to the lake -- and we have such high regard for this thing -- that we need to do something, and I don't think that that includes waiting for something else to be proven beyond all shadow of a doubt.

MR. STEIN: Well, Mr. Poston, you know, I have relied in the past on your valuable advice in the various jobs you have had throughout the country. While you are here, I would like to ask you one question. I have been listening to testimony here for several days. Part of the testimony is that since we don't know possibly what the thermal effects of a discharge of heat should be, we should let this go on in the lake, have some studies made, not do anything now, but wait until these studies are completed before we put in a control measure.

What do you think of that approach?

MR. POSTON: Well, I think that there are many ways to avoid action, and you can get many technical answers to any particular problem -- the reasons for doing and reasons for not doing. I think you must not forget your goal, which is to prevent eutrophication in the lake, and that you should move towards that end as fast as you can.

MR. STEIN: Thank you.

MR. PURDY: Just one comment. I don't think our problem is quite that easy. For example, I think that the city of Chicago adds fluorides to their drinking water supply for a beneficial purpose. Fluorides in excess concentrations are harmful, and in the same vein we have to weigh on what is the harmful level of heat into the lake, and it is just not that easy.

MR. STEIN: I fully agree with what you say, Mr. Purdy. I thought we talked about that. As I understand the story, whether you have an outboard motor or whether you have a municipal sewage everyone has added heat to the lake.

I think the question here is one of standards which are supposed to be met, as contrasted to a situation where we just move in and abate it after the damage occurs.

MR. PURDY: Sometimes I think we might have to reput this because although we are not changing up here our audience is.

MR. STEIN: Are there any other comments or questions for Mr. Poston from the audience? If not, thank you very much, Mr. Poston.

Mr. James Vaughn.

STATEMENT OF JAMES C. VAUGHN,
ENGINEER OF WATER PURIFICATION,
CHICAGO, ILLINOIS

MR. VAUGHN: Mr. Chairman, conferees, and ladies and gentlemen.

This is a progress report on Lake Michigan water quality as related to Chicago water treatment plants.

This fourth report to the Four-State Enforcement Conference on Pollution of Lake Michigan and its Tributary Basin will be similar in most respects to the one presented earlier this year at Milwaukee. In general, the story is one of continuing improvement in water quality at Chicago. However, increases in concentration of certain constituents sound an ominous note for the future. On the whole, the record as summarized here suggests that gains have been made in improving water quality of Lake Michigan, permits one to infer that further gains are possible, and at the same time points out the directions in which gains in quality are necessary. It provides grounds for hope but not for complacency.

Several of the tables in this report have been abbreviated, to avoid undue repetition. Examination of the record of earlier sessions of this conference will provide the data not present here.

For orientation, Figure 1 (See P. 1558) locates Chicago with respect to major features of the southwest part of Lake Michigan. The city, its intakes, and its treatment plants are located between the Calumet industrial area and what is often called the North Shore. Reference will be made to both areas later.

The next several figures describe certain parameters important to operation of the South Water Filtration Plant (SWFP). Figure 2 (See P. 1559) demonstrates that the bacteriological quality of the raw lake water continued to improve during the first half of 1970. Previous improvements have often been followed, one can see, by deterioration, but the fact that the most recent improvement has continued for 2-1/2 years provides ground at least to hope that it will be permanent.

Figures 3, 4, and 5 (See Pp. 1560-1562) illustrate the data in Table 2. (See P. 1551) Here again is continued improvement. As Figure 3 shows, during half of 1970, both the number of "oil refinery" odor days and of odor periods are much less than half of the corresponding values for 1969.

Similarly, in Figure 4, one can see clearly

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that the ammonia nitrogen concentrations associated with hydrocarbon odors have continued to decline. These two parameters (odor and ammonia nitrogen) are important for their effect on plant and operating costs, since they profoundly affect the amounts of activated carbon and of chlorine required for proper treatment of the water.

It will come as no surprise by now to see that Figure 5 demonstrates that in fact the maximum activated carbon dosage required for treatment of hydrocarbon odors decreased during the first half of 1970 to a value below any previous one shown on the figure.

Figures 6 through 9 (See Pp. 1563-1566) contain selected data related to water quality in the Calumet industrial region, south of Chicago. Figure 6 is a map on which are indicated water system intakes, standard sampling points, and the principal waterways which connect to Lake Michigan.

On Figure 7 one sees annual values for average coliform MPN at the mouth of the Indiana Harbor Ship Canal (IHSC) and the mouth of the Calumet River. Here again, coliform MPN's have been decreasing for 2 years, and in both cases the MPN has continued to decrease so far in 1970.

The picture in Figure 8 is somewhat different. The annual average ammonia nitrogen at the mouth of the Calumet River was near its 20-year peak in 1967 and 1968, but has decreased significantly so far in 1970. In the upper curve, the ammonia nitrogen at the mouth of the IHSC, which had actually been above the scale on the chart in 1968 and 1969, has decreased noticeably. The values so far in 1970 are far higher than most historical ones, and certainly far higher than one would wish to see, but at least there has been a relative improvement.

In Figure 9 one notices that phenol concentrations at the mouth of the IHSC have increased somewhat so far in 1970. However, the increase is not so large so as to suggest any reversal of the general downward trend which began in 1964, and cannot as yet be called significant.

Figures 10, 11, and 12 (See Pp. 1567-1569) illustrate, in part, those changes in water quality which should cause unease. As Figure 10 demonstrates, nutrient concentrations are and have long been high enough to permit nuisance algae growths. The data collected in 1969 suggested that numbers of plankton might be starting to decline, but the data for the first half of 1970 contradict this interpretation. As the eye looks over this bar chart, it automatically tends to see two continuous curves. The annual averages would lie along a curve which tends to increase towards the right, at first gradually, then more steeply. Examination of the bars for the maximum day produces an effect which is generally similar but much more pronounced. One is strongly tempted to conclude that the decrease in 1969 was merely a statistical randomness of the kind one should expect in a curve which is increasing at an exponential rate.

On examining determinations of phosphate in Lake Michigan water at Chicago, one finds a possible explanation for the difference between 1969 and 1970 data. Tabulated below are selected points from distribution of total phosphate for the last 3 years:

	PERCENTAGE POINTS OF DISTRIBUTION		
Year	5%	50% (median)	95%
1968	0.01 ppm	0.05 ppm	0.14 ppm
1969	0.01	0.04	0.12
1970 (Jan-June)	0.02	0.05	0.12

A few other statistics are significant. The arithmetic average concentration for total phosphate in 1969 was 0.05 p.p.m.; in 1970 so far it has been 0.06 p.p.m. In 1969, 60 percent of determinations were above 0.04 p.p.m.; in 1970, 70 percent have been above this value.

When one compares the data with the value of 0.03 p.p.m. which is often quoted as the threshold above which nuisance algal blooms may occur, an even more depressing set of figures emerges. In 1968, 80 percent of determinations were above this limit. In 1969, 70 percent were higher. In January to June 1970, 90 percent were higher.

Either the reduction in phosphate observed in 1969 was illusory and merely a product of chance, or the ground gained in 1969 has been lost, and more along with it. Whatever interpretation is correct, data collected at Chicago provide no basis at present for asserting that any improvement, i.e., reduction, in phosphate levels of Lake Michigan has occurred.

One peculiar aspect of these data becomes evident when one plots their size distributions. In 1968 and 1969 the distributions were skewed to the right; i.e., there were more high values than would be expected from sampling in a lake at equilibrium with respect to phosphate concentration. This could be caused by irregular large inputs, by inadequate mixing of waters receiving constant inputs, or perhaps for other reasons. In the

1970 data, this skewness has nearly disappeared. If this means that major phosphate inputs have been eliminated, and that the lake is approaching an equilibrium at its present level of phosphate, there is reason for concern certainly for the immediate future, and perhaps for the long term. This would imply that nuisance algal growths should be expected until mixing with the deeper waters plus whatever processes may cause deposition in sediments have reduced the concentration of dissolved phosphate below whatever level is critical for Lake Michigan.

Surveys of Lake Michigan near Chicago

Figure 11, taken from the city's third report to this conference, represents the trend of chloride and sulfate concentrations over the period 1860-1960. It is worth noting that it shows the same sort of exponential increase in concentration as was suggested earlier in the discussion of plankton numbers.

Portions of these curves, together with straight-line trends based on a simpler method of interpretation are shown in Figure 12. As suggested in the third report, the sulfate concentrations continue to lie between the two projections, while the chloride concentrations remain near the straight line. Both have increased. Perhaps more significant, however, is the fact that here again the variation has begun to resemble more closely that which one would expect in sampling from an equilibrated system. In part this can be attributed to the fact that the points for 1970 represent only half a year, but it is unlikely that this is a complete explanation.

Figure 13 (See P. 1570) based principally on data in Table 4 (See P. 1553), may appropriately conclude our discussion of data collected at Chicago waterworks intakes. It illustrates, in terms of raw water odors and carbon usage, the improvement that has taken place in one important characteristic of Lake Michigan at Chicago.

During the first half of 1970, odors were less frequent and less severe. On only 1 day, April 20, 1970, was it necessary to feed more than 30,000 pounds of carbon. This contrasts with 10 days in 1969, and an average of 17 days per year for the last 10 years. Further confirmation of improvement in raw water quality will be noted if one examines Tables 3, 5, and 6 (See Pp. 1552, 1554, 1555).

Whatever may be in store for the future, there is no denying that from the plant operator's point of view, there has been improvement recently in the quality of raw water.

I might depart from the text at this point to say that from the first of July we have enjoyed the lowest coagulate requirements in the history of either plant. Never before have we been able to produce satisfactory water with a coagulate slightly in excess of 6 p.p.m. We enjoy our pleasures when we have them and we hope to continue.

MR. STEIN: By the way, Mr. Vaughn, while you are interrupting, the schedule indicates now that you are going on after lunch.

Will you continue?

MR. VAUGHN: Turning now to measurements over a larger area, let us consider in Figures 14-17 (See Pp. 1571-1574) some of the data collected in our lake sampling program. As in earlier figures, data for 1970 cover only the period from January to June. For lack of time to redraw the entire figure, data for 1970 in Figure 14 have been fitted between those for 1968 and 1969. The limits on the chart are those set by the Illinois Sanitary Water Board for the open waters of Lake Michigan, and have received the approval of the Federal Government. Clearly, at nearly every location covered by these surveys, the phosphate concentration increased above the concentrations found in 1969. At one point (3N) no change was observed. Clearly, too, concentrations at all points were above the annual average concentrations in the relevant ISWB standard.

In Figure 15, plotted in the same manner and showing average ammonia nitrogen concentrations, there has been a small decrease in general compared to 1969 measurements, although concentrations in general are above the maximum annual average permitted by the Federally-approved ISWB standards.

Figure 16 compares data for 1969 and 1970 on total and fecal coliform organisms at the same locations. Obviously, even taking the logarithmic nature of the scale into account, there has been a sharp decrease at every point, as there have been decreases at locations mentioned earlier.

Figure 17 illustrates average phosphate concentrations for surveys during the first half of the year, along the shore of the lake south of the area shown in Figures 14, 15, and 16. Here phosphate concentrations at two points (6S and 7S) have declined slightly, but at all other points they have remained at 1969 levels or increased somewhat. All are above the maximum annual average concentration of ISWB standard, and most of the averages are above the higher limit for daily values.

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Table 8 (See P. 1557) summarizes results of tests made for 5-1/2 years on seventeen of the parameters in the ISWB standard for open waters of Lake Michigan. For each fraction, the numerator is the number of days on which the standard was exceeded; the denominator, the number of days for which tests were made.

Data for 1965-1969 have been reduced to annual averages; data for 1970 represent the period January to June. The increases in permissible concentration for chloride, sulfate, and filterable residue incorporated into the ISWB standard were assumed to take effect at the start of 1970.

In the main, these data confirm what has been said earlier. Changes in bacteriological and most chemical parameters so far in 1970 suggest improvement in water quality in the lake. It is interesting to note that chloride concentration which exceeded the 1965-1969 standard only once in 5 years, has exceeded the more generous 1970 standard twice in half a year. Sulfate concentration, which never exceeded the 1965-1969 maximum daily concentration, has exceeded the larger permissible maximum daily concentration seven times so far in 1970. Filterable residue, which exceeded the 1965-1969 permissible concentration only three times in 5 years,

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has exceeded larger permissible concentration thirty times in 1970, so far. And, of course, total phosphate, whose permissible concentration remains unchanged at .04 milligrams per liter for daily samples, and which exceeded this concentration nearly half the time in 1965-1969, is now exceeding that concentration about two-thirds of the time.

At this time, Mr. Chairman, I would like to read the addendum which was provided for the conferees and the Secretary, and prepared by Mr. Benjamin Willey, Director, Water Purification Laboratory, city of Chicago. And, if you have any questions, I will ask Mr. Willey to answer them.

Suggestion has been made that alternate methods of cooling are available for waste heat disposal, such as dry and wet type cooling towers and spray ponds. In view of this report in which we have shown increasing trends in both chloride and sulfate concentrations in water at the southern end of Lake Michigan, we could only view with alarm the use of wet cooling systems. These would inherently provide for concentration of dissolved solids which would have to be disposed of in large measure by blowdown.

Since calcium carbonate deposition can be a major problem in both condensers and cooling towers it is most likely that alkalinity reduction and pH readjustment would be required with conversion of most or all of the alkalinity to sulfate ion.

Dissolved solids in Lake Michigan water are approximately 150 milligrams per liter, with about 110 milligrams per liter of alkalinity, 25 milligrams per liter of sulfate and 8 to 10 milligrams per liter of chlorides. Assuming evaporative cooling and recirculation of condenser cooling water under conditions frequently encountered in the Great Lakes area, a concentration of 10 times the raw water would be expected as an average high dissolved solids in the recirculating water, to be maintained by blowdown plus a nominal draft. This would mean blowdown solids of approximately 1,500 milligrams per liter to 1,800 milligrams per liter (12,500 to 14,000 lbs./million gallons) with most of it present as sulfate. Chlorides would approach 80 to 100 milligrams per liter. To return this water to Lake Michigan would further materially increase the sulfate content in the local area and eventually add to the already significant rate of rise in sulfate as well as chloride in the lake water. Addition of wastewater of this dissolved solids magnitude would be in violation of SWB-7 and would probably be equally

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objectionable to other wastewater courses affecting streams or rivers in the area.

Although question has been raised concerning whether the effects of thermal pollution could be considered reversible in some instances, there can be no question that sulfate and chloride ion pollution from cooling water blowdown would be both harmful and irreversible.

I will proceed with the main text.

Following the report of finding mercury in the Lake St. Clair, Port Huron and Sarnia area, Government, State, and municipal laboratories began testing in various areas of the Great Lakes system. At the present time a total of 453 tests have been run by the city of Chicago Water Purification Laboratory covering samples taken from Lake Michigan from the Wisconsin line to the Michigan line. The surveys included the North Lake Survey, South Lake Survey, North Harbor Survey, mouth of the Chicago River, Navy pier and the Calumet-Indiana Harbor Ship Canal Survey. In addition, many raw water samples were tested at Central, South, and Hammond intakes and outlet (treated) waters were tested from Hammond, 73rd and 79th Street outlets of SWFP, and north and central outlets from CWFP. All samples were below the detectable limit for mercury.

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Tests prior to August 21, 1970, were reported on a detectable limit of 0.5 p.p.b. Tests on and after August 22, 1970 (275 determinations), reported mercury below 0.1 p.p.b., which is less than .01 microgram per liter. Therefore, based on our tests, the southern end of Lake Michigan can be stated to be free of mercury contamination at the present time.

MR. STEIN: What kind of test did you use, Mr. Vaughn?

MR. VAUGHN: Our method was modified, and the thing that is shocking about the whole mercury story, if I may ad lib on it, is the fact that mercury is a very heavy material, settles at the bottom of the lake and probably would remain inactive, but it combines with the organic materials in the lake, in the sediments, to make soluble and volatile compounds. So this method is a new method that involves the use of an atomic absorption unit in which I add the proper reagents to convert the mercury to a volatile or soluble compound and run a stream of air through that at a fixed rate through a quartz cell through which a cathode ray tube suitable for mercury goes, and then you write it on the chart.

MR. STEIN: In other words, it is what we would call "flameless atomic absorption?"

MR. VAUGHN: Yes.

MR. STEIN: The low parts per billion, how far down --

MR. VAUGHN: Well, the limit is supposed to be 0.5 p.p.b., but the standard will come out very clearly as low as 0.1 p.p.b.

MR. STEIN: Let me try to reframe the question.

We are consistently getting results from our laboratory down to 1 part per billion on the production-line basis. Do you mean to say in your testing when you say, "below detectable limits" that means below 1 part per billion or below 0.5 parts per billion?

MR. VAUGHN: Well, we look below 1, in fact we look below a half.

MR. STEIN: That is right.

Well, if we don't run it too fast and we take our time, we can get down to 0.2 p.p.b., but for practical purposes, we are using 1 part. I assume that you are using that as a cutoff point to talk about -- no?

MR. MAYO: One.

MR. VAUGHN: Well, Mr. Stein, we will let Mr. Willey explain briefly that. He is in direct charge of that.

and much more familiar with it than I am.

MR. WILLEY: I am Ben Willey, Director of the Water Purification Lab for the city.

Our methodology has improved to the point where we are getting low detectable limits of 0.1 p.p.b. Of course, the proposed standard is ,5 p.p.b., or 5 micrograms per liter is the Russian standard and the one which we are presently using as a proposed limit.

MR. STEIN: Who is using that?

MR. WILLEY: I understood that the U. S. Public Health Service put this in there about March or April of this past year. There is something in the record on this that they proposed that we take this over.

Anyway analytically we started out with the flameless atomic absorption method being very easily detectable down to a half part per billion. We have since twice step-wise improved the accuracy to where we now can read one-tenth of a p.p.b. and know that it is there. All of our tests in southern Lake Michigan thus far have been well below that detectable limit.

MR. STEIN: Thank you. I think you have a good program here but I want to make one thing pretty clear: I don't want anyone going away with the notion that you are going to have a standard for a half part per billion and that is the standard we are looking for. I don't know that we have any numbers yet, but so far we are talking about trying to reduce mercury down pretty much to background levels if we can. We are coming pretty close. The plants have responded really famously on this. Plants which were putting out 20, 30, 40, 60 pounds of mercury a day are almost all down to below a pound and the vast majorities, I think, are down below a half pound. Of course, when you have to scrabble for inches or ounces that is when the problem becomes more difficult.

But I don't want anyone to get the impression that there is a numerical tolerable standard of mercury that the governmental agencies have put out or agreed upon.

MR. WILLEY: That is right. I think that this could be mentioned in this sense. In our early work when mercury was found, we went to the wet method. We aimed to find out how to get it. Obviously, the wet method did not give us the answer on the basis of the Russian standard, and certainly we shouldn't go any higher than that standard.

So we went from that to atomic absorption flame method. This also was not suitable, and finally when we got the flameless method we were well under any previously talked about limits.

MR. STEIN: Mr. Purdy.

MR. PURDY: While we are talking about detectable limits, I think we also ought to talk about detectable limits in what? And are you speaking now of the detectable limit at the water, and do you have that same detectable limit in bottom muds and on fish?

MR. WILLEY: No, we have a much lower detectable limit in water. We have a higher accurate detectable limit -- half a p.p.b. in mud -- rather in fish. In muds, the detectable limit is much higher. I understand it is 5. This is the most difficult thing we have to do.

MR. STEIN: We also have a problem. I guess, Mr. Vaughn, according to your testimony you possibly don't have it. But what happens with us is when we take the material from an industrial discharge, it often has a lot of other gunk in it. When we run it through the flameless atomic absorption method, it just puts the machine out of commission for days. As you can appreciate, in order to do this in the Federal operation, we have taken laboratory equipment and turned that into a production line device, which has given us a lot of problems. But when we get these industrial samples, we have to run them twice through a pretesting system to be sure that it won't wreck our flameless atomic absorption system and disable our production line.

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By the way, the response we have gotten from the industry in this reduction program of mercury, has been as rapid as any that I have ever experienced. We have really cut the mercury discharges, at least from those sources which were pouring it into the water courses, very, very rapidly within the past several months.

Would you continue, Mr. Vaughn?

MR. VAUGHN: I would like to add one thing, the estimate -- that is Lake St. Clair, the St. Clair River -- it was estimated that 565,000 pounds of mercury have been discharged to that area over the last 20 years. That is a figure that sort of keeps me awake nights.

MR. STEIN: That is right.

Did you ever figure out how much this mercury costs? I am frequently asked that question. I am not necessarily asking it here. But consider the cost per pound of mercury and how many pounds were being discharged daily. I don't think we have any disagreement on the figures that we had, with those industries involved. This was never an area of disagreement -- their measures equaled our measures. But when you consider the cost of mercury and the amount of mercury which was discharged into the wastewater each day, a lot of the people have asked me how the industry in this country could have afforded to put that much stuff out in their waste. I don't know what the answer to that is.

MR. VAUGHN: I think the cost is $7.50 a pound.

MR. STEIN: Go ahead.

MR. VAUGHN: Conclusion. From the plant operator's viewpoint there has been a measurable and continued improvement in water quality of Lake Michigan at Chicago. This improvement started in 1969 and has continued in 1970, resulting in considerable reduction in difficulty and cost of water treatment. Most of the measured parameters of water quality have shared in this improvement.

Two sorts of water quality parameters, however, do not fit this pattern. One group, related to the burden of dissolved solids, has showed a continuous increase in concentration, perhaps even at an increasing rate. The other group, consisting of algal nutrients, shows no improvement. In the case of phosphate, there is evidence that the improvement observed in 1969 has been lost, and that further increases in phosphate concentration have occurred in 1970. Furthermore, it may at least be conjectured that concentrations of phosphate in the relatively shallow waters of Lake Michigan from which water supplies are drawn are tending toward an equilibrium concentration which is well above the threshold concentration for nuisance algal growth.

For these reasons, while the outlook for the recent past and the short-term future permits optimism, the outlook for the longer term is badly clouded. Clearly considerable effort is still required to improve and protect the quality of Lake Michigan's waters. Without effective control of its water quality, Lake Michigan could deteriorate to the level of Lake Erie.

The tables and charts are arranged in the back of the book.

MR. STEIN: Without objection, they will be included in the transcript, Mr. Vaughn.

(The tables and charts follow on pages 1551 through 1574.)

MR. STEIN: Mr. Miller.

MR. MILLER: Mr. Vaughn, I am interested in the comments that you made particularly on the sulphates because I know that there have been large quantities of sulphates that have been reduced or eliminated from waste discharges in the Indiana area. What time of year did

TABLE 2

SUMMARY OF "OIL REFINERY WASTE" TYPE ABNORMAL ODOR PERIODS
IN RAW LAKE WATER SUPPLY TO SOUTH WATER FILTRATION PLANT
1950-1970

Year	Odor Periods	Total Odor Days	Maximum Threshold Odors During Periods 4-20	21-50	51-100	Maximum Activated Carbon Dosage Applied lb/mil gal
1950	10	36	6	3	1	1158
1951	20	127	16	4	-	446
1952	17	30	16	1	-	590
1953	16	18	16	-	-	266
1954	12	23	11	1	-	356
1955	15	36	15	-	-	279
1956	13	28	12	1	-	415
1957	18	49	18	-	-	325
1958	17	43	16	1	-	503
1959	19	40	17	2	-	712
1960	21	42	20	1	-	324
1961	23	94	23	-	-	388
1962	23	76	23	-	-	270
1963	28	72	27	1	-	680
1964	28	89	27	-	1	745
1965	15	46	14	1	-	320
1966	26	95	25	1	-	385
1967	21	89	20	1	-	557
1968	22	57	17	1	-	411
1969	15	42	13	1	-	557
1970 Jan-June	5	12	5	-	-	213

Bureau of Water, Department of Water and Sewers, City of Chicago

TABLE 3

SUMMARY OF MAXIMUM AMMONIA NITROGEN IN INTAKE WATER SUPPLY, AND ACTIVATED CARBON AND CHLORINE APPLIED DURING ABNORMAL ODOR POLLUTION PERIODS SOUTH WATER FILTRATION PLANT, 1950-1970

Year	Maximum Ammonia Nitrogen (ppm)	Maximum Activated Carbon Dosage (lb/mil gal)	Maximum Chlorine Dosage (lb/mil gal)
1950	0.276	1158	84.0
1951	0.196	446	45.5
1952	0.248	590	45.1
1953	0.120	266	35.4
1954	0.148	356	20.8
1955	0.125	279	24.3
1956	0.180	415	24.4
1957	0.248	325	26.8
1958	0.680	503	19.4
1959	0.290	712	24.5
1960	0.272	324	16.0
1961	0.358	388	20.3
1962	0.590	370	27.2
1963	0.230	680	42.8
1964	0.496	745	56.1
1965	0.198	320	53.1
1966	0.260	385	53.9
1967	0.260	557	70.0
1968	0.250	411	51.1
1969	0.250	557	37.8
1970 Jan-June	0.100	213	33.2

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TABLE 4

SUMMARY OF ACTIVATED CARBON APPLIED
FOR REMOVAL OF ODORS IN LAKE WATER
SOUTH WATER FILTRATION PLANT
1950-1970

Year	Total Activated Carbon Applied (lbs)	Average Carbon Dosage (lb/mil gal)	Maximum Hourly Carbon Dosage during Odor Periods (lb/mil gal)
1950	2,874,905	26	1158
1951	3,545,552	31	446
1952	3,203,426	26	590
1953	1,775,063	14	266
1954	2,011,359	16	356
1955	2,057,781	17	279
1956	1,981,108	16	415
1957	3,032,729	24	325
1958	2,762,540	22	503
1959	3,035,509	23	712
1960	2,727,005	21	324
1961	2,632,923	21	388
1962	2,865,541	22	370
1963	3,194,443	23	680
1964	3,773,655	27	745
1965	3,094,606	23	320
1966	4,678,661	33	385
1967	4,455,273	32	557
1968	4,879,309	33	411
1969	2,542,600	18	557
1970 Jan-June	880,900	13	213

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TABLE 5

Annual Consumption of Activated Carbon,
Coagulants (Alum, Ferrous Sulfate), and Chlorine
1965-1970

Year	Activated Carbon		Coagulants		Chlorine		Total Water Treated
	Total lb.	lb/milgal	Total lb.	lb/milgal	Total lb.	lb/milgal	(milgal)
1965	3,094,606	23	14,279,870	104	2,797,986	20.4	136,895
1966	4,678,661	33	16,445,820	116	3,518,720	24.8	142,084
1967	4,455,273	32	15,778,872	112	3,388,261	24.0	141,107
1968	4,876,309	33	15,907,820	109	3,215,810	21.3	146,166
1969	2,542,600	18	14,701,900	104	2,969,600	16.1	141,779
1970 (Jan-June)	880,900	13	6,708,100	99	906,400	13.4	67,508
Total	20,528,349		83,822,312		17,796,777		775,539
Average	3,732,427	26	15,420,433	108	3,235,778	22.9	

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TABLE 6

Summary of Costs: Activated Carbon,
Coagulants (Alum, Ferrous Sulfate), and Chlorine
1965-1670

Year	Activated Carbon		Coagulants		Chlorine	
	Total	$/milgal	Total	$/milgal	Total	$/milgal
1965	$ 243,055.45	$1.78	$ 268,806.52	$1.96	$122,776.01	$0.90
1966	361,222.18	2.54	303,788.28	2.14	162,470.73	1.14
1967	368,913.81	2.61	293,547.31	2.08	167,047.76	1.18
1968	415,789.00	2.86	304,206.00	2.07	146,122.00	1.00
1969	224,134.00	1.58	263,900.00	1.86	143,098.00	1.01
1970 (Jan-June)	77,749.00	1.15	131,071.00	1.94	41,800.00	0.62
Total	$1,690,863.44		$1,565,319.11		$741,932.50	
Average	$ 307,429.72	$2.18	$ 284,603.47	$2.01	$134,896.82	$0.96

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TABLE 7

CONTRACT PRICES PER TON
Central & South Water Filtration Plants
1965-1970

Year	Chemical		
	Alum (Soln)	Carbon	Chlorine
1965	$39.07	$156.18	$96.74
1966	40.55	156.70	95.20
1967	41.85	166.60	97.20
1968	43.45	178.00	93.40
1969	43.75	173.00	95.40
1970	44.05	178.00	95.40

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LEGEND:
$\ngtr$ Not more than
$\nless$ Not less than

TABLE 8
CONTROL POINT - OPEN WATER
SOUTH WATER FILTRATION PLANT
COMPARISON OF ACTUAL RESULTS WITH WATER QUALITY CRITERIA
1965-1970

PARAMETER	QUALITY CRITERIA		Exceeding Daily Average 1965-1969 Avg	Exceeding Daily Average 1970 Jan-June	Exceeding Single Value 1965-1969 Avg	Exceeding Single Value 1970 Jan-June
Coliform Bacteria	Annual Avg.	$\ngtr$ 200				
(MPN/100 ml)	Daily Avg.	$\ngtr$ 2,500	2/364	0/181		
Fecal Streptococci						
(Number/100 ml)	Single Day	$\ngtr$ 25			7/294	2/175
True Color	Annual Avg	$\ngtr$ 5				
(Units)	Single Day	$\ngtr$ 15			0/240	0/181
Threshold Odor	Single Value	$\ngtr$ 8			17/365	
	Daily Avg	$\ngtr$ 4	27/365	5/181		0/181
Temperature (°F)	Single Day	$\ngtr$ 85			0/356	0/181
pH	Annual Range	8.1-8.4				
(Units)	Daily Range	7.7-9.0	0/365	0/181		
Dissolved Oxygen	Annual Avg.	$\nless$ 90				
(Percent Saturation)	Single Day	$\nless$ 80			1/10	0/25
Ammonia Nitrogen	Annual Avg	$\ngtr$ 0.02				
(mg/l)	Daily Avg	$\ngtr$ 0.05	34/365	0/181		
Methylene Blue Active	Annual Avg	$\ngtr$ 0.05				
Substance (mg/l)	Single Day	$\ngtr$ 0.20			0/95	0/82
Chlorides	Annual Avg	$\ngtr$ 8 (9)				
(mg/l)	Single Day	$\ngtr$ 15			0.2/289	2/180
Cyanides (mg/l)	Single Day	$\ngtr$ 0.025			0/28	0/27
Fluorides	Annual Avg	$\ngtr$ 1.0				
(mg/l)	Single Day	$\ngtr$ 1.3			0.2/315	0/181
Dissolved Iron	Annual Avg.	$\ngtr$ 0.15				
(mg/l)	Single Day	$\ngtr$ 0.30			0/283	0/181
Phenol Like Substances	Annual Avg.	$\ngtr$ 0.001				
(mg/l)	Single Day	$\ngtr$ 0.003			60/233	0/178
Sulfates	Annual Avg	$\ngtr$ 23 (24)				
(mg/l)	Single Day	$\ngtr$ 50			0/297	7/173
Total Phosphates	Annual Avg	$\ngtr$ 0.03				
(mg/l)	Single Day	$\ngtr$ 0.04			144/299	126/181
Filterable Residue	Annual Avg	$\ngtr$ 162 (165)				
(mg/l)	Single Day	$\ngtr$ 200			0.6/143	30/125

Number of days exceeding criteria/Number of days tested

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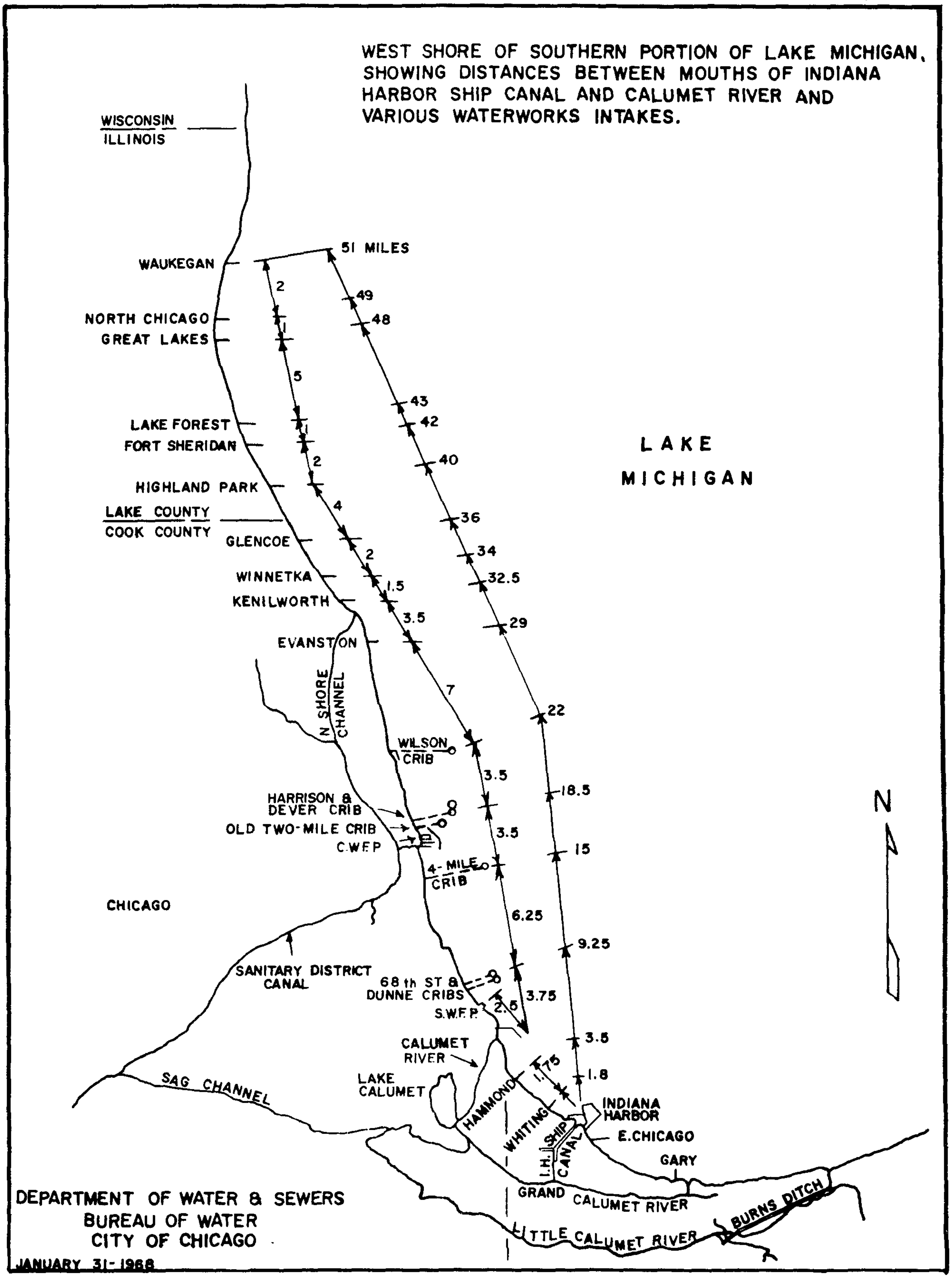
FIGURE I


WEST SHORE OF SOUTHERN PORTION OF LAKE MICHIGAN, SHOWING DISTANCES BETWEEN MOUTHS OF INDIANA HARBOR SHIP CANAL AND CALUMET RIVER AND VARIOUS WATERWORKS INTAKES.
WISCONSIN
ILLINOIS
WAUKEGAN
51 MILES
NORTH CHICAGO
GREAT LAKES
LAKE FOREST
FORT SHERIDAN
HIGHLAND PARK
LAKE COUNTY
COOK COUNTY
GLENCOE
WINNETKA
KENILWORTH
EVANSTON
N SHORE CHANNEL
WILSON CRIB
HARRISON & DEVER CRIB
OLD TWO-MILE CRIB
C.W.F.P.
4-MILE CRIB
CHICAGO
SANITARY DISTRICT CANAL
68 th ST & DUNNE CRIBS
S.W.F.P.
CALUMET RIVER
LAKE CALUMET
SAG CHANNEL
HAMMOND
WHITING
I.H. SHIP CANAL
INDIANA HARBOR
E. CHICAGO
GARY
GRAND CALUMET RIVER
LITTLE CALUMET RIVER
BURNS DITCH
LAKE MICHIGAN
N
2
1
5
1
2
4
2
1.5
3.5
7
3.5
3.5
6.25
3.75
2.5
1.75
49
48
43
42
40
36
34
32.5
29
22
18.5
15
9.25
3.5
1.8
DEPARTMENT OF WATER & SEWERS
BUREAU OF WATER
CITY OF CHICAGO
JANUARY 31-1968

AVERAGE COLIFORM PER 100 ml SOUTH WATER FILTRATION PLANT INTAKE 1950 - 1970

YEAR	COLIFORM PER 100 ml ANNUAL AVERAGE	COLIFORM PER 100 ml MAXIMUM DAY
1950		
1951	14.0	375
1952	9.7	495
1953	13.9	534
1954	20.0	959
1955	42.3	1300
1956	38.7	1400
1957	70.8	9600
1958	63.1	6400
1959	85.6	3200
1960	65.2	2900
1961	52.4	3000
1962	69.5	1700
1963	200.8	5800
1964	110.2	1900
1965	46.3	1100
1966	35.8	1200
1967	260.0	13000
1968	82.0	2400
1969	59.0	980
1970	12.7	220

DEPARTMENT OF WATER & SEWERS
BUREAU OF WATER
CITY OF CHICAGO

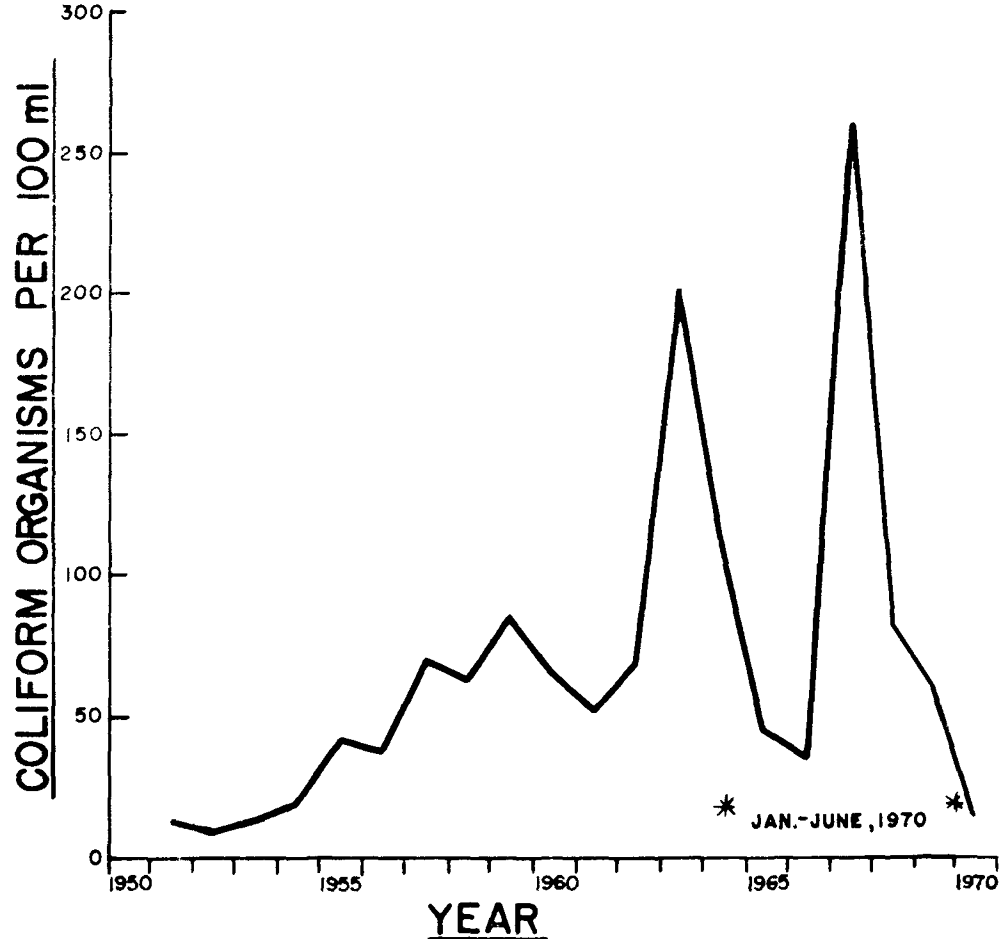
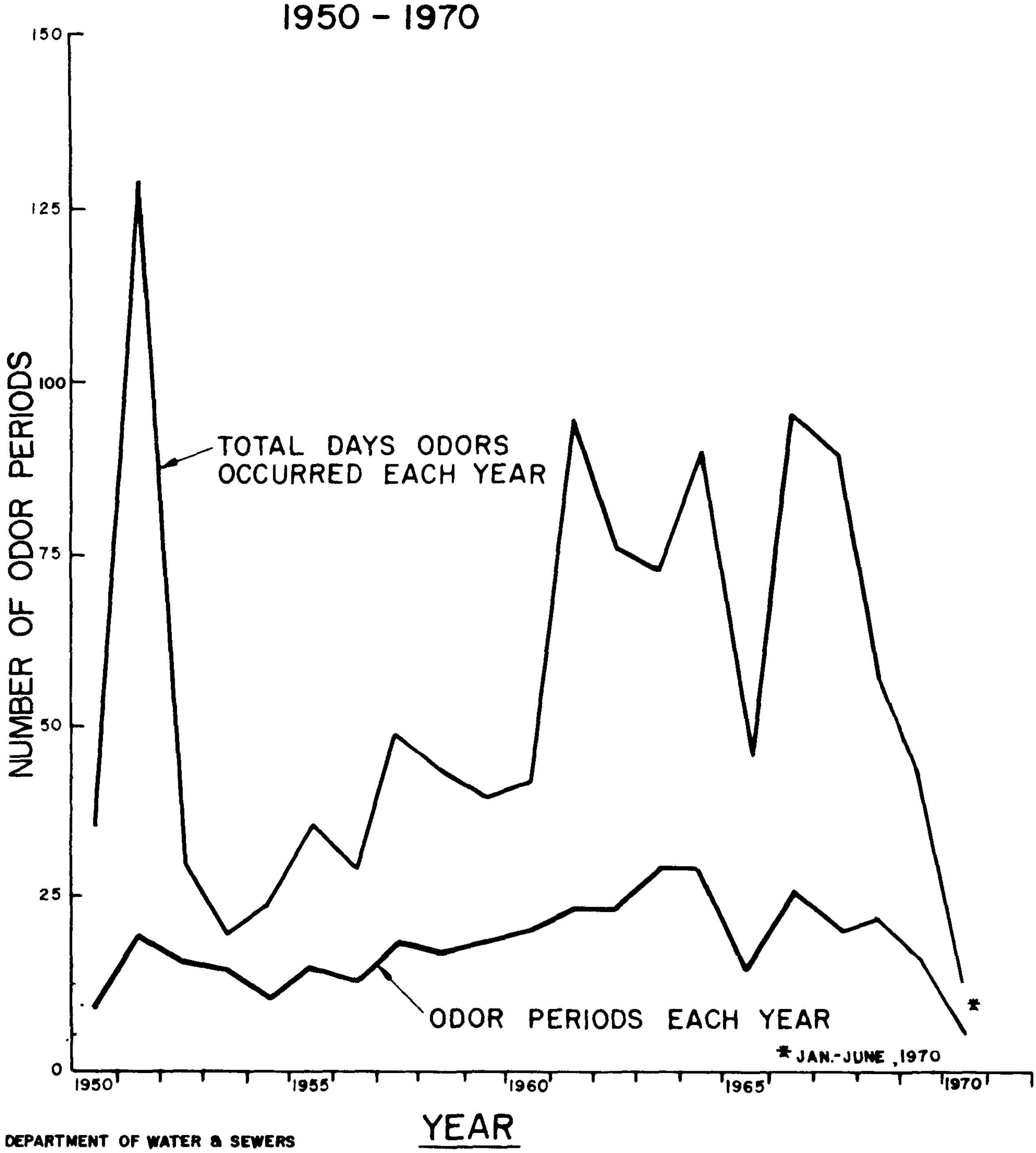


FIGURE 2

ABNORMAL "OIL REFINERY" TYPE ODOR PERIODS

SOUTH WATER FILTRATION PLANT INTAKE
1950 - 1970



DEPARTMENT OF WATER & SEWERS
BUREAU OF WATER
CITY OF CHICAGO

FIGURE 3

FIGURE 4

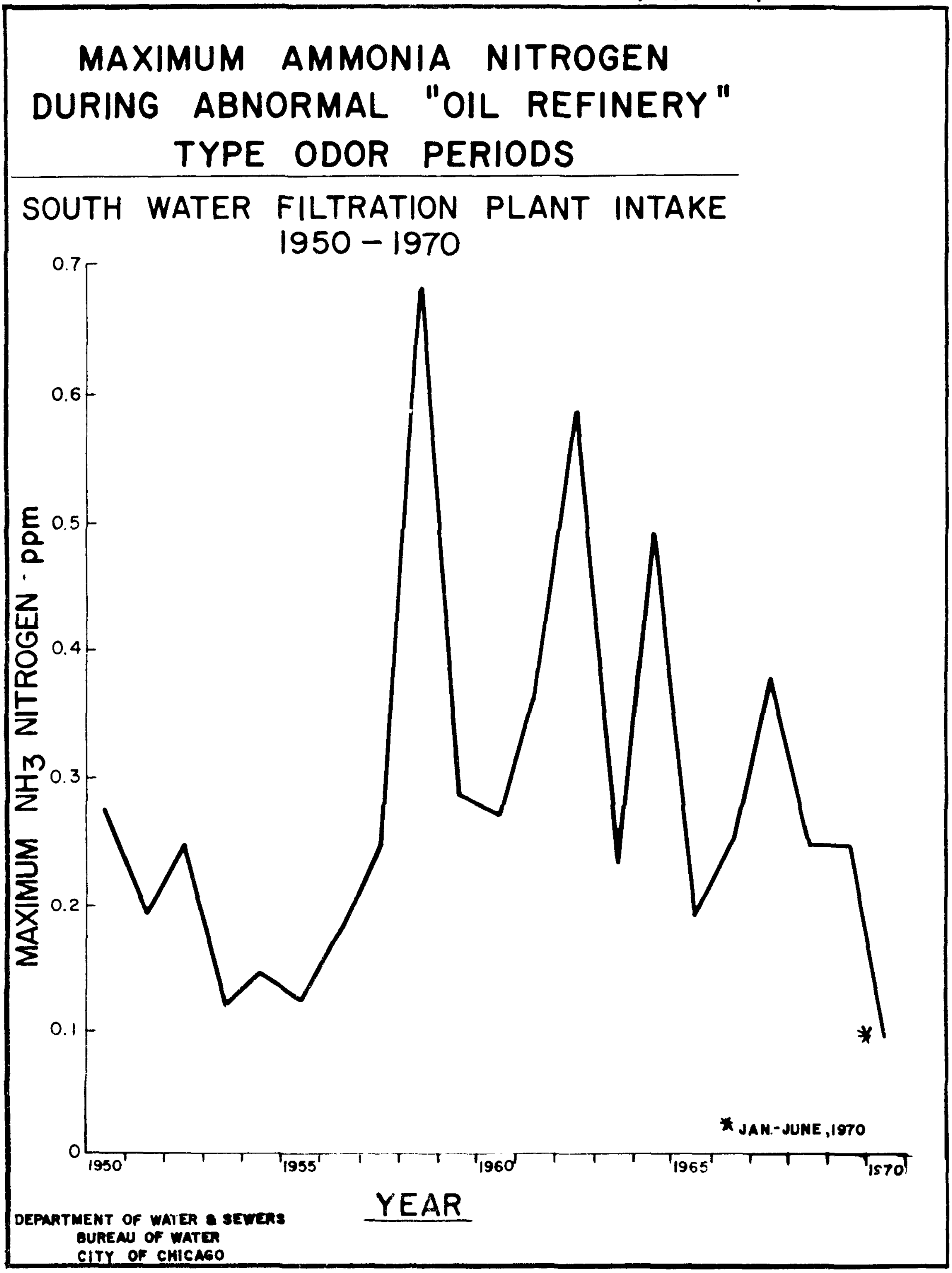
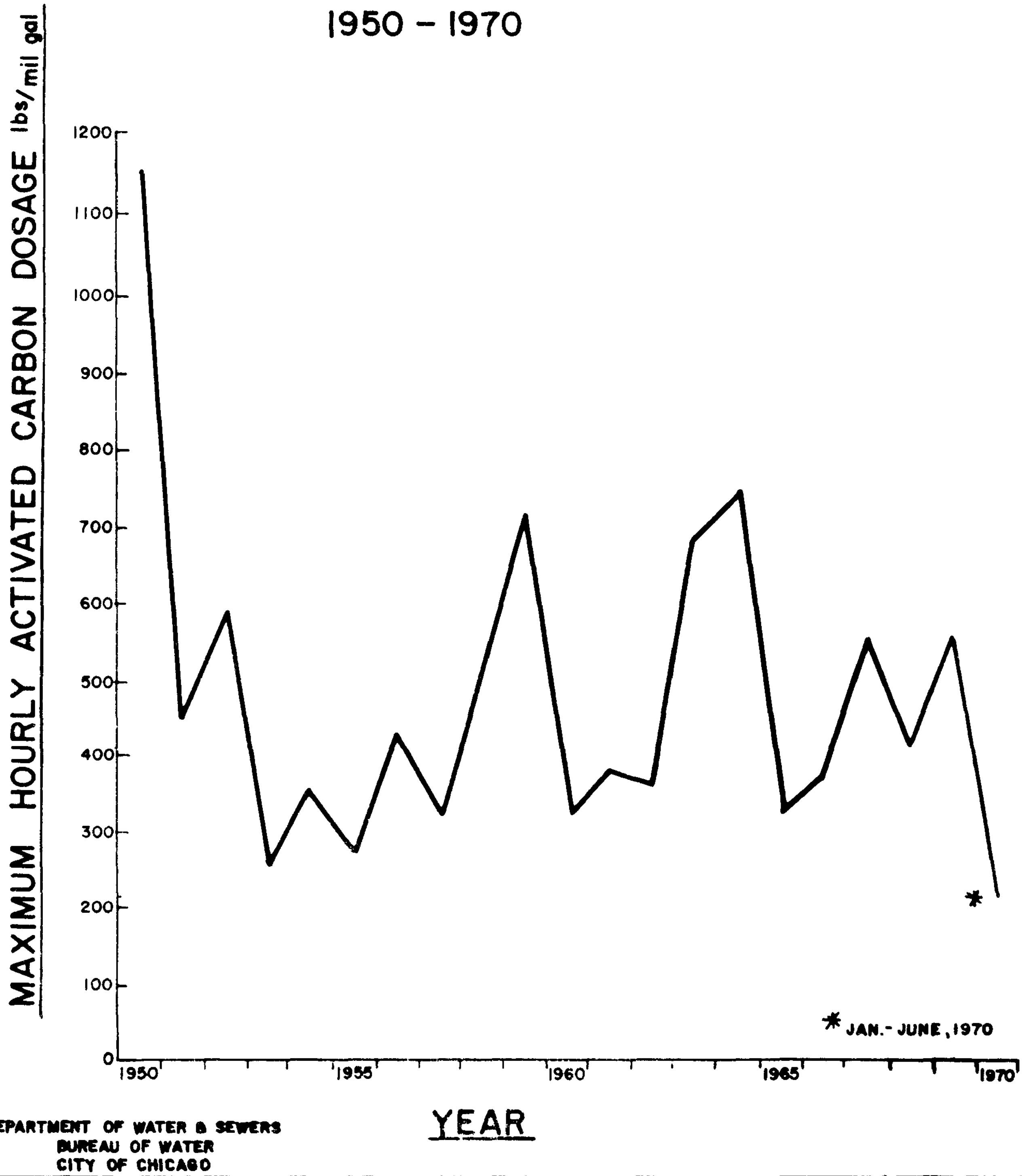

MAXIMUM AMMONIA NITROGEN
DURING ABNORMAL "OIL REFINERY" TYPE ODOR PERIODS
SOUTH WATER FILTRATION PLANT INTAKE
1950 – 1970
MAXIMUM NH_3 NITROGEN - ppm
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1950
1955
1960
1965
1970
YEAR
* JAN.-JUNE, 1970
DEPARTMENT OF WATER & SEWERS
BUREAU OF WATER
CITY OF CHICAGO

FIGURE 5

MAXIMUM ACTIVATED CARBON DOSAGE DURING ABNORMAL "OIL REFINERY" TYPE ODOR PERIODS

SOUTH WATER FILTRATION PLANT INTAKE
1950 - 1970



DEPARTMENT OF WATER & SEWERS
BUREAU OF WATER
CITY OF CHICAGO

WEEKLY POLLUTION SURVEYS - LOCATION OF SAMPLING POINTS

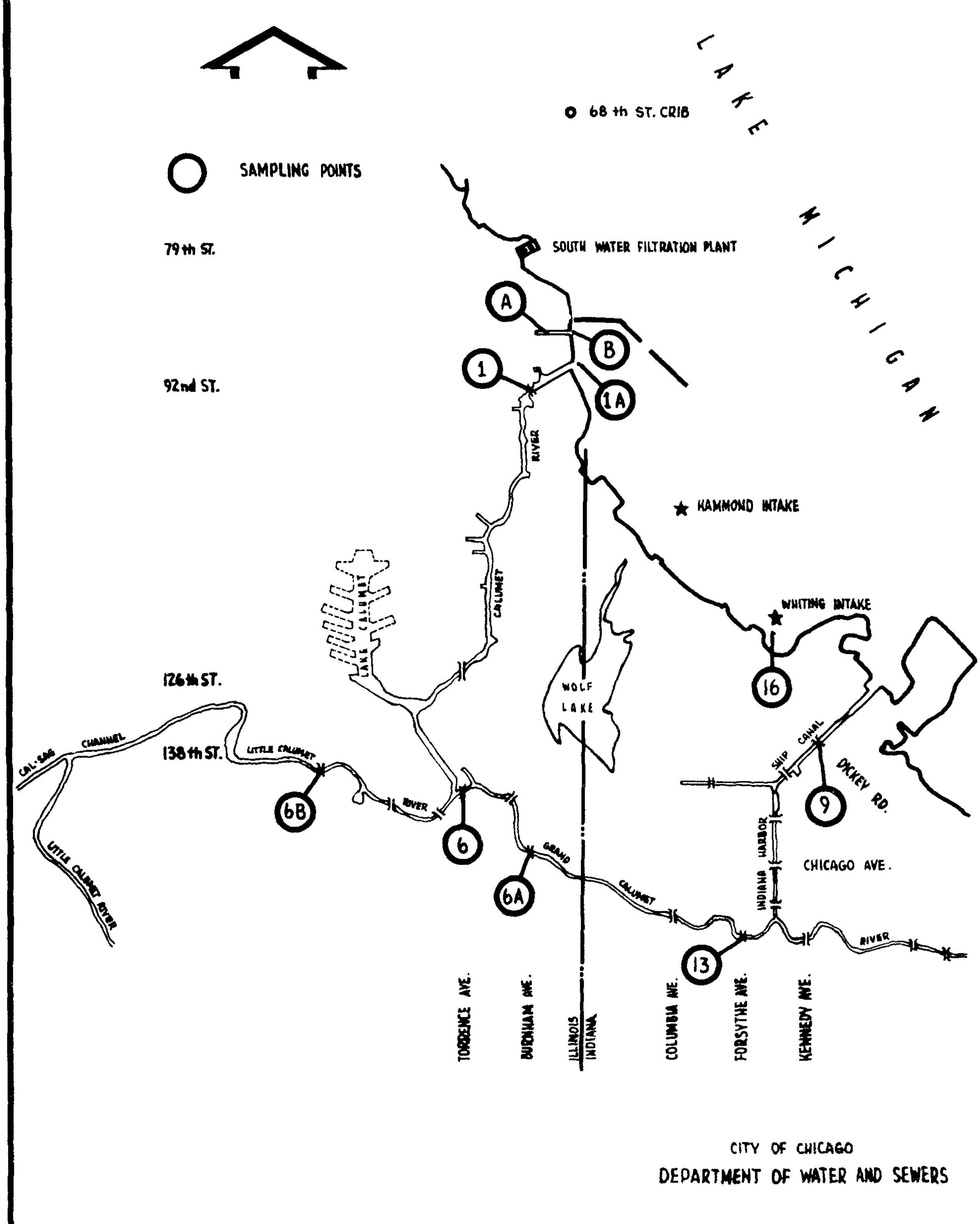


FIGURE 6

JUNE 1969 D.P.

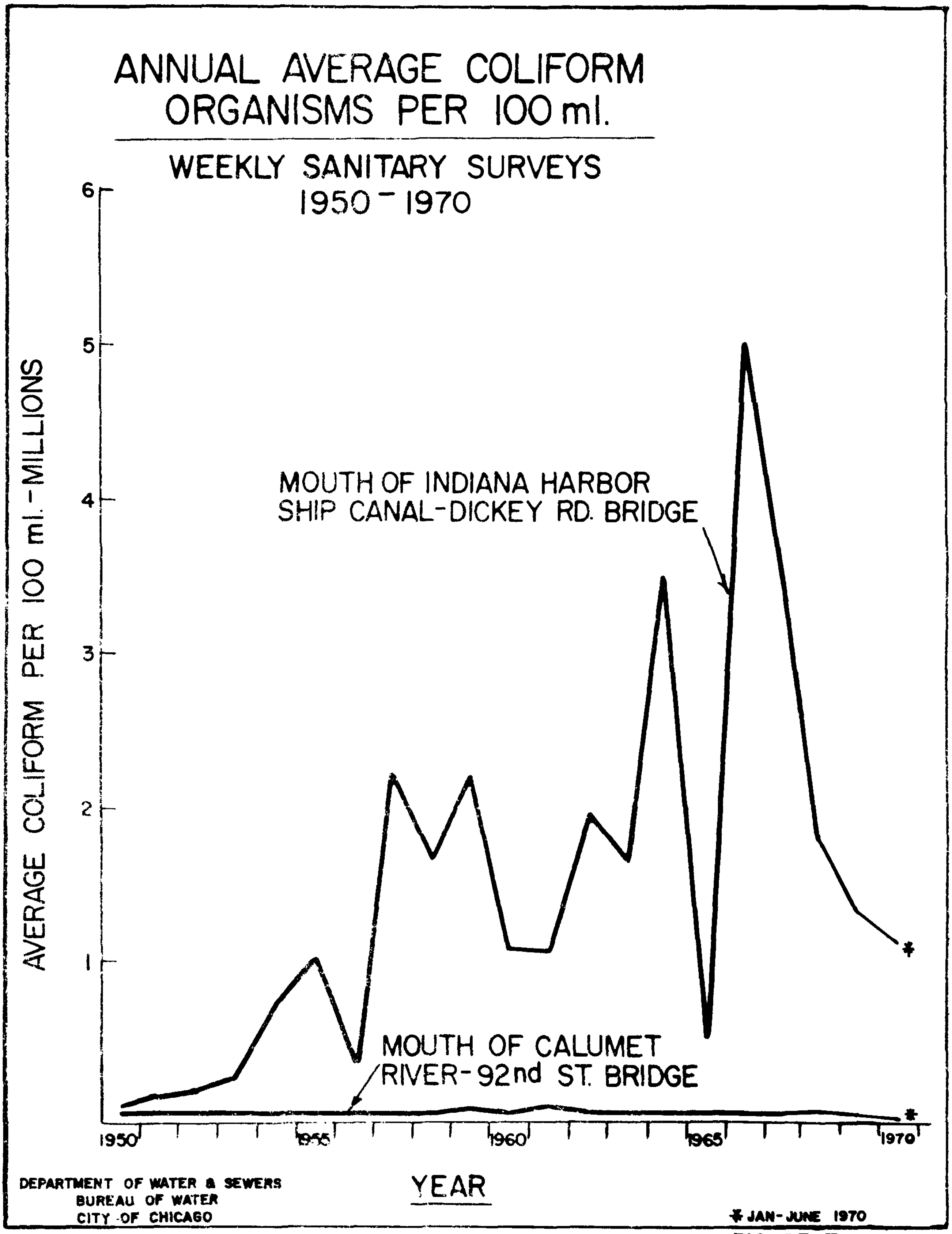

ANNUAL AVERAGE COLIFORM ORGANISMS PER 100 ml.
WEEKLY SANITARY SURVEYS 1950 - 1970
AVERAGE COLIFORM PER 100 ml. - MILLIONS
6
5
4
3
2
1
MOUTH OF INDIANA HARBOR SHIP CANAL-DICKEY RD. BRIDGE
MOUTH OF CALUMET RIVER-92nd ST. BRIDGE
1950
1955
1960
1965
1970
YEAR
DEPARTMENT OF WATER & SEWERS
BUREAU OF WATER
CITY OF CHICAGO
* JAN-JUNE 1970

FIGURE 7

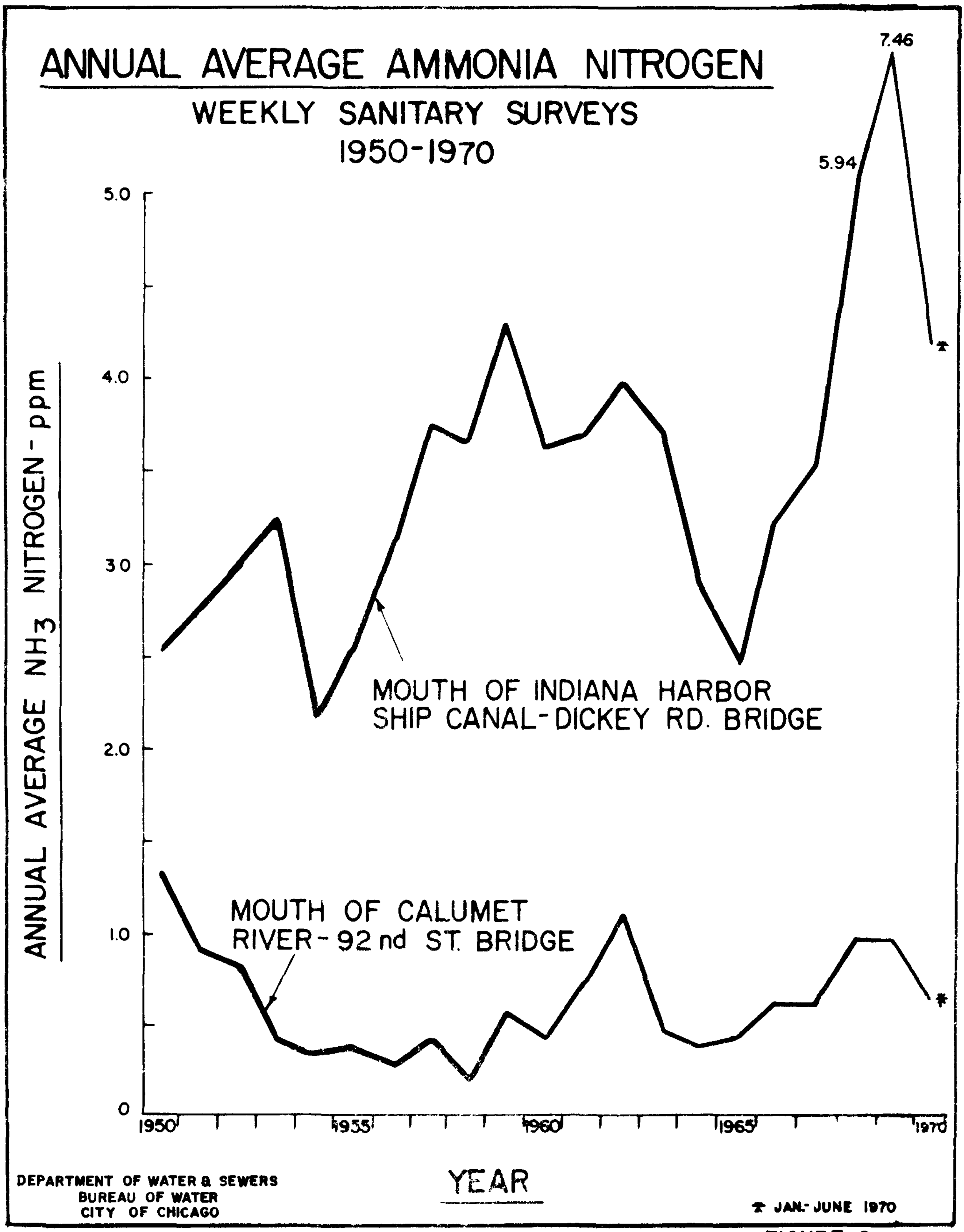
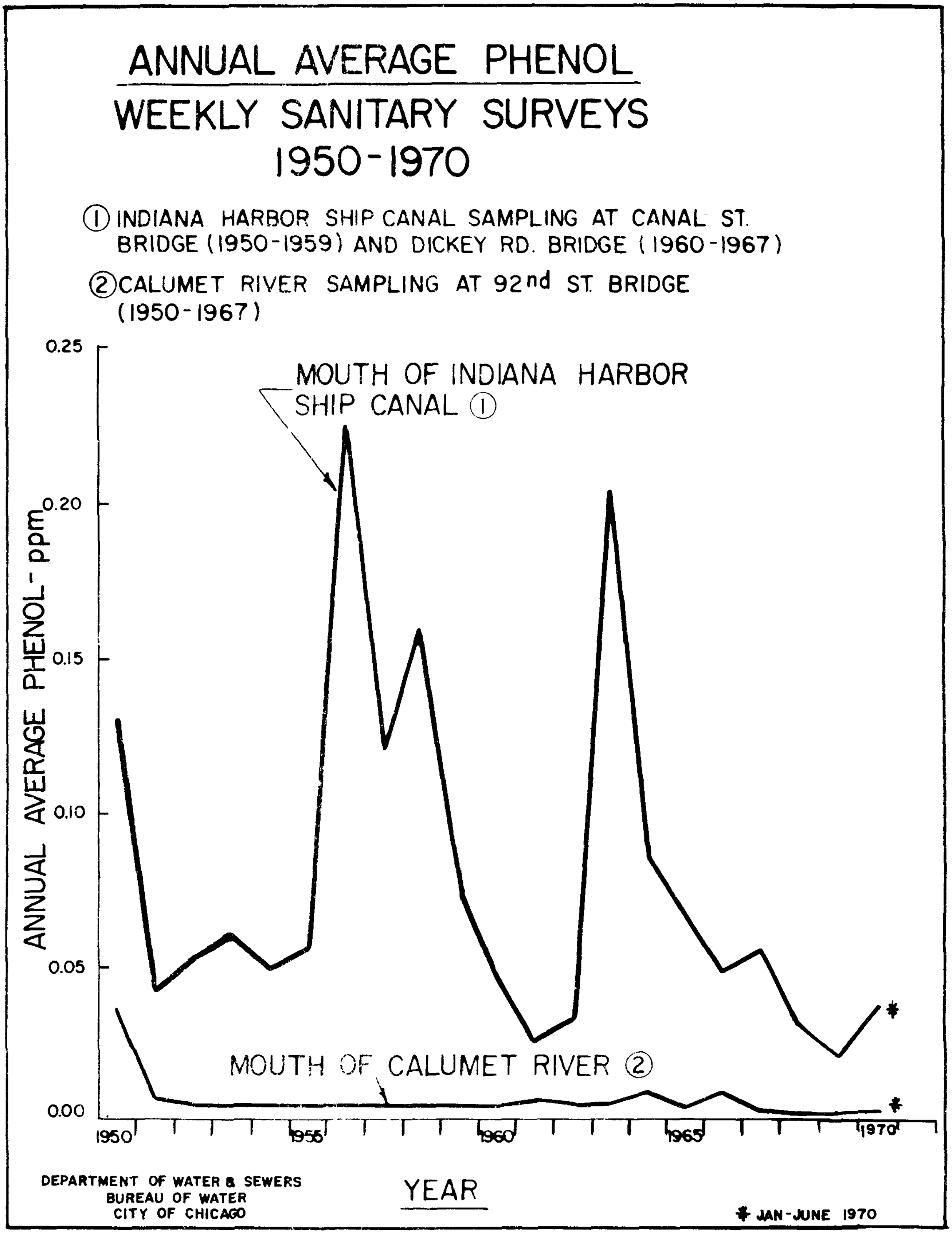

ANNUAL AVERAGE AMMONIA NITROGEN
WEEKLY SANITARY SURVEYS
1950-1970
7.46
5.94
5.0
4.0
3.0
2.0
1.0
0
ANNUAL AVERAGE NH3 NITROGEN - ppm
MOUTH OF INDIANA HARBOR
SHIP CANAL - DICKEY RD. BRIDGE
MOUTH OF CALUMET
RIVER - 92 nd ST. BRIDGE
1950
1955
1960
1965
1970
YEAR
DEPARTMENT OF WATER & SEWERS
BUREAU OF WATER
CITY OF CHICAGO
* JAN.- JUNE 1970

FIGURE 8



ANNUAL AVERAGE PHENOL
WEEKLY SANITARY SURVEYS
1950-1970
① INDIANA HARBOR SHIP CANAL SAMPLING AT CANAL ST. BRIDGE (1950-1959) AND DICKEY RD. BRIDGE (1960-1967)
② CALUMET RIVER SAMPLING AT 92nd ST. BRIDGE (1950-1967)
MOUTH OF INDIANA HARBOR SHIP CANAL ①
MOUTH OF CALUMET RIVER ②
ANNUAL AVERAGE PHENOL - ppm
0.25
0.20
0.15
0.10
0.05
0.00
1950
1955
1960
1965
1970
YEAR
DEPARTMENT OF WATER & SEWERS
BUREAU OF WATER
CITY OF CHICAGO
* JAN-JUNE 1970

FIGURE 9

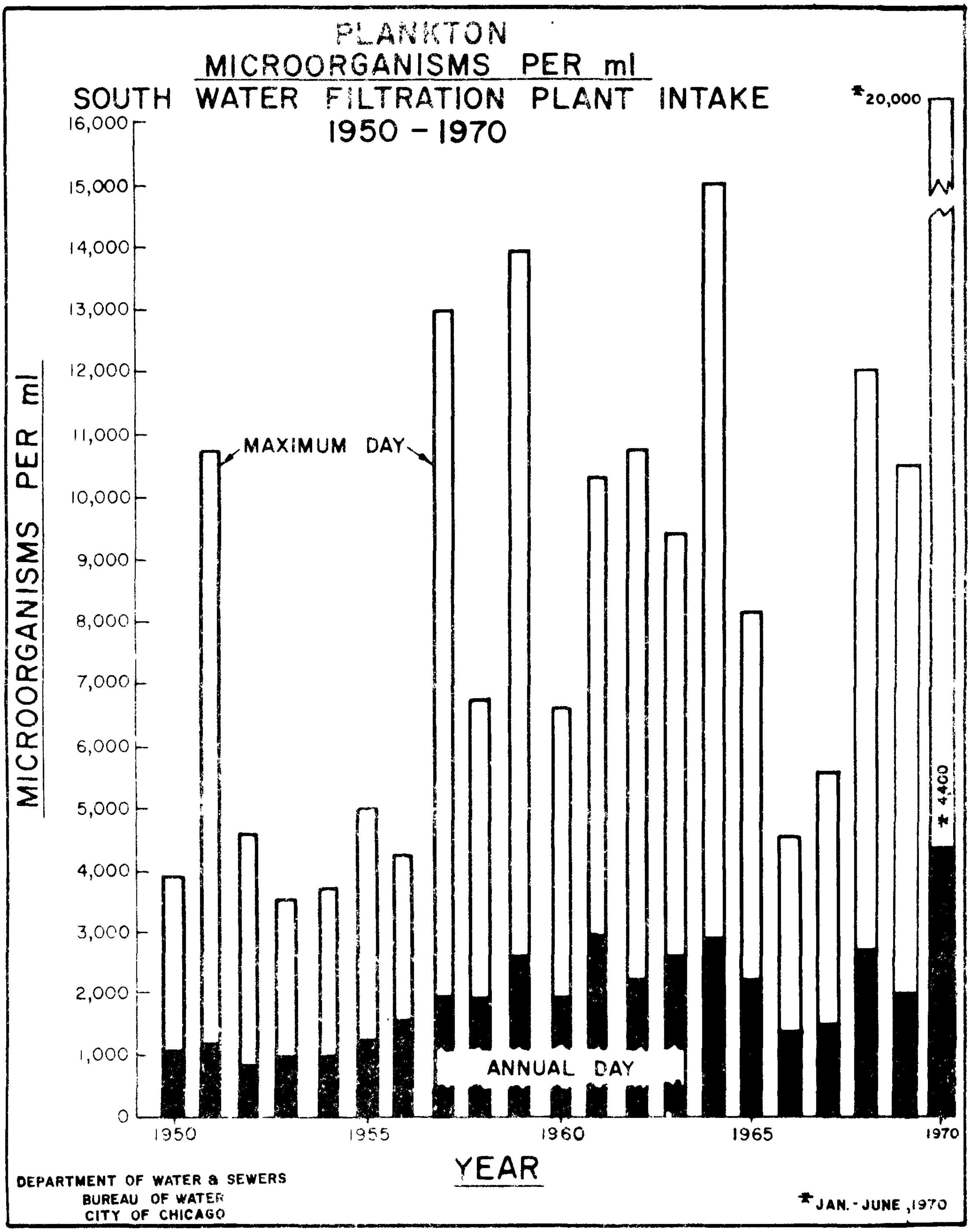

PLANKTON
MICROORGANISMS PER ml
SOUTH WATER FILTRATION PLANT INTAKE
1950 - 1970
*20,000
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
MICROORGANISMS PER ml
MAXIMUM DAY
ANNUAL DAY
* 4400
1950
1955
1960
1965
1970
YEAR
DEPARTMENT OF WATER & SEWERS
BUREAU OF WATER
CITY OF CHICAGO
*JAN. - JUNE ,1970

FIGURE 10

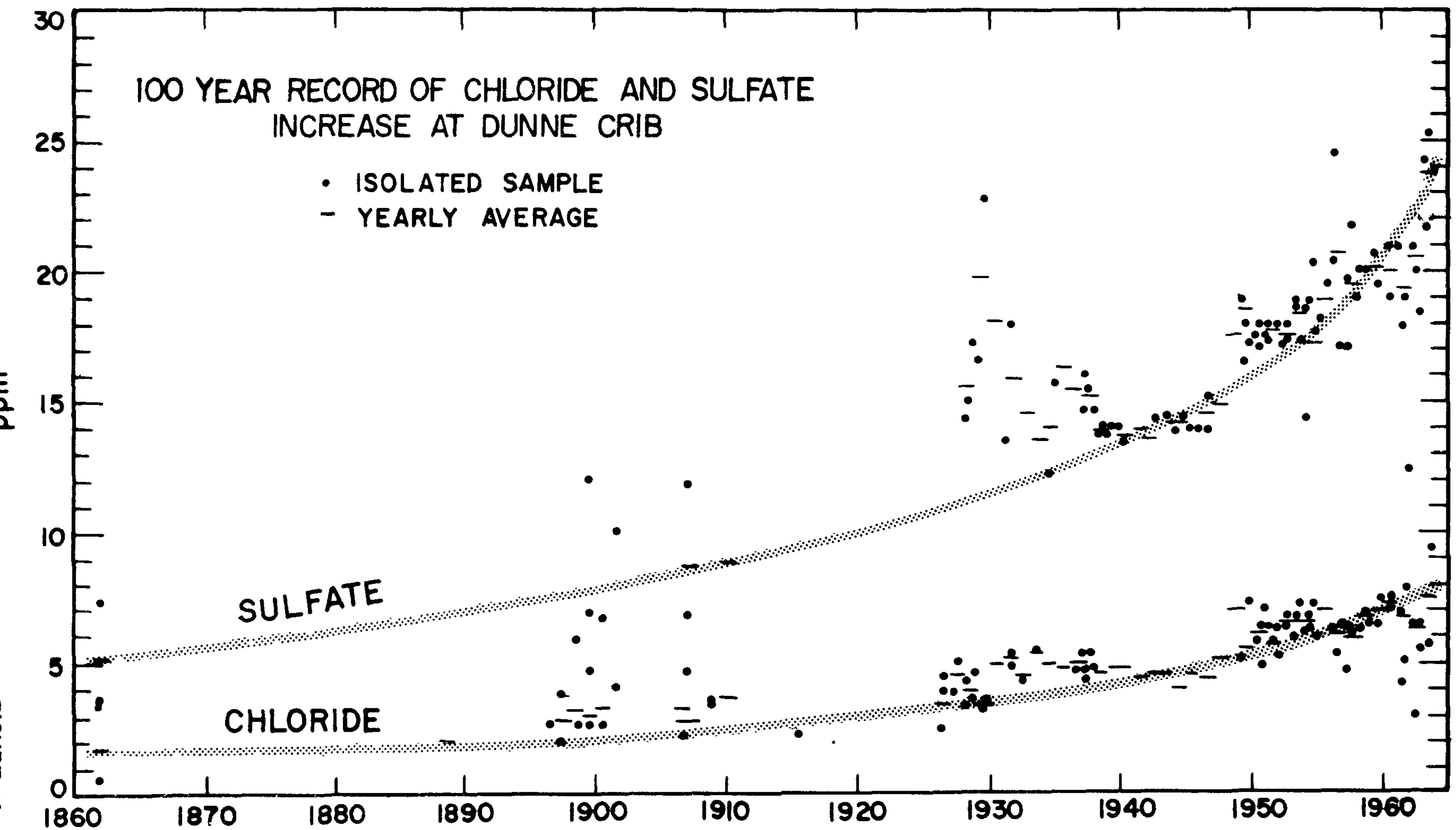

100 YEAR RECORD OF CHLORIDE AND SULFATE
INCREASE AT DUNNE CRIB
• ISOLATED SAMPLE
– YEARLY AVERAGE
SULFATE
CHLORIDE
ppm
30
25
20
15
10
5
0
1860
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960

FIGURE 11

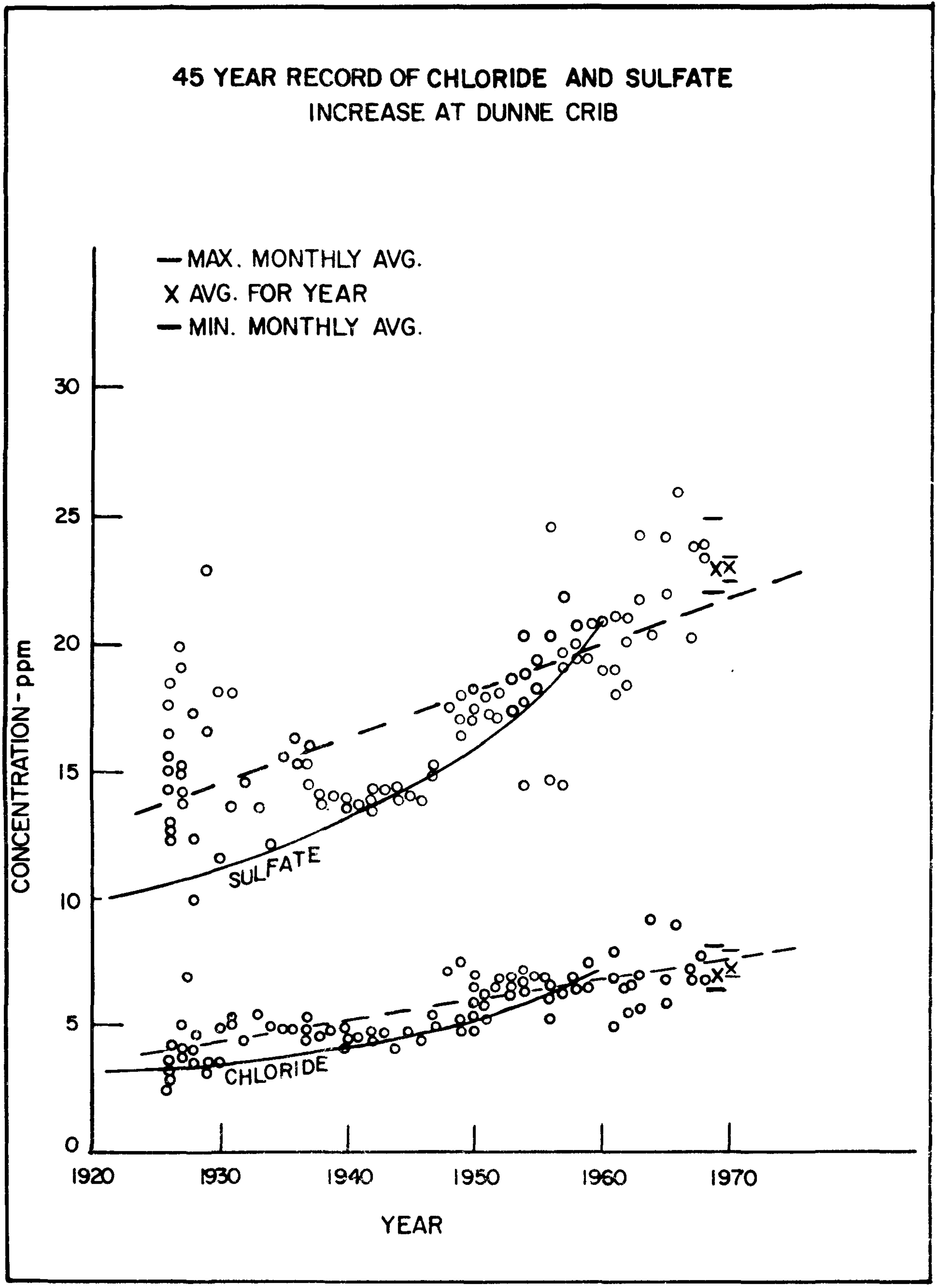

45 YEAR RECORD OF CHLORIDE AND SULFATE
INCREASE AT DUNNE CRIB
— MAX. MONTHLY AVG.
X AVG. FOR YEAR
— MIN. MONTHLY AVG.
CONCENTRATION - ppm
30
25
20
15
10
5
0
SULFATE
CHLORIDE
1920
1930
1940
1950
1960
1970
YEAR

FIGURE 12

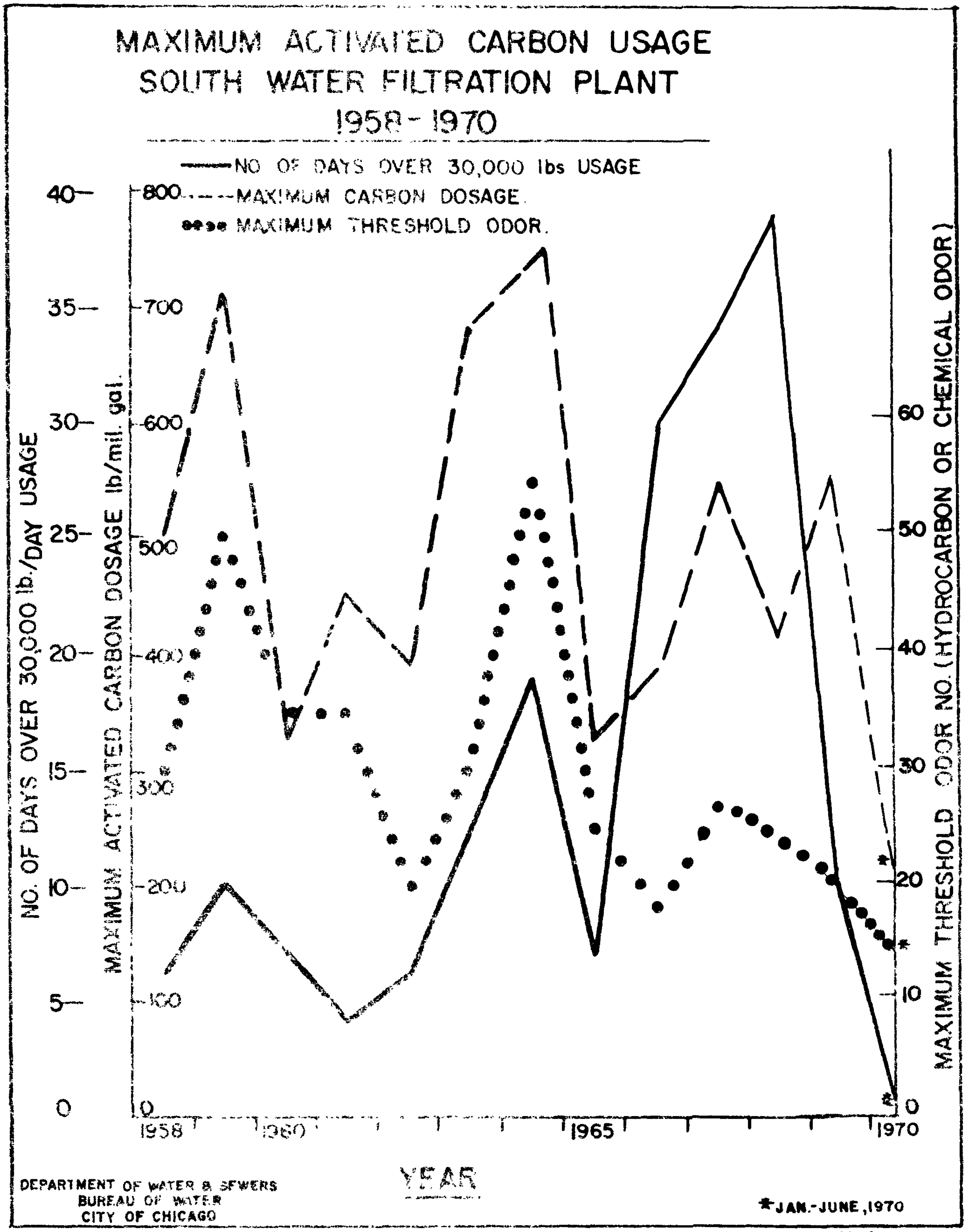

MAXIMUM ACTIVATED CARBON USAGE
SOUTH WATER FILTRATION PLANT
1958 - 1970
NO OF DAYS OVER 30,000 lbs USAGE
MAXIMUM CARBON DOSAGE
MAXIMUM THRESHOLD ODOR.
NO. OF DAYS OVER 30,000 lb./DAY USAGE
MAXIMUM ACTIVATED CARBON DOSAGE lb/mil. gal.
MAXIMUM THRESHOLD ODOR NO. (HYDROCARBON OR CHEMICAL ODOR)
0
5
10
15
20
25
30
35
40
0
100
200
300
400
500
600
700
800
10
20
30
40
50
60
1958
1960
1965
1970
YEAR
DEPARTMENT OF WATER & SEWERS
BUREAU OF WATER
CITY OF CHICAGO
*JAN.-JUNE, 1970

FIGURE 13

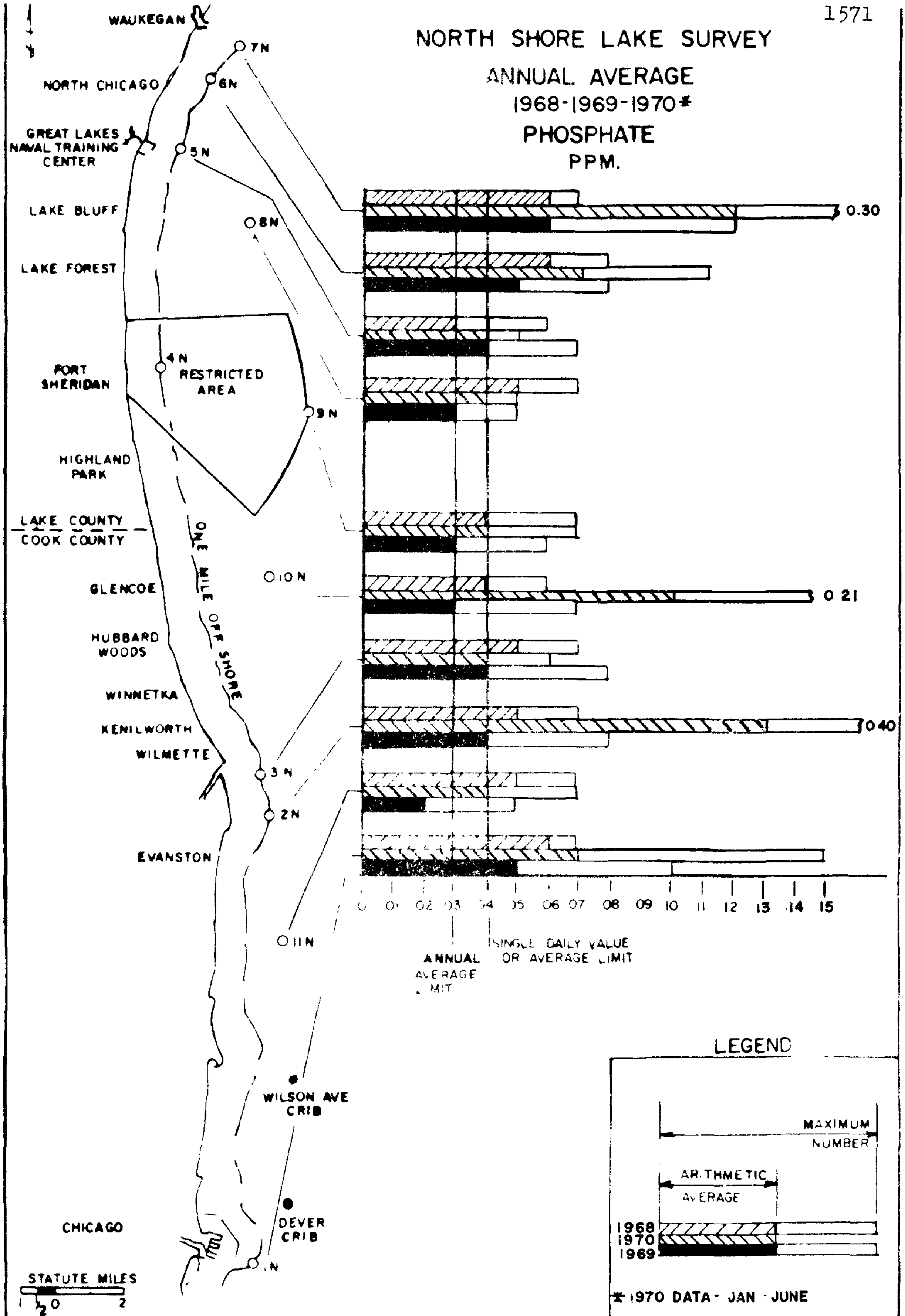


FIG. 14

WATER QUALITY SURVEILLANCE SECTION

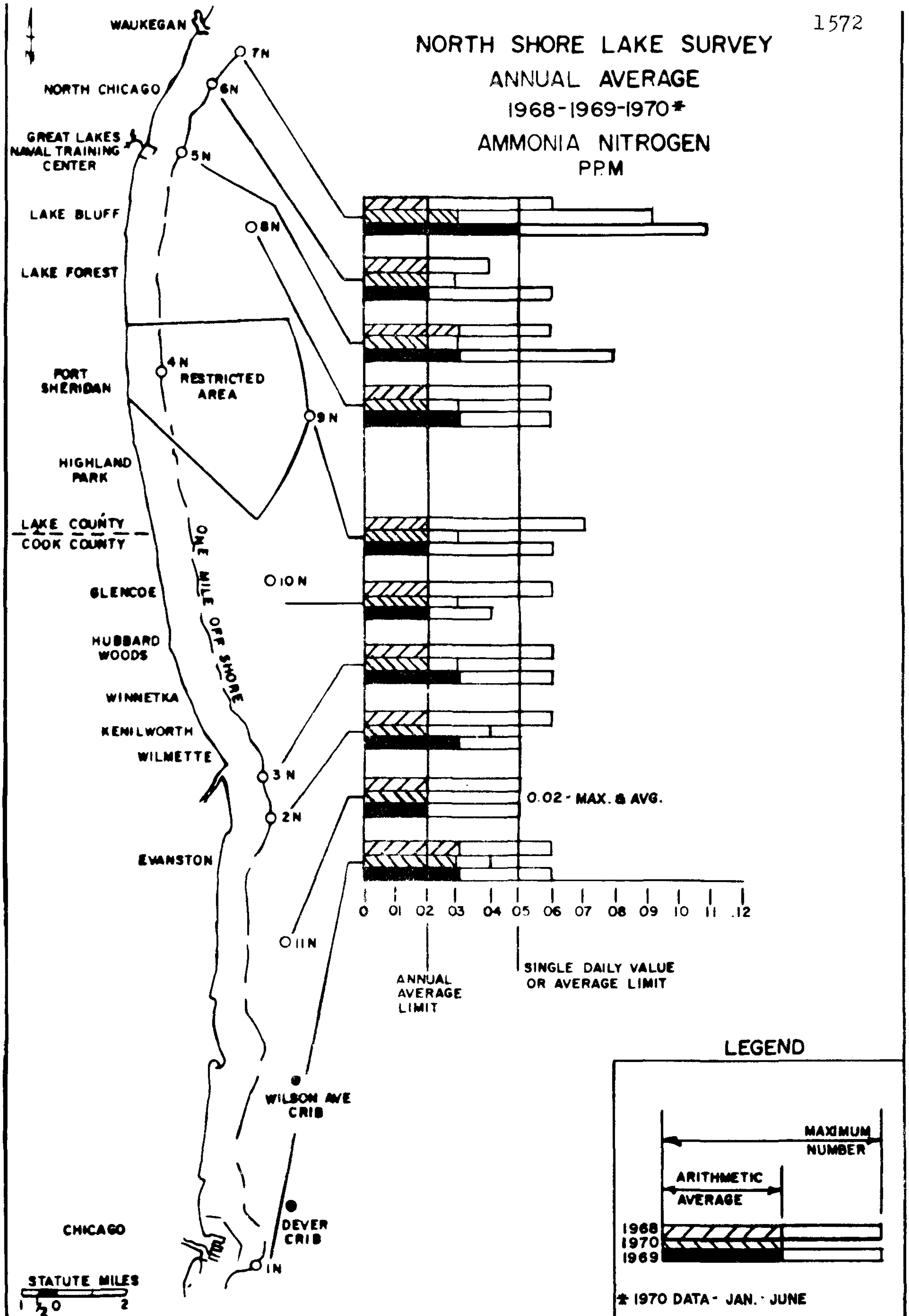
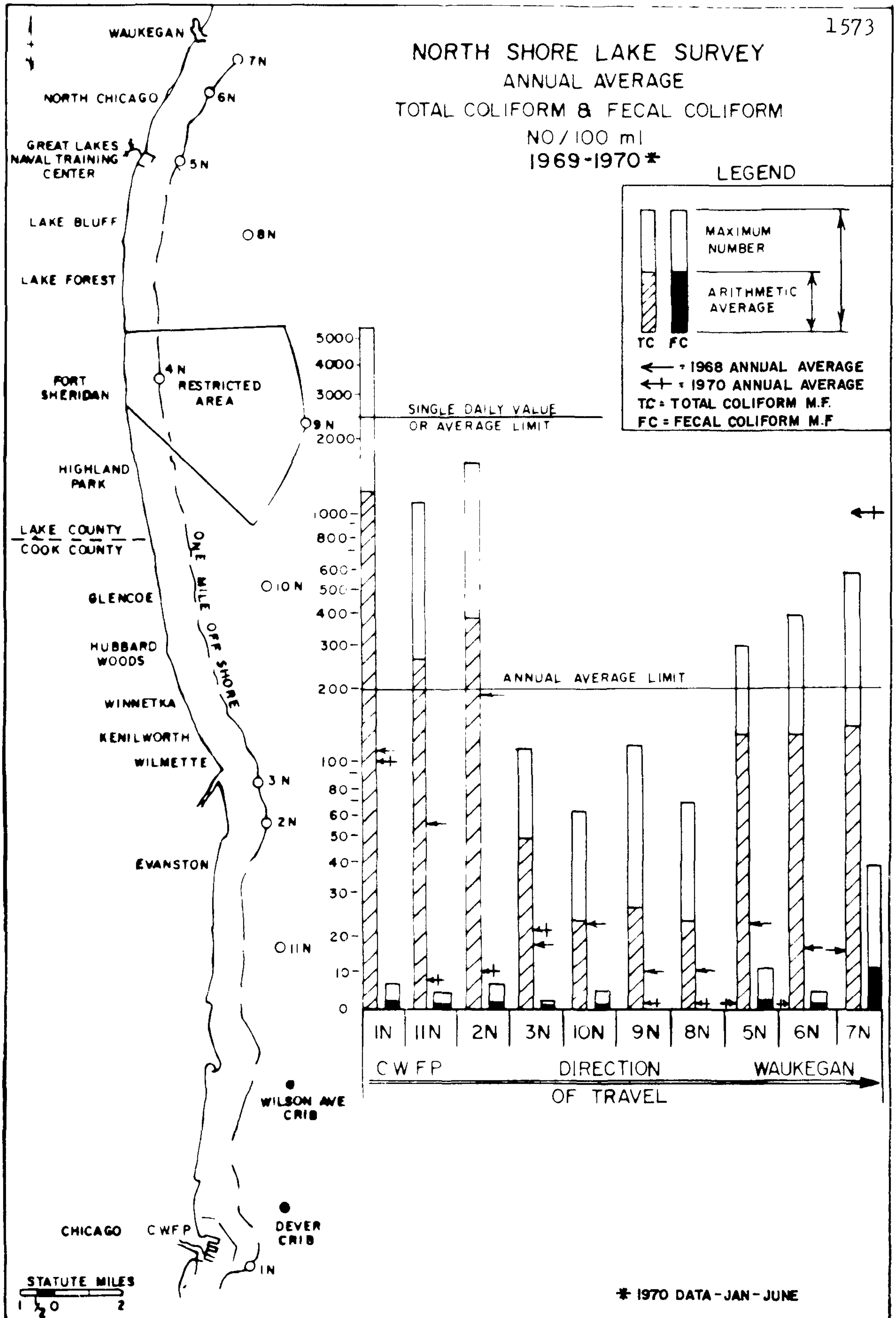


FIG. 15

WATER QUALITY SURVEILLANCE SECTION



GB FIG. 16

WATER QUALITY SURVEILLANCE SECTION

1574

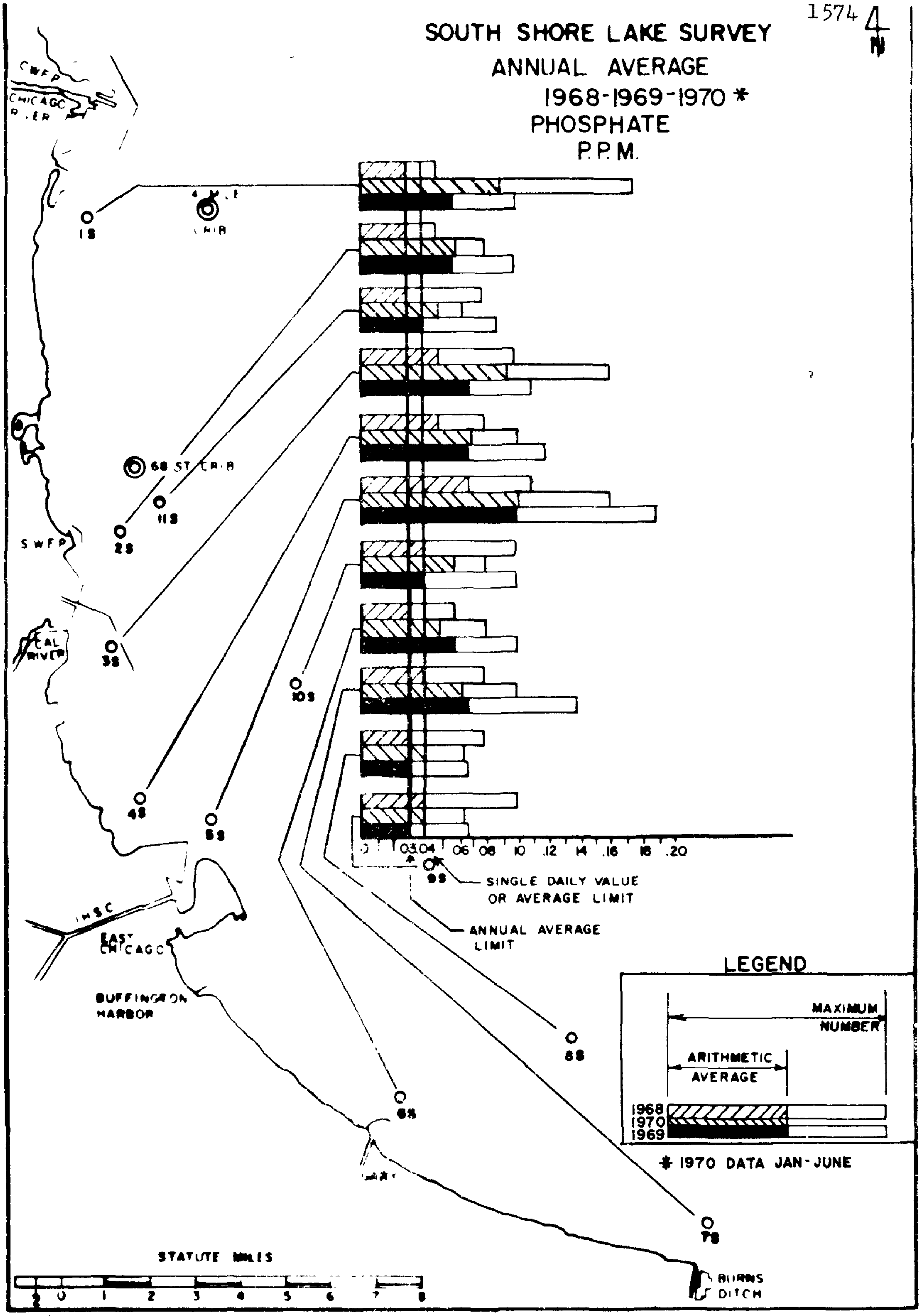


FIG.-17

WATER QUALITY SURVEILLANCE SECTION

these seven that exceeded the daily maximum occur in 1970? Do you know?

MR. VAUGHN: I will ask Mr. Reed who tabulated this material for me to answer that. His name appears on the front of the report.

MR. REED: I can't tell you offhand. I can send the data in to the conferees if you like.

MR. MILLER: Well, I was just curious as to whether there might be connection with the ice salt or ice control and runoff and this type of thing.

MR. REED: I don't believe so. They were a little later in the year than one would expect that to happen.

MR. MILLER: There certainly have been massive reductions of sulphate in Indiana.

MR. REED: Still the tests we run are daily and those averages are very stable and reliable and for that reason do indicate an undeniable increase.

MR. STEIN: Are there any -- yes, Mr. Currie.

MR. CURRIE: I think, Mr. Chairman, that the statement of Mr. Vaughn as well as that of Commissioner Poston suggests very strongly the desirability that this conference very soon address itself again to the question of phosphates.

J. C. Vaughn

I think that when we have a statement such as in Mr. Vaughn's presentation that concentrations of phosphate in the shallow waters are tending toward an equilibrium concentration which is well above the threshold concentration for nuisance algal growths, that we may be in serious trouble. I welcome the city of Chicago's attempt to deal with this problem. I would also like to report that the Illinois Pollution Control Board has before it at present a proposal to strengthen the phosphate standard of water quality for Lake Michigan from its present annual average value of 0.03 to 0.02 p.p.m., and I would also like to suggest that Mr. Dumelle, one of my colleagues on the Pollution Control Board, has a statement which he would like to make relevant to the subject of phosphate inputs to the lake, and I hope that he will have an opportunity to make that.

MR. STEIN: We will put him on right after Mr. Vaughn.

Are there any other comments or questions?

Mr. Vaughn, I would like to call your attention to page 7. I am going to say before I go into this question that we have indeed had a great service here by Mr. Vaughn, and before him by Mr. Burstein, in providing us with this information. All too often we have had remedial programs that we didn't know -- really in the detailed sense that we have had from Mr. Vaughn -- what the conditions of the water were before we started. After these millions of dollars worth of works went into effect we really didn't know whether we had an improvement or not.

I think Mr. Vaughn now, and Mr. Burstein through the years, as a watchdog provided for us this one area in which we have "before" and "after" result and really look at what we are having in water quality. I don't think there is any other situation like this. I say to Mr. Currie and some others that we should not despair on this, because the first few years that Mr. Vaughn gave us in this report I think were dismal indeed.

We have had the program going and we just couldn't see any improvement in water quality. Then we began to get a few glimmers. As Mr. Vaughn points out, in some areas we have a trend. But I thoroughly agree with you that when Jim Vaughn points up a danger signal it is time for the conferees to investigate and explore it.

But may I go back to page 7? You talk about chloride concentrations, sulfate concentrations, and filterable residue which increased. And what has happened? We presumably have more generous requirements for, say, the residue and the chlorides and you have had more violations.

Now, the question, I think, Mr. Vaughn -- I wonder if this is maybe a correlation between relaxing the requirement and your getting more violations of the relaxed requirement than you did of the more stringent requirement because once you relax it, people might think they can get by with a little more.

MR. VAUGHN: The Technical Advisory Committee that began with the -- they began with the old GLIRB Project. They spent many hours discussing whether they should stagger those results in chlorides from filterable residue,which is a direct reflection of the other two. And the consensus was that we should so stagger them because if we are going to increase anyway, we had no real reason for trying to set up standards that you couldn't enforce --because once it is above that level you are stuck with it whatever it is; they aren't going to take it out. And some of us felt that those relaxed standards -- staggered standards were really -- we always were constantly fighting the Drinking Water Standards, which would permit 250 parts per million or less and --

MR. STEIN: I would ask the Technical Committee and particularly the conferees to look at this. I take Mr. Vaughn's views seriously. We had some relatively rigid standards and they were violated a number of times. Not too many instances, but when the standards were relaxed, we had a much greater percentage of violations. Before considering relaxation of the standards now, I believe the Technical Committee and the conferees would be well advised to think very carefully of more than the technical defense of the regulatory program. They should be more concerned with the defense, or lack thereof, of the discharge itself, when it automatically would not deteriorate the water quality much more than you would do with your relaxation.

I think that is a very interesting observation, Mr. Vaughn.

MR. MILLER: I would like to respond a little bit to that, Mr. Chairman, in that I served on the Technical Committee that developed those standards, I don't think that -- at least to me -- the term "relaxed" is the right terminology, in that these standards were designed, based upon curves, to take into account the increases that are going to continue to occur. So that, as far as application to a discharger, there has been no relaxation to the one who is discharging; that these standards were to take into account naturally-occurring increases into play.

MR. PURDY: The only comment I have, Mr. Chairman, is that I think we would be leaving the wrong impression if we left the impression that we would have expected to have seen a change in phosphate concentration at this point in time.

The program that has been developed by this conference has not really unfolded, and I would have been extremely surprised to have seen a change.

MR. STEIN: I think that is a good point.

Our phosphate reduction date is set for the end of 1972.*

Again, I am not sure, once the phosphates are in the lake, they are going to be in the ecocycle and the ecosystem. Unless they find the abyss of Lake Michigan -- if there is one, and I guess there might be -- and it is so far buried, they are not going to come out, and that is going to take a little time. So I think Mr. Purdy's statement is very pertinent concerning the notion that until the phosphate reduction programs go into full effect, we probably can expect an increase in the phosphate loading of the lake.

*By December 1972 - See Lake Michigan Summary of Conference (First Session), dated January 31, February 1-2, February 5-7, March 7-8 and 12, 1968.

J. C. Vaughn

I think possibly -- I will just put this out -- maybe the significance is that with the kinds of loadings we are having of phosphates now, that the rate of increase might be a little more significant or a little more alarming than we have considered. But, again, I would think that the Technical Committee and the group will have to consider this rather closely. I would suggest, again, at least one of the things in addition to the thermal considerations that we are talking about, I think if the conferees are agreeable, we can discuss Mr. Currie's proposal of how we deal with the nutrient problem and particularly the phosphate question and see if there is time for a reappraisal.

MR. CURRIE: Mr. Chairman.

Two additional points: I have great difficulty in reconciling the increasing concentrations of dissolved solids which are permitted by the current regulations with the nondegradation principle which is incorporated in all of the standards. Secondly, with regard to phosphate dates, I quite agree that the current date for doing anything about our most serious Lake Michigan problem is set too far in the future. For that reason, I have suggested in a letter which I sent to the members of the conference before it began that the conference consider accelerating the date of phosphorus removal from 1972 to 1971.

MR. STEIN: We will be happy to take that up.

You know that as in all bodies like this some people are for moving faster and some for moving more slowly. I think that was the most equitable agreement we could get when we arrived at that determination, but we will be glad to reopen that question if you wish.

MR. PURDY: Again, Mr. Chairman, I would hate to leave the impression that we have set 1972 as a date at which phosphorus treatment is to come into effect, without having it also understood that this conference set this as an outside date and that there are facilities that will be coming into play yet this year, and so this is an outside date and not a date at which time no progress will be made prior to it.

MR. STEIN: That is correct.

Are there any other comments?

MR. FRANGOS: Mr. Chairman, I just have three questions to ask of Mr. Vaughn, and if he doesn't have the data with him maybe he could give it to us a little later.

But the first: At what depths are the intakes from which the phosphorus analyses are made?

MR. VAUGHN: The South Plant, from which most of the phosphorus analyses are taken has two intakes: one is the crib, at a depth of some 35 feet in the water, the center line of the gates are 17 feet below datum*-- Chicago datum, and the shore intake has a center line of about minus 22 feet. Since we use varying quantities of shore and greater, according to the daily demand, it was decided in the Technical Advisory Committee that when we made a control point that the header which represents a varying mixture of the crib and shore waters, of which the percentage of each is not easily determinable, that we would use the header sample, so those are the official phosphate values.

At the Central Plant, we have the shore intake only and, again, the central line of the shore gate is about 18 feet below datum.

MR. FRANGOS: What would be the average height? I was trying to get a feel of how close you are to the bottom.

MR. VAUGHN: Well, at the crib intake we are roughly 17 -- the bottom line of the gate would be about 14 feet above bottom of the crib, and at the shore end gate, that is only about 2 feet above water.

MR. FRANGOS: Well, you have answered the second question I had already. But the other one, then: Have you done any sampling in the upper zones at all?

*Basic lake level

MR. VAUGHN: We have not had the time or the manpower to sample at varying depths. I believe we consistently sample 5 feet below the surface when we make surveys.

MR. FETTEROLF: I would like to ask either you or Mr. Willey whether the figure -- your figure 14 is for soluble orthophosphate as PO_4.

MR. VAUGHN: Mr. Reed can answer that. He prepared the data for us.

MR. REED: It is an easy one. Yes.

MR. STEIN: Are there any other comments or questions?

Mr. Nelle, did you want to ask a question?

MR. NELLE: Could I, Mr. Chairman? I have been pretty quiet here. I too served on this committee to develop the standards and, as I recall, the information relative to the presence of phosphorus in the lake 5 years ago was rather sparse and unless a lot more information is gotten we have as much as 20 and 30 times the difference in certain areas in Lake Michigan in phosphorus. I don't think it is a simple problem, and if you stop phosphorus today, it is very possible there will be phosphorus there for a long sustained period and floating all over the lake.

So let's don't think of

it as a constant amount spread out through the lake or even existing in various quarters. I think we have a problem just like this thermal water problem, so let's don't make it too simple and think that somebody can come up with an answer right now.

MR. STEIN: If we made these problems too simple, Mr. Nelle, they wouldn't need people like us.

Mr. Dumelle.

MR. DUMELLE: I thought as long as we were talking mercury I would like to make a few comments on it. As I understood Mr. Willey -- and I stand corrected if I am wrong -- he said that most of the values on the testing of Lake Michigan were below a tenth of a part per billion. And this is at variance with the Federal tests which were conducted while I was Director of the Lake Michigan Basin Office. There most of the values seemed to fall below 1 p.p.b.,including the last date I looked at before I left there at the end of July.

So from that, I deduced that this was probably the background level, at least for the Illinois portion of Lake Michigan, and this incidentally included a lot of data from Wisconsin and Michigan from the water intakes, and the average seemed to fall below about 1 p.p.b.

So based on that, we have proposed a mercury standard of 1 p.p.b. feeling that this is the background level which you alluded to, Mr. Stein, and also an effluent standard of 1 p.p.b., so that no one would add anything to the water he was using from the lake. So all I am saying is that I would like to have the Federal data entered in the record about flameless AA so that we could all know whether we are talking the same.

MR. STEIN: I would like to ask: Mr. Dumelle, are you saying that the water the plants take in from Lake Michigan contain 1 p.p.b. mercury in them now?

MR. DUMELLE: Or less. I say we had some values of -- as I recall it -- 1.0 or 1.4.

MR. STEIN: I want to get with you on this. Also I think while we are here we might resolve it. But here is the theory we are using: we check the water intake of the various plants, then we check the discharge water, and then we check the mercury content at both ends. We don't want to charge any plant with a discharge of mercury which they have taken in with their intake water. But we have found that with the addition of relatively small amounts of mercury when multiplied by the effluent flow results in substantial amounts of mercury being deposited. We have found that these have increased. To our dismay and surprise, even when there are very small amounts going in, they have

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been concentrated in the fish, which concentrate mercury at a rate of about 3,000 to 1. As you get older fish and bigger fish, we find surprising concentrations in fish roes.

Really when we have dealt with the gross mercury problem, I think we are pretty well on our way to pushing that back now. So I think it behooves us, if we are talking in terms of a definitive program and future control of mercury, we have to think whether there is going to be any tolerable limit, that is, any tolerable limit over what a plant has taken in in its intake water. I don't know whether you people have thought about that, but this is the problem we are wrestling with now.

Let me repeat this very, very fast. I think we can get a plant and from their large amount of mercury discharges, we are down now to 1/2 lb. per day. I can see within the next 2 or 3 months we will have these plants down below 1/4 lb. per day.

Now, what we do with that last 1/4 lb. or what requirement we have with that is going to be the crux of our decisions for the long haul on mercury. And I wonder if you people in Illinois and other States can think this through with us, because I think this is going to be a very difficult problem and one we are going to have to make a decision on in the relatively near future.

MR. DUMELLE: I might say we are having these hearings on the proposed mercury standards on October 8 in Springfield and October 14 in Chicago, and any of the conferees would be welcome to attend or to send observers. We have also asked through Commissioner Dominick that perhaps you could furnish from your staff Mr. Sidio or someone else who is conversant with the mercury situation.

But the point I am trying to make is: I think there is a difference here as to what is the background level in Lake Michigan. We are in agreement that we ought to hold the level at background, and if the background is coming from air pollution and the burning of fossil fuels that is another problem that we will have to get at, too. But I think we are agreed on that, but we want to know what that is.

MR. FETTEROLF: Mr. Dumelle, I am not sure what form of mercury you would be wanting to set your standards on, and I am not sure that Mr. Sidio would be aware of data recently developed by Dr. Mount in his laboratory at Duluth which shows that for metal mercury a half a part per billion in the water is toxic to minnows in from 30 to 40 days, so I think you might ask Dr. Mount to participate in your public hearings if he has any information.

MR. DUMELLE: We would be very glad to.

MR. STEIN: May I make a suggestion to the State people? The best way to do this, I think, is to get in touch with the Regional Director Mr. Mayo, and you will get in touch with the appropriate people, and we will give you what support we can.

MR. DUMELLE: We have kept him informed, Mr. Stein.

MR. STEIN: Thank you.

MR. DUMELLE: One other comment, and that is I appreciate Mr. Vaughn's data, but I know the Lake Michigan Basin Office also conducts a Calumet area sampling program and sampled many in June of this year and has material going back for the last few years, and I would ask that that be incorporated into the record.

MR. STEIN: Could that be made available to us?

MR. VAUGHN: The Lake Michigan Basin?

MR. STEIN: Yes.

Jake, would you come up?

MR. DUMELLE: I am sorry.

MR. STEIN: Does he have this material you are asking for?

MR. DUMELLE: No, I don't think you would have it. I think it would have to come from the Lake Michigan Basin Office unless they have interchanged it.

MR. MAYO: Would you be a little more specific about which data you want introduced here?

MR. DUMELLE: On the water quality data on Lake Michigan somewhat comparable to Mr. Vaughn's data; whatever is out in that area from the regular sampling program at the basin office. Mr. Bowden has conducted this program, and we recently cut it back because of the limitations of when I was there -- limitations of manpower -- to a June and January sampling -- but it had been going on weekly as I recall it.

MR. STEIN: Do you have that?

MR. BOWDEN: I am Robert V. Bowden. I am with the FWQA Lake Michigan Basin Office.

The data that Mr. Dumelle is referring to has --

MR. STEIN: Will you talk up, sir?

MR. BOWDEN: The data that Mr. Dumelle referred to has been used as the basis for a report to the Two-State Conference in the Calumet area, and it has been prepared by a technical committee appointed by that conference for presentation to that conference.

If it is desirable that that data be placed on the record at this conference, it is available and can be made available within a short period of time.

MR. STEIN: How thick is it?

MR. BOWDEN: The report, I believe --

MR. STEIN: The data. How many pages would it encompass?

MR. BOWDEN: The raw data would be quite voluminous.

MR. STEIN: Let's say this, for the time being: We will keep that data as an exhibit and as part of the record, and it will be made available to Mr. Dumelle for his inspection and the other conferees, and after looking at that if you still want this in the record or a subsequent record, I think we should examine that before we give the green light because of the printing cost.

(The above mentioned data, marked Exhibit 2, is on file at Hq FWQA, Washington D. C., and the Great Lakes Regional Office, Chicago, Illinois.)

Thank you very much.

MR. WILLEY: Speaking to Mr. Dumelle's comment relative to the 1 part per billion or the one-tenth of a part per billion analytical data or background, I think that we were at the 1 part per billion point at one time, too. Whether that is decided as background, this is something other than an analytical problem. We faced it as an analytical problem and we watched, as I pointed out, half a part per billion was the point that we set as our limit. We could say it would be below that point. We can clearly state that it is below a tenth of a part per billion now because on samples, some standards on waters which we have run that would run 0.15 or 0.18, we can detect this verv readily now, and so we are reporting our results as 1/10 as the base limit of our analytical accuracy.

One of the ways we did this, by the way, is to increase the length of the tube through which the gas passes, and this increases the accuracy somewhat. There might be one other aside that I might mention, just as a sort of a favor. We checked a couple of swimming pools and the organo-mercury compound used in swimming pools. We got a report on one that was 18 parts per billion. So somebody might do something about that some day. It is not in our area of activities.

MR. STEIN: Mr. Dumelle.

MR. DUMELLE: I think we are still confused here. I have no quarrel with the tenth of a part per billion as a sensitivity level. What I am asking Mr. Willey is what is his background level that he is finding in Lake Michigan water.

MR. STEIN: I understand this. By the way, let me make clear to the group and the audience: We are dealing with what in a regulatory program is one of the most difficult problems we have, and that is the question of zero tolerance. I don't know that we are going to resolve that with mercury or any other item that we run into here, and this is another subject in itself. If you want to talk to me privately, I will be glad to give you the theoretical problems we have with the zero tolerance, but this is common to all regulatory programs when we get down to one of these very low limits, and I suggest we leave that at this conference at this point.

Are there any other questions for Mr. Vaughn? If not, thank you very much.

Did you want to make a statement, Mr. Dumelle, now?

MR. DUMELLE: Yes.

MR. STEIN: How long will that be?

MR. DUMELLE: Five minutes. I won't read the paper and, of course, I would like it included in the record, Mr. Stein.

MR. STEIN: Without objection, this will be done.

(The document above referred to follows in its entirety.)

STATEMENT BY JACOB D. DUMELLE
MEMBER, ILLINOIS POLLUTION
CONTROL BOARD

to the

LAKE MICHIGAN ENFORCEMENT CONFERENCE
September 28 - October 2, 1970, Chicago, Illinois

My main point in speaking to the Conference is to assert that published phosphate loadings into Lake Michigan are probably far too low and that a greater proportion of phosphate is being generated from land runoff than has been realized.

Two ways exist to indicate that phosphate loadings have been underestimated. First, is the comparison of Lake Michigan data to Lake Erie data. Second, is the use of Vollenweider's charts of "admissible" and "dangerous" levels of phosphorus loadings to lakes.

Lake Erie Comparison

Using the International Joint Commission report on Lake Erie (Vol. 2) of June, 1969 a total of 6,740 tons of phosphorus (P) is generated annually from 29,650 sq. miles of land (p. 260). Converting to phosphate, the gross land runoff for Lake Erie is 1,365 lbs./sq. mi. annually.

For Lake Michigan, using the 5,000,000 lbs. of phosphate (PO_4) said to be generated by land runoff annually (Proceedings, Lake Michigan Conference, Vol. 2, February 1, 1968, p. 703) and the 45,500 sq. mi. of land area, results in a comparative phosphate runoff of 110 lbs./sq. mi. per year or one-twelfth of the Lake Erie figure.

I do not have available to me a detailed breakdown of these gross land areas by agriculture, forest and urban uses but the 12.4:1 difference in phosphate runoff rates seems far too great.

-more-

And since the IJC report is the later of the two estimates and a great deal of work went into the Lake Erie phosphate figures I feel that it is more reliable than the Lake Michigan figures.

If the Lake Erie gross land runoff figure of 1,365 lbs./sq. mi. is applied to Lake Michigan's larger drainage area, then 62,100,000 lbs. of phosphate are generated from this source annually. Adding this to the 10,000,000 lbs./yr. from municipal treatment plants results in a total estimated annual phosphate loading to Lake Michigan of 72,100,000 lbs./yr. The 72,100,000 lbs./yr. of phosphate is 4.8 times the published 15,000,000 lbs./yr. phosphate figure for Lake Michigan.

Analysis of Vollenweider Chart

The IJC report reproduces Vollenweider's chart of "admissible" and "dangerous" limits of phosphorus loading to lakes (p. 241). Using Lake Michigan's mean depth of 84.2 meters the chart gives "admissible" loadings of 0.36 g/m^2 yr. and "dangerous" loadings of 0.7 g/m^2 yr. The chart is reproduced and attached.

Using Lake Michigan's area of 5.82×10^{10} m^2 and converting the 15,000,000 lbs. of phosphate estimated input per year to phosphorus (2.27×10^9 g) a supposed annual loading of 0.039 g/m^2 yr. is occurring. This loading is only 11% of the "admissible" level from Vollenweider's chart and would indicate that Lake Michigan is in no danger from eutrophication caused by phosphorus.

Dr. A.F. Bartsch, head of the FWQA National Eutrophication Research Program, has termed eutrophication Lake Michigan's "most pressing problem" (1968 Proceedings, pp. 737-738). His opinion would be completely at variance with conclusions to be drawn from Vollenweider's chart.

The new Federal report "Physical and Ecological Effects of Waste Heat on Lake Michigan" quotes Schelske and Stoermer (pp. 79-80) as stating

> "The evidence compared with data from Lake Erie and Lake Superior suggests that accelerated eutrophication in Lake Michigan is rapidly approaching the point of a severe environmental change in which the diatom flora will be reduced or replaced by green and blue-green algae."

It seems obvious that the estimated phosphorus input to Lake Michigan as previously published (5,000,000 lbs. per year as phosphorus or 15,000,000 lbs. per year as phosphate) is far too low. If the loadings were in fact only 11% of "admissible" loadings these authorities cited would not be sounding alarms about eutrophication and delineating physical changes which are taking place. Furthermore, the conference program of 80% phosphorus removal from municipal treatment plants would not be necessary.

Revised Estimate of Phosphorus Loading

If the "dangerous" level as indicated by Vollenweider for Lake Michigan is used, a revised estimate of phosphorus loading can be computed. Using this level (0.7 g/m^2 yr.) and multiplying by Lake Michigan's area of 5.82×10^{10} m^2 results in a phosphorus loading of 4.07×10^{10} g/yr. This is equal to 89,800,000 lbs. of phosphorus per year or almost 18 times the old figure of 5,000,000 lbs./yr. As phosphate, the figures would be three times higher or 269,400,000 lbs. per year compared to the old figure of 15,000,000 lbs./yr.

If the municipal contribution of phosphate is correct at the old level of 10,000,000 lbs. per year, then the balance, 259,400,000 is the land runoff figure. Put another way, the municipal-to-land ratio of phosphate contributions changes from 2:1 (10 million lbs./yr. : 5 million lbs./yr.) to 1:25.9 (10 million lbs./yr.: 259 million lbs./yr). These figures indicate that the critical factor in saving Lake Michigan will be control of land runoff.

Possible Defects in Revised Estimate

The figures estimated above are extremely high and almost double those of Lake Erie's estimated 154,000,000 lbs./yr. input of phosphate (IJC, p. 205). The revised estimate may be too high because:

a.) Vollenweider's "dangerous" level may not apply to Lake Michigan because of its extremely long flushing rate.

b.) The inshore water in which the phosphorus is added, may function largely as a body of water separate from the open waters (those beyond 100 ft. in depth and generally more than 3 miles from shore). Eutrophication may be occurring in

the limited volume of the
inshore waters (4% of the
lake) at loadings below the
"dangerous" level for the
entire lake but at or above
it in this separate zone.

Recommendation

It is recommended that the conferees set up a technical committee to thoroughly review phosphate inputs to Lake Michigan and to report back by January 1, 1971 with their best estimate of the source and amount of phosphate. The methods and techniques used in compiling these same types of data for the International Joint Commission's report on Lake Erie should be examined.

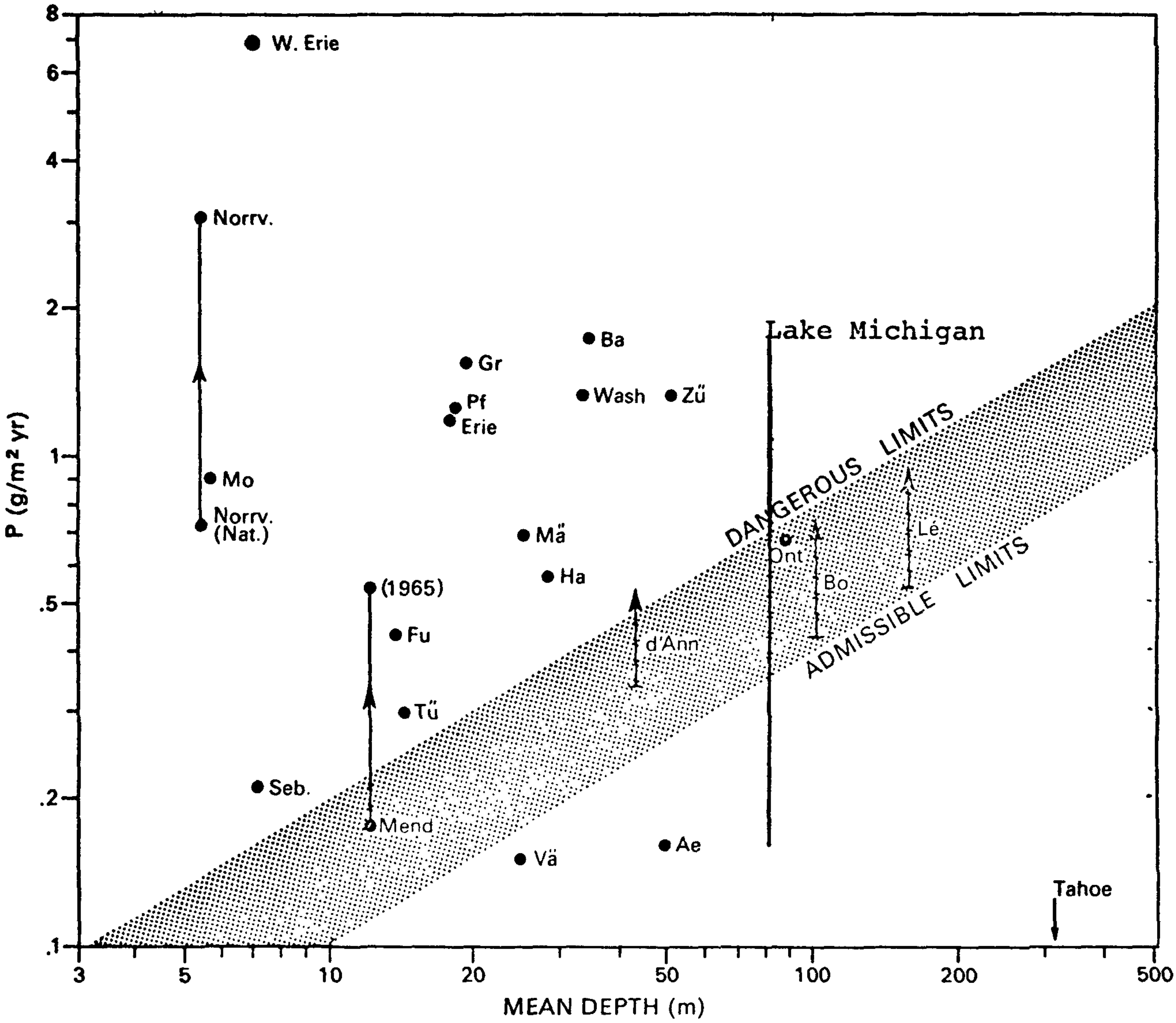

Fig. 3. 3. 1 Phosphorus loading *versus* mean depth for various lakes.

Abbreviations: Ae (Aegerisee), Ba (Baldeggersee), Bo (Bodensee, Obersee), d'Ann (Annecy), Fu (Furesø), Gr (Greifensee), Ha (Hallwilersee), Lé (Léman), Mä (Mälaren), Mend (Mendota), Mo (Monona), Norrv (Norrviken), Ont (Ontario), Pf (Pfäffikersee), Seb (Sebasticook), Tü (Türlersee), W. Erie (western basin, Lake Erie), Wash (Washington), Vä (Vänern), Zü (Zürichsee). The value for Bodensee is twice the value for orthophosphate-P (After Vollenweider, 1968).

STATEMENT OF JACOB D. DUMELLE, MEMBER,
ILLINOIS POLLUTION CONTROL BOARD,
CHICAGO, ILLINOIS

MR. DUMELLE: It seems to me that if the major problem of Lake Michigan is eutrophication, and if the major solution to this problem is phosphate that we ought to keep a continuing surveillance on the phosphate inputs to Lake Michigan, and so while I was Director of the Lake Michigan Basin Office, I took a look at the inputs and came up with these discrepancies which I put down here. I have put all of the numbers down so that anyone can check my arithmetic, and that is another reason for not reading them off.

But just to summarize, if we take the Lake Erie data in terms of land runoff phosphates, as reported in the International Joint Commission Report,and convert that to pounds per square mile, and do the same thing for Lake Erie -- excuse me -- Lake Michigan on the basis of the figures previously announced at this conference, we come up with a difference of 12.4:1. In other words, Lake Erie's runoff figure is 12.4 times that of Lake Michigan on a gross basis.

J. D. Dumelle

I realize probably more of Lake Michigan's Basin is forested than the Lake Erie Basin and this may make a difference, but it just doesn't seem to me it ought to be 12.4 times different.

And I go through the computation and show that when you add municipal contribution, the total loading then to Lake Michigan could be 4.8 times what we thought it was. And then I do the same thing using Vollenweider's Chart which is in the IJC Report and which is attached to my paper, and under the assumption which can be questioned, but under the assumption that Lake Michigan is receiving a dangerous input of total phosphorus. If you look at the chart which is attached you will see I have drawn in a line at the 84.2 meter level which is the average depth of Lake Michigan, and somewhere along this line is whatever total phosphorus is going into Lake Michigan.

I take the intercept at the top of the shaded band and, as you can see, that is .7 grams per square meter per year. Incidentally, right next to it you can see Lake Ontario, that little dot there, which is in the mesotrophic zone. The upper zone, where you can see the dots for Lake Erie and the West Basin of Lake Erie are the eutrophic zones and the bottom zone where Lake Tahoe is indicated are the oligotrophic zones.

J. D. Dumelle

Somewhere along that line must be Lake Michigan, and if we take the .7 and take that postulate that Lake Michigan is getting a dangerous input of the phosphates and we work through the numbers, we come up with a very, very large amount of total phosphate to Lake Michigan, something in the order of 25.9 times what we thought it was.

All I am saying is that somewhere between the 4.8 and the 25.9 is probably the right figure and you can argue that you know it really doesn't matter what the number is, the algae are responding to it, whatever is coming in. But I think it is very important as far as this conference is concerned because if land runoff is contributing much more than we thought, perhaps we are chasing the wrong source of pollutants in our priority order and maybe in a sense we are doing what they did in Los Angeles where they tried to suppress sulphur dioxide from the refineries only to find out it was the automobiles and was an entirely different chemical equation.

In a sense, we may be going after the wrong source faster and leaving the other one alone. So what I am suggesting is that the conference set up a eutrophication committee to look at these numbers and to look at all of the monitoring data on the tributaries, and to either verify or come up with a better figure so we can be guided in our control measures. There are some reasons perhaps why Lake Michigan does not respond the way Vollenweider says, and perhaps this goes back to the difference between the inshore waters and the offshore waters. I mentioned this in the paper, but I really don't know where we are on it. I think it is confused enough that it would permit a great deal of attention.

MR. STEIN: Thank you, Mr. Dumelle.

I think you raised these questions when we started out with our discussions on phosphorus control. Like zero tolerance, when you get down to that point you start defining these things. Then I guess we have this second problem you raise, which is indigenous to whatever we do, and I felt rather sympathetic when I was charged with still having that mercury program.

Here is what we are doing. We have an active enforcement program for all of the people who are discharging a significant amount of mercury into our waters. But I am not sure we are getting at the big source of mercury in doing that. There may be mercury in fossil fuels or other yet to be discovered places which are getting in. Some of the companies have come in -- and I guess the power companies are here, and this is a quote, not mine -- and they say, "We are putting in 12 pounds of mercury and you are getting us down. But there is a power company up the road that is probably putting out 50 or 60 pounds a day through its stack. Why don't you get them?"

You know, the stack isn't my business.

I am not talking about the validity of that, but everything we do has this kind of limitation.

MR. DUMELLE: Mr. Stein, you are going into a new Agency next week and it will be part of your business.

MR. STEIN: Let me clarify that. Really the new Agency is supposed to go into effect next week, but we have a 60-day grace period. They are even giving grace periods now for establishing new Agencies, so we are going to have to wait another 2 months.*

Are there any other comments?

MR. PURDY: Mr. Stein, while we are talking about setting up committees, I hope you do leave me one or two people as an enforcement staff to carry out the recommendations of the committees. But with respect to the phosphorus loading to the lake, I think that there is some information on this in the present record.

In our report to this first conference, January 1968, we did report on the basis of stream flows and sampling at the mouths of the rivers the phosphorus loading

* By law the Environmental Protection Agency becomes effective December 2, 1970.

from Michigan, and this does total to be about 90 pounds phosphorus as P per square mile of drainage basin. So you do have some concrete information in the record, I would say.

MR. STEIN: Are there any other comments?

MR. DUMELLE: Let me just comment on that -- two things: If it is 90 pounds as phosphorus per acre -- per square mile, and we trim that to convert it to phosphate, it becomes 270, and I think the figure I quoted was 110 which, again, shows that it is too low; and, secondly, your data, Mr. Purdy, showed a very great increase because of rainfall. I think a 54 percent increase from one year to the next. And it may be that these old figures were collected in a dry year, or incorrectly collected, and that may be one reason why they are so very low.

MR. STEIN: Are there any other comments?

If not, thank you. We will consider that, too. I do sympathize with Mr. Purdy's comment.

You know, the policeman's lot is not a happy one. I think if you will look right at the Federal Agency and see the support troops and the people that are on the line in Enforcement, we don't have as good enforcement as even the modern armed services.

Are there any other comments or questions now? We will stand recessed for lunch until 2:00 o'clock.

(Noon recess.)

AFTERNOON SESSION

- - -

MR. STEIN: Let's reconvene.

May we have Mayor Frank Harangody of the city of Whiting.

STATEMENT OF FRANK HARANGODY, MAYOR,
CITY OF WHITING, INDIANA

MR. HARANGODY: Mr. Chairman, conferees, ladies and gentlemen.

The conferees are assembled at this conference to consider setting a standard of 1-degree rise at point of discharge in order to abate thermal pollution. The city of Whiting is concerned that a 1-degree rise will place an undue hardship on municipal governments.

You are aware that the Lake Michigan Basin is an area where people heat their homes in the winter and cool their homes in the summer. The water supplied by municipalities to homes stands in piping systems, toilet tanks, and flush bowls and absorbs heat from the homes in the winter. In the summer, much municipally-supplied water is used to cool air conditioner systems which also add heat to the water. It is very questionable whether enough dilution will take place that a municipality can return the water in keeping with a 1-degree rise without the installation of costly cooling equipment.

The State of Indiana held a hearing on May 6, 1970, that was attended by the city of Whiting. The water quality standard that was adopted by the State of Indiana concerning water temperature increases allows a 5-degree rise. The city of Whiting believes the standard adopted by the State of Indiana to be reasonable.

I am also here to present a report concerning the efforts of the city of Whiting to abate pollution of Lake Michigan consistent with applicable water quality standards.

The city of Whiting is a body politic and corporate, organized and existing under and by virtue of the laws of the State of Indiana, under and by the authority of which it exercises the powers of local administration and government as a political subdivision of the State of Indiana. The records show that in 1938 the city of Whiting attempted to build a sewage treatment plant in order to stop the flow of raw sewage into Lake Michigan. Application was made under the P.W.A. and the W.P.A. program and the city raised $200,000 for its share of the project.

In the years prior to 1943, there was not enough

Federal money to accomplish the project. The 2-percent debt limit placed on municipalities by the Constitution of the State of Indiana prevented the city of Whiting from accomplishing the project without Federal financial assistance. Subsequent to 1941, during the war years, a shortage of materials prevented the commencement of construction of the sanitary sewage treatment facility.

In 1943, the State of Illinois filed a lawsuit in the Supreme Court of the United States suing the city of Whiting as one of the many municipal and industrial defendants. As a result of this lawsuit, the city of Whiting had three choices. These choices were:

1) Constructing and placing in operation an adequate sewage disposal plant, or

2) By delivering and continuing to deliver all of Whiting's sanitary sewage and domestic wastes to the sanitary district of Hammond for treatment and disposal pursuant to said agreements of February 19, 1945, and August 5, 1946, or

3) By any other feasible method acceptable to Illinois and Indiana which will eliminate, discontinue and terminate the discharge of sanitary sewage and domestic wastes directly or indirectly into Lake Michigan.

The city of Whiting, at that time, elected the second option to discharge its sewage to the city of Hammond's treatment facility. The $200,000 was used to construct the tie-in and to pay the legal fees incurred as a result of the lawsuit.

The contract for sewage treatment was signed between the city of Whiting and the Sanitary District of the city of Hammond on February 19, 1945, providing for a charge of $40 per million gallons. Since that time, the dry weather flow and as much of the wet weather flow as the city of Hammond could handle has been treated by the city of Hammond. The treatment cost from 1945 to 1962 was gradually increased from $40 to $60 per million gallons. From 1962 to 1970, the treatment cost has skyrocketed from $60 to $130 per million gallons. This is a yearly cost over which the city of Whiting has no control since it is subservient to the dictates of the city of Hammond. The escalating cost is placing an excessive burden on our taxpayers while we have no recourse but to pay.

Since this tie-in was made, the wet weather flow which the city of Hammond cannot accept due to plant limitations is being diverted into Lake Michigan by the city of Whiting at the Atchison Avenue and Front Street outfalls. This condition has caused the city of Whiting to be cited in both the First and Second Sessions of the

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Conferences in the Matter of Pollution of Lake Michigan and its Tributary Basin.

I took office as mayor of the city of Whiting in 1968. The condition of Lake Michigan was of great concern to me since I have been a resident of Whiting all of my life. My administration has been devoted since 1968 to accomplish everything it could do to save the city of Whiting's most priceless asset, Lake Michigan.

An application was filed in 1968 requesting financial assistance in the form of Federal funds to construct a separate sewer system or equal. This application was approved by the Lake-Porter Counties Regional Transportation and Planning Commission, the Northeastern Illinois Planning Commission, and the Indiana Stream Pollution Control Board. Whiting's application for Federal funds was approved by Cincinnati and then referred to Chicago where it was assigned File No. WS-IND-82. We were not able to proceed because of the Indiana constitutional 2-percent debt limit placed on municipalities which prevented the city of Whiting from being able to provide the necessary local funds.

The city of Whiting then caused to be prepared House Bill No. 1808 which was introduced in the 1969 session of the Indiana General Assembly. This bill provided that any city or town contiguous to a second-class city could form a first-class sanitary district. Indiana law allows a statutory debt limit of 10 percent of assessed valuation for a first-class sanitary district. House Bill No. 1808 received bi-partisan support and was passed by the Legislature and signed by the Governor becoming Chapter 248 of the Acts of the 1969 Indiana General Assembly.

The Common Council of the city of Whiting then duly adopted and passed Ordinance No. 1118 which created a first-class Sanitary District for the city of Whiting. After adoption and approval of this ordinance, I appointed the Board of Sanitary Commissioners.

The first order of business of the Board of Sanitary Commissioners was to interview numerous engineering firms for the purpose of hiring a competent engineer to prepare a feasibility study in order to determine a means of ending the city of Whiting's sewer and pollution problems. They selected the firm of Russell, Schubert, Hamilton and Associates, Inc., of 1403 North Delaware Street, Indianapolis, Indiana. The contract was signed and preliminary work began.

The Indiana Stream Pollution Control Board, on January 20, 1970, ordered that a hearing be held in

Indianapolis on February 10, 1970, concerning the city of Whiting's combined sewer overflows at Atchison Avenue and Front Street. The city was represented at this hearing by Leroy L. Young, Secretary of the Board of Sanitary Commissioners; Board Attorney Donald L. Gray; Ernest R. Hamilton, and myself. The evidence presented at this hearing was taken under advisement.

The Board of Sanitary Commissioners filed with the Indiana Stream Pollution Control Board on April 15, 1970, an application for applying for State and Federal funds for the proposed water pollution control facilities.

On June 22, 1970, Ernest R. Hamilton presented to the Board of Sanitary Commissioners Plans A, B, C, and D as possible alternative solutions to the sewer and pollution problems. Plans A and B were two methods of installing separate systems in the city of Whiting. Plans C and D provided that the city of Whiting build their own sewage treatment facility. None of the plans were accepted as such; however, the Board of Sanitary Commissioners tentatively approved Plan C with variations. After further research, Ernest R. Hamilton prepared Plan E.

By letter dated June 19, 1970, B. A. Poole, Technical Secretary of the Indiana Stream Pollution Control Board, notified Donald L. Gray, Attorney for the Whiting

Sanitary District, that A. C. Offutt, M.D., Hearing Officer, had filed the hearing officer's recommended findings of fact and suggested order of the Stream Pollution Control Board versus the city of Whiting, Indiana, in Case No. B-76.

Leroy L. Young, in behalf of the city of Whiting, by letter dated July 6, 1970, objected to these findings of fact in the report of the hearing officer since these recommended findings of fact contained statements that were not factual, were inaccurate, and were highly argumentative. It was requested that the Indiana Stream Pollution Control Board not enter the recommended action of the hearing officer until the city of Whiting had the additional time needed to present a workable plan. Preliminary Plans A, B, D, C, And E, together with drawings as prepared by the consulting engineer, were delivered to the Indiana Stream Pollution Control Board on July 21, 1970.

The Board of Sanitary Commissioners approved Plan E and sought the approval of the Indiana Stream Pollution Control Board. Indiana law requires that all such installations, as we propose to build, must be approved by the Indiana Stream Pollution Control Board.

This approval is an absolute prerequisite before

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the Board of Sanitary Commissioners could authorize their engineer to proceed to Phase II, which includes preparation of detailed plans and specifications.

A 137-page report entitled, "Sanitary Sewerage System and Water Pollution Control Facilities," prepared by the consulting engineer, delineates in Plan E a complete solution to the sewage and pollution problems of the city of Whiting which the city of Whiting can accomplish with limited financial assistance.

Plan E provides for:

1) A treatment facility of the very latest design with the most effective equipment now known to the engineering profession. It would provide primary, secondary and tertiary treatment of all sanitary, storm and industrial wastes. Here I wish to emphasize that we propose to treat all of the wastewater of the city of Whiting, including both wet weather and dry weather flow. The capacity of the treatment facility is sized so it will handle the dry weather flow plus an average daily amount of storm water in excess of the daily average for the heaviest month of rainfall since 1885.

2) A retention basin large enough to handle the entire storm runoff of the heaviest month of rainfall since 1885.

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3) The outfalls at Atchison Avenue and Front Street that connect the sewer system of the city of Whiting to Lake Michigan would be removed and sealed.

4) The completely treated effluent from the new facility would be discharged into the Indiana Harbor Canal near Indianapolis Boulevard depending on the route approved.

The Indiana Stream Pollution Control Board, at its meeting on July 21, 1970, adopted and recommended findings of fact and suggested order of the hearing officer and summarily overruled the objections filed by Leroy L. Young. This was done without notice to the city of Whiting and the opportunity to be present as required by Indiana law.

The city of Whiting received a letter from B. A. Poole, dated July 27, 1970, which reads as follows:

"Re: Application for State and Federal Grant Funds for Sewage Work Project, Whiting

"A review has been made of your project application. It is noted that a Federal grant of $1,436,250 and a State grant of $718,125 are requested to help finance the construction of a new treatment plant, intercepting sewers, outfall sewers, pumping station, detention basins, etc. An engineering report has not been submitted.

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"The proposal to construct a new sewage treatment plant and to discontinue the discharge of dry weather sewage flow to the Hammond Sanitary District for treatment at the district sewage treatment plant is at variance with Federal Water Quality Administration requirements which place additional emphasis on the requirement that treatment works be included in a metropolitan or regional plan for pollution abatement.

"In view of the preceding, no priority rating is recommended for the Whiting project as described by your application. It is recommended that the city proceed with a project to abate the discharge of combined sewer overflow to Lake Michigan, to provide adequate disinfection of all stormwater discharge to Lake Michigan and to make improvements to the sewer system as necessary to assure that all sewage and wastes from the city of Whiting is discharged to the Hammond Sanitary District for treatment.

"Very truly yours, B. A. Poole, Technical Secretary"

Many phone calls were made to the staff of the Indiana Stream Pollution Control Board between July 27 and September 8, 1970, requesting a conference to discuss Plan E. Finally, on Septeberm 8, 1970, the Board of Sanitary Commissioners consisting of Joseph A. McDonald,

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Edward D. Harbin, and Leroy L. Young, Board Attorney Donald L. Gray, Ernest R. Hamilton and two of his associates, and myself, met with Perry Miller, Acting Technical Secretary, and Oral Hert, Director of the Division of Water Pollution Control of the Indiana Stream Pollution Control Board staff.

They stated that Plan E was unacceptable to them for the following reasons:

1) They would have to monitor another treatment facility.

2) Mr. Perry Miller stated he has principles which would not allow him to recommend that the city of Whiting build its own sewage treatment facility.

3) The plan would be unacceptable to the Federal Water Quality Administration.

4) Perry Miller could not recommend approval of the Whiting project even if it had been proposed 10 years ago because of the 1943 lawsuit.

5) They were opposed to Whiting having a new outfall which would not flow westward in the Illinois waterway system.

After questioning, it become obvious that these members of the staff had not studied the report and that they were unaware of what we proposed to build in Plan E.

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Yet they made a judgment that we should not be allowed to build a sewage treatment plant of the most advanced design that would include tertiary treatment.

This session was completely fruitless. The staff members present from the Indiana Stream Pollution Control Board were, in their words "principled." However, we must solve a city's problems and we consider this attitude to be the typical dogmatic bureaucratic attitude which is the subject of editorials. They assume dictatorial powers and attempt to make everyone appearing before them bend to their wishes.

The Board of Sanitary Commissioners requested a hearing before the Indiana Stream Pollution Control Board at their next meeting that was being held on September 15, 1970.

The Board of Sanitary Commissioners, Board Attorney Donald L. Gray, Ernest R. Hamilton, Charles Schubert, and two of their associates, and myself, appeared before the Indiana Stream Pollution Control Board on September 15, 1970.

I presented the following statement:

"In Re: City of Whiting, Water Pollution Abatement

"Gentlemen:

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"As Mayor of the city of Whiting, Indiana, I can only view with disfavor the condition of Lake Michigan. The citizens of Whiting have been deprived of the full use of their park and beach facilities for many years and it is my sincerest wish that the pollution of Lake Michigan be abated. Physically the city of Whiting has more shoreline than either Hammond or East Chicago and our citizens have as much or more to gain per capita from stopping the pollution of Lake Michigan than the citizens of any other city in the State. Therefore, we are pledging our best efforts to work towards alleviating this problem and our citizens are ready to sacrifice for a complete solution to the problem.

"I cannot accept the thought that we should buy a partial solution when a full solution is possible.

"I disagree that the city of Whiting should continue to pump storm and sanitary overflows to Lake Michigan with only disinfection as ordered by the Indiana Stream Pollution Control Board on June 19, 1970.

"The sewage treatment charges of the city of Hammond have increased from $60 per million gallons in 1962 to $130 per million gallons in 1970. This escalating cost of treatment prohibits the city of Whiting from committing itself to a future program of complete

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dependence on the city of Hammond and prohibits pumping all storm and wastewaters to the Hammond Sanitary District on the basis of economics.

"We have caused to be prepared a 137-page report entitled, "Sanitary Sewerage System and Water Pollution Control Facilities," copies of which have been delivered to the Indiana Stream Pollution Control Board staff.

"We have also caused to be prepared a fact sheet which summarizes said report and is attached to this statement.

"The analysis and evaluation of the five alternative plans in this report by the city administration of the city of Whiting in conjunction with the consulting engineer leads me to the conclusion that Plan E is the complete solution that we have sought.

"We are therefore asking this Board to do the following:

"1) Order that the city of Whiting be rated.

"2) Determine the priority of the city of Whiting's application for sewage treatment project construction grant.

"3) Modify the Board's order of June 19, 1970, to allow evaluation of the five alternative plans submitted by the city of Whiting.

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"4) Modify the Board's order of June 19, 1970, to approve Plan E of the city of Whiting as an effective project for pollution abatement consistent with applicable water quality standards.

"Respectfully submitted, Frank Harangody, Mayor, City of Whiting."

Mr. B. A. Poole, Technical Secretary of the Indiana Stream Pollution Control Board made many statements throughout the course of the meeting of September 15, 1970. Some of these statements were made in the presence of the city of Whiting and some were not. The city of Whiting has procured a tape of this entire meeting and I must admit that Mr. B. A. Poole used his influence in the form of half truths and innuendoes to the utmost to influence the Board's decision that the city of Whiting not be rated and that Plan E not be approved. At one point in these tapes Mr. B. A. Poole said, and I quote, "I <u>scanned</u> their report last night." (Emphasis supplied)

His statements made during the course of the day prove that he had not given the report any consideration and did not understand its content.

The reasons given by the staff of the Indiana Stream Pollution Control Board have caused several inquiries by the city of Whiting. The following are our conclusions

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based on these inquiries:

1) The record of the lawsuit originated by the State of Illinois in the Supreme Court in 1943 shows that the city of Whiting submitted three alternatives to cease pollution of Lake Michigan. The first of these alternatives was that the city of Whiting build their own sewage treatment facility. This we have proposed since 1945 and we are still asking that we be allowed to do so at the present time.

2) Regarding the allegation of Mr. Perry Miller and Mr. B. A. Poole that the Federal Water Quality Administration would not allow the city of Whiting to build a treatment facility, Mr. Holloman of the Federal Water Quality Administration for the Lake Michigan Basin stated that he was not aware of any such ruling or prohibitive policy. It was requested of Mr. Holloman that he transmit any and all Federal policies, rules, regulations, etc. concerning the city of Whiting to me as soon as possible.

3) I was truly amazed by the statement of the Indiana Stream Pollution Control Board staff that an Indiana treatment facility could not be built unless it could discharge its effluent into a waterway draining westward into Illinois. I have not been able to determine that the Federal Government is in collusion with the State

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of Indiana against the State of Illinois and I am quite sure the State of Illinois would not agree to this arrangement. Gentlemen, I believe pollution must be abated.

4) The Board of Sanitary Commissioners of the city of Whiting has retained an attorney to investigate the possibility of seeking relief in the courts by obtaining an injunction against the Indiana Stream Pollution Control Board whose actions against the city of Whiting have been arbitrary, capricious, and detrimental to the best interests of the city of Whiting.

The city of Whiting as of today does not have the necessary approval of the Indiana Stream Pollution Control Board for its water pollution abatement project.

In effect, the Indiana Stream Pollution Control Board has patted the city of Whiting on the back and sent them home with instructions to come back next year.

It is my understanding that it is the avowed Federal policy to save Lake Michigan and not let it deteriorate to the same fate as Lake Erie.

It has been reported that Congress is going to appropriate billions of dollars for water pollution control projects.

The present public awareness of the environmental

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ecological problems in the United States makes it seem incongruous that all of the good intentions of the Federal Government and municipalities such as the city of Whiting can be so easily frustrated by a staff decision to postpone action by a State water pollution control agency.

It is a paradox of our time that when you have Federal and State laws to compel municipalities and industries to institute water pollution abatement control projects that the city of Whiting comes forward seeking approval and financial assistance to voluntarily construct a sanitary treatment plant of the latest engineering design providing tertiary treatment to eliminate the discharge of raw sewage in Lake Michigan and to maintain water quality standards, that they are summarily rejected. Let's face it, gentlemen, no action is tantamount to rejection.

If this is true, this means that the 1968, the 1969, as well as this conference being held in Chicago this week is nothing more than window dressing that attempts to fool the people that live in the Lake Michigan Basin. You have a conferee present who by his actions has denied the city of Whiting the opportunity to solve its sewer and pollution problems and, on the other hand, insists that the discharge from combined sewers must be stopped. He knows that this is not possible.

Gentlemen, the people of Whiting, Indiana, would like to be convinced that what you are doing in these conferences concerning water pollution abatement is more than a mental exercise for the purpose of getting publicity.

It is within the power of those present here to insist that the city of Whiting be allowed to proceed with its water pollution abatement project.

Thank you, Mr. Chairman, for the opportunity to present this statement.

MR. STEIN: Thank you, Mr. Mayor.

Do you have any comments or questions?

Do you want to stay at the podium?

MR. HARANGODY: I will stand up here if you don't mind, Perry.

MR. STEIN: You don't mind, do you?

MR. HARANGODY: No, I don't mind.

MR. MILLER: I think I must respond on behalf of the Stream Pollution Control Board to this presentation by the mayor of the city of Whiting, and I certainly would say that there are many things that I disagree with which he has included in what he has presented. But I think the real important thing for the conferees to consider is that the staff and the Board in its actions were considering

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that the request of Whiting was for a new discharge that would go into Lake Michigan.

To understand this, I think you must know that the city of Hammond, which is currently treating the wastes for the city of Whiting, discharges into the Grand Calumet River which during most all of the time flows westward into Illinois and does not come back to Lake Michigan. And any plant discharging for the city of Whiting into the Indiana Harbor Canal would be tributary to Lake Michigan and not to the Grand Calumet River.

This new source of pollution is contrary to the recommendations and findings of the conferees of this conference of the Calumet area conference. Further we believe also that there is some implications at least in the new regulations adopted by FWQA requiring regional types of programs. It was on the basis also that the Board does have an order that was issued and one of the findings, as the mayor said, is that -- and recommendations -- is that they continue to discharge to the city of Hammond, and we believe that proper procedures were followed in the issuance of this order.

So it was on this basis that we -- and I say "we," the Indiana Stream Pollution Control Board -- came to a decision that it would not rate the Whiting project, that we would explore the possibilities with FWQA as to the compliance with their regulations, as to compliance with the findings of the conferees of this conference, and if they were agreeable, then we would rate the project next year. I think that this was a justifiable conclusion, and one that is based upon fact, that is not arbitrary, and it is in keeping with the policies of the State of Indiana and of the conferees.

MR. STEIN: Are there any other comments or questions?

Do you want to respond to that, Mr. Mayor?

MR. HARANGODY: In the Federal Register, there is a requirement that you have a central disposal unit. However, this is not in the immediate future. Mr. Miller would not tell us if the plant he wishes us to implement would be valid in the next 5 years. He couldn't guarantee anything. There is no such regional plan as of now and none in the foreseeable future. There are no laws on the books to implement such plan,and we must stay at a standstill until such thing has been permitted by State statute, etc., etc. That is all I have to say.

MR. STEIN: Any other comment or question?

Mr. Mayor, let me tell you, you have presented the last three or four pages as a fact. What do you think of those facts? Do you agree that that is a fact sheet?

MR. MILLER: No, I don't agree this is a fact sheet. There are many facts pointed out in this presentation which, so help me, are not factual.

MR. STEIN: One of these things relates -- I think maybe I better clarify that. You say it is within the power of those present here to insist that the city of Whiting be allowed to proceed with its water pollution abatement project.

Now, I know we have in the Federal statute -- it is rather complex -- but we have the primary rights and responsibilities to abate water pollution resting with the State, and we set up certain requirements at this conference, and we turned it back to the States to administer this under State laws and regulations. This is the Federal statute procedure. Therefore, your problem, as you pointed out here -- and if there is a problem and I am sure there is -- relates to your relationship with your State government, isn't that correct?

MR. HARANGODY: If you put it that way, but they refer us to the Federal Government.

MR. STEIN: Right. Now, we cannot, as far as I read the Federal law, require any State government to issue or not issue a permit that it is taking under its laws and procedure. Not only can't we do it, but I don't think the other States can do it for a neighboring State.

However, the city of Whiting presumably is still discharging stormwater contrary to the standard requirements, as I understand it, and the requirements of the conference.

Now, we do have a procedure under the Federal Government whereby we can get this resolved one way or the other. That is, we can file a 180-day Notice against the city of Whiting and see what you are going to do. If you don't do it, we can go to court and the Federal Court can decide what is going to happen.

Now, I think the alternatives that the conferees here have should be borne in mind, because I do not think we have the power by any law that I know of to change or direct the State of Indiana to change its law, change its procedure, or adjust its orders. This is a State matter over which none of the people at this table, other than the Indiana representatives, have any authority. While I appreciate what you are saying and what you are asking us to do, I am not sure that is within our powers.

MR. HARANGODY: Our city attorney would like to speak.

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MR. GRAY: In reply to Mr. Stein's comment, I would like to direct your attention to my understanding of the law and that is this: The Federal Government has the most powerful weapon called the purse strings. It is my understanding that the Government provides under Public Law 600 funds which can be used in two methods: one by direct construction grants on a 30-percent basis without State participation; the other is where you have the 50 percent -- 25 percent State participation and 25 percent by the local government.

Our application was filed in keeping with the Indiana rules to try to secure a grant of the 75 percent moneys. My theory, and our thinking in the city of Whiting is this: that we cannot get this type of funding.

The engineering report shows an alternative, which is to apply for Federal funds on a 30 plus a possible 10 percent increase for a total of 40 percent funding. This is within your bailiwick as I understand the FWQA Act. And it is our impression that we have been informed by the State that if the Federal Government says that it is permissible to create or construct a water treatment plant, teritary phases of the most advanced design, we would not be discharging pollution into Lake Michigan; we would be discharging an effluent that would be clean and clear enough to drink.

The Federal law says that you are to maintain the quality of the water of Lake Michigan and you are to do everything within your power to maintain and set the standard for good quality water.

MR. STEIN: Let me clarify that. While there may be some differences in what you have said and this, I don't think that is the operating point. Whether you get 30 percent money, 33 percent money, 55 percent money, the same limitation prevails.

Let me give you this limitation. When this law was passed, there were various points of view taken about primacy of State, Federal, or local rates. One of the things that the Congress put forth as a prerequisite to any grant -- any grant, whatever the money is, and this is the point -- was that the priority listing for that grant would be in the hands of the State agency, not the Federal Government. The Federal Government was not given the authority to select projects within the State. All we can do is make allocations of the grant funds.

Now, it is true that the State priority system must meet certain Federal criteria, and the project also, once it achieves a State priority, must meet certain other Federal requirements. But I repeat: Under the

Federal law, no one in the Federal Government selects the priority of a project within a State. That is up to the State Government, and until we get a certification from the State, we can't give you any construction grants. The law is very clear on that. The Congress was very clear on that. And I think even with the newer members, no one is proposing changing this.

But this is not, sir -- if you don't like the way this works -- and I know there are differences of opinion -- this is not the right forum. We can use it as a sounding board, but if anyone is going to change that it has to be the Congress and not us. As far as I know there has been no serious proposal to change that feature of the Federal law.

MR. GRAY: Mr. Stein, I am cognizant of what you are saying and I recognize that the Federal law does provide that it must be with "the approval" of the State pollution control agency. This we are not quarreling about.

However, what we are saying is that when we in a small community go to the State agency, we are told of the existence of certain Federal policies which are prohibitive in nature. We come to you and say, "Well, now, if these are a matter of Federal policy, this certainly should be within your jurisdiction, and therefore you would have the ability to determine what your own policies are and whether they would prevent Whiting from doing what it is attempting to do."

This is the information and the impression -- I use that word "impression" -- that we have received is that Federal policy is adverse to the city of Whiting, and we say to you gentlemen sitting here dictating or creating or establishing Federal policy: Is this true? And, if so, please be aware of our problem and take this into consideration in establishing your Federal policy.

MR. STEIN: By the way, I fully understand that. I think we have something here that has to be solved. But again in reading your report, there are a lot of other things beyond the Federal policy. I am not making a judgment; obviously we cannot do that. But there are allegations here whether the State is seriously considering your project, whether they understood it, whether they even read your proposal, etc.

MR. GRAY: This is a matter for the State court.

MR. STEIN: I understand that.

But it seems to me, sir, that before we get even

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to the Federal issue, we have to get these things resolved with the State, because we are not proceeding in an orderly way. In other words, I have known the people in Indiana State Government for many years, and I know all of the people including Dr. Offutt, the hearing officer, that you mentioned here. It has been my experience through the years that these people are among the most knowledgeable people in water pollution. They are aware of the Federal and State law and State regulations. As I understand it, when they have certain prerogatives under the Federal Act, they have to make that initial determination.

I would suggest if the issue gets narrowed down to the point that there are no allegations on either side but the sole difference between you and the State might be a question of Federal policy, that is the time perhaps that you may want to direct your inquiry. But the way this case sits now, there seems to be a good deal to be done between the municipality and the State to get the project squared away. The answer is if there is a Federal question; if we are dealing with a clear Federal question and if that is the only impediment to the project. As I read it there seems to be a lot more than that.

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MR. GRAY: Well, the record -- the 16-page presentation by the mayor was an attempt to present an actual chronological sequence of events which have occurred which have led us to be at this meeting today.

In all fairness to Mr. Offutt for whom I have great respect, at the time of the hearing on the 15th of September, there were only four members in actual attendance when Whiting made its presentation, including Mr. Offutt. Mr. Perry Miller -- he was physically present but he did not become vocal and make any comments either for or in opposition to Whiting's request. The opposition was from Mr. Blucher Poole, and the recommendations of the staff and the technical secretary were accepted by the four members who constituted a quorum at that meeting.

We have requested the opportunity to be present at the next meeting on -- I believe it is scheduled for October 20, because we do sincerely and earnestly feel that they obviously did not understand or fully realize what we were trying to propose to them.

What we were concerned about is the fact that we are under order from the Board as well as a prior order from 1967 from the Federal Government to do something by the end of 1970, and were in effect told to go home and come back next year. That puts us in kind of a limbo.

MR. STEIN: I think it does. I think if you don't do anything by 1970 you are going to be in violation of a Federal directive, and we are going to be around to see you.

MR. GRAY: So all I can say, gentlemen, is "help."

MR. STEIN: I don't know if the cities appreciate it when we knock on their door, but we will be there.

Now, I suggest you sit down once more with the State of Indiana and try to get this resolved.

I am making this suggestion to both the Indiana representatives and you. Now, if you both feel, after your next meeting -- the city, the State, just yourselves get together -- that there are issues which cannot be resolved because of unclarity or some doubt or disagreement on what the Federal requirements are and you both agree that the Federal people would be useful, I would suggest that you get in touch with Mr. Mayo. I am sure his office or we would be glad to provide all of the assistance we can.

The reason I suggest that you get together again is that it will narrow the issue before you get the Federal people in it -- the Federal questions. Because I don't think it will be helpful at all if the Federal people get involved in some of the differences which you apparently have between you and the State. This is in the nature -- and I don't like to make an analogy -- of a family quarrel and you get a third party in. You are not going to solve the situation, you are just going to complicate it. And a good portion of these questions are whether you understand the project and what you want to go for are really not Federal questions.

MR. MAYO: Frequently it is the third party that endsup in the hospital.

MR. STEIN: That is right.

MR. GRAY: I want to thank Mr. Stein and the other conferees for listening, and I like Mr. Stein's analysis and recognition of the problem. I do concur with the thought that perhaps we should and we would be receptive to sitting down with Mr. Perry Miller who has now assumed the position and title and the power of Mr. Poole, and I would hope he would do this with an open mind. What we were concerned about is to be foreclosed for one full year, and this was the impression that we received when we walked out of Indianapolis.

MR. MILLER: First of all, I want to say that we

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are aware, and we have studied this report, and the comments of Mr. Poole at the Board represented the staff's viewpoint and that there is no question about this.

I think there is another problem that Whiting has that we don't need to go into as far as eligibility for funds in this fiscal year, even if they were rated. But we certainly, I think, have viewed this with an open mind. And our thought, as far as the requirement in the regulations and of this conference, is that the State of Indiana is involved in interstate conferences -- this is in the interstate waters -- that we are adding a new source of pollution, and admittedly it is small, even with tertiary treatment. But these are issues that have to be resolved, I think, before we can come to grips. And I firmly believe that since Whiting's sewage has been treated since 1945 by the city of Hammond, that it can continue to be treated there and that Whiting can treat stormwater as well.

MR. GRAY: I think that could become involved in a two-way discussion which won't be fair to the conferees. So I will follow Mr. Stein's admonition that this is a matter that should be handled within our local State government. I assume Mr. Perry Miller is aware of the fact that the city of Whiting does wish to be in attendance at the next regularly scheduled Board meeting on October

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20. This was so stated on September 15.

And as to what other course of action we will take, I should like to suggest, in trying to define and narrow the issues -- and if there is a Federal question, and there is a Federal question or more than one question, we would like to anticipate the assistance of your Federal Regional Office here in Chicago.

MR. STEIN: Yes. By the way, we are not limited to that. Although I think this can be resolved in the Chicago office, if you ask us a Federal question regarding your operation, we will commit the whole Federal resource if there is a Federal question to help solve this problem.

MR. GRAY: Thank you, Mr. Stein.

MR. STEIN: I have one more. I think you raise a rather interesting question here. If you say reduction of heat is a burden, it may be a burden on the municipality or we have a problem of heat in the lake.

You know, from reading this, I get the idea that you are committed. I don't think there is any question of your commitment to provide as clean water to the lake as you can regardless of the permits of the plant. I am not getting into that because that is between you and the State. You are talking about coming up with

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tertiary treatment and even treating the stormwater, and that is further than what I think most cities have gone. So I think on its face, the end results of what you are trying to do in the program are commendable.

If we have the heat problem, I think we have to really look at this. I am not sure that we can ask the cities -- and you may have a point -- to reduce the heat from their water. Some of the cities particularly may use water from wells, which in the winter when it starts out is warmer than the surface water. But if we have a heat problem in the lake and we set up categories and the cities are out, and we are not going to have too many restrictions on them, and based on an assumption which we haven't made yet that we have to control the heat, this may lead us to even more stringent requirements on industrial users.

And you recognize the implications of what you are doing, because if we are going to make this kind of classification, and you have powerplants and other industries putting out heat and we have to keep that heat down, and we are going to recognize that the problems of municipalities may be a little more lenient, this may require us possibly to require more stringent requirements on the other dischargers to the lake if we have to control it.

MR. GRAY: While our written report doesn't cover this -- and I am not an expert and I am not an engineer -- the observation I wanted to make was the fact that I was aware that some of your industrial users in the Lake Michigan Basin -- their attorneys have called me and pointed out that this conference was significant; that if they wish to establish thermal heating plants or plants using that type of heat, they might be discharging an effluent that would have a 14-degree rise.

Now, some of these same industrial users were in attendance at that meeting we had in Indianapolis on May 1 at which I was present, and the State of Indiana -- if I am wrong, Mr. Miller, correct me -- we had an 8-degree input-output rise permissible and they wanted to reduce this down to 5 degrees, and I assume that the Board will act accordingly.

Now, with reference, however, to Lake Michigan, we are in a position that we have a water intake from Lake Michigan. So we are vitally concerned, because our source of raw water is from Lake Michigan, so we need to have it clean, too.

Then, also I have talked to the consulting engineers, I am informed that we do have the problem that with municipal discharge of water into a lake, that it is going to be in the wintertime below ground and, therefore, at a temperature higher than freezing, and the probability is that your shore front where the outfall would be located is freezing. So the paradox would be that we have to discharge ice cubes to maintain the same degree of temperature as the surface of the water. I don't mean to be funny but it did cross my mind.

So, therefore, the municipalities are perhaps in a special category which would mean they could be excluded entirely or else could be made, as you put it, more lenient -- the thought being that because we increase it 2 degrees, I think the point was we will have to make the industries more restrictive, isn't that right?

MR. STEIN: That is right.

MR. GRAY: Okay.

MR. STEIN: If we make these categories enough to preserve the waters of the lake that you use as your water intake, you see the basic job we have -- and you hit this firmly here -- is not to have this water resource deteriorate because this is one of our most important national assets. But if the water resource deteriorates, you are going to have a heck of a time with your water supply. I know Mr. Vaughn from Chicago who spoke this morning, and is still here maybe can translate this. Before we had this program under way and -- this comes from a 1943 case -- there were times that the city of Chicago water intake had taste and odor problems from the phenols and other substances which presumably were traced to petroleum operations in your area. This I think we have knocked down considerably due to this program.

What I am saying is that if heat, in fact, is a problem or anything is a problem in the lake, people who have to use the water for their water intake like Hammond and Chicago are going to be the first --

MR. GRAY: And Whiting.

MR. STEIN: -- and Whiting, I am sorry -- and Whiting are going to be the first ones to suffer because you are right on the line, dependent on that water for your water supply.

MR. GRAY: That is correct, and I think you have hit the button on the head, too. Only in relation to the question is heat increase a contributing factor to further degradation of the lake, this is what you must initially decide. Once you make that decision, then you implement it, and I am not the authority on that.

I have read the comments last night in the papers of some professor that appeared here and said that Lake Michigan in substance is the largest mixing basin in the world and added heat really won't make that much difference on aquatic life, etc., etc.

I was in attendance at a hearing on May 6 when we had that professor from the University of Minnesota working under a Federally-funded project on research. He came to Indianapolis and presented a written report, which Mr. Miller should have available in his file, in effect, saying that heat increase does not adversely affect aquatic life. But I won't take any posture or position on that because I am not the authority. That is up to you gentlemen to decide.

MR. STEIN: Thank you very much.

May we have Paul A. Kuhn for Raymond E. Anderson?

STATEMENT OF RAYMOND E. ANDERSON, GENERAL MANAGER, NORTH SHORE SANITARY DISTRICT, WAUKEGAN SEWAGE TREATMENT PLANT, WAUKEGAN, ILLINOIS (PRESENTED BY PAUL A. KUHN)

MR. KUHN: My name is Paul A. Kuhn, Associate in the consulting firm of Greeley and Hansen. We are the consulting engineers for the North Shore Sanitary District.

Chairman Stein, I want to apologize for Mr. Anderson. He is laid up with a virus and is unable to present the paper himself, and as we helped him prepare it, he asked me to present it. This is a statement on Lake Michigan thermal pollution standards.

We understand that the principal concern of the hearings on thermal pollution standards for Lake Michigan has been standards for heated cooling water discharges to the lake. We believe that attention should also be given to the following discharges which are governed by thermal pollution standards which now exist or may be established.

1. Discharges of treated municipal wastewater.

2. Discharges of treated municipal combined sewage overflows.

The North Shore Sanitary District is now discharging treated municipal wastewater to Lake Michigan. Our present program envisions the ultimate diversion of all such discharges from Lake Michigan. The Sanitary District, however, lacks sufficient financing to forecast with certainty the time at which the discharge from the Waukegan Sewage Treatment Plant will be diverted from the lake. If necessary financing is made available to the Sanitary District through the passage of the proposed $750 million Anti-pollution Bond Issue, and from other sources, we can expect to accomplish the Waukegan diversion before the end of 1973.

The Sanitary District's project includes facilities for the treatment of combined sewage overflows at the

North Chicago and Waukegan Sewage Treatment Plants. It is expected that the discharge of such treated wastewater to the lake will continue during periods of wet weather for the foreseeable future.

We will direct our remarks concerning thermal pollution standards to the discharge of treated municipal wastewater at the Waukegan Sewage Treatment Plant, as this is the only municipal sewage treatment plant in Illinois which will discharge treated municipal wastewater to Lake Michigan following completion of the first phase of the Sanitary District's current construction program. The data available on thermal effects of the discharge of treated wastewater at Waukegan are as follows:

1. Waukegan Water Treatment Plant raw water temperature records.

2. Waukegan Sewage Treatment Plant raw sewage temperature records.

No data are available on the thermal effects of treatment of combined sewer overflows, as facilities for the treatment of such wastewaters have not yet been constructed. We would expect some difference in temperature between effluent from a combined sewage overflow treatment facility and the receiving lake water. Furthermore, we would expect that such discharges could meet any thermal pollution standard attainable by the effluent from a municipal wastewater treatment plant.

Municipal sewage is principally water from the public water supply system plus the waste materials added to it as the water is used by the public. Heat is added to the water supplied for public use through the discharge of such heated waters as laundry, bathroom and kitchen wastes. Some of the heat added to the sewage by the public may be lost to the ground as the sewage flows to the treatment plant. Such heat losses are, however, insufficient to offset the heat gain through public use of the water.

No data are available on the change in temperature of the sewage through the sewage treatment process as effluent temperatures have not been measured and recorded. Attention is, therefore, directed towards a comparison of raw sewage and raw water temperatures.

The regional Waukegan Sewage Treatment Plant was put into operation in 1937. The outfall of the Waukegan Sewage Treatment Plant is approximately 5,500 feet from the original Waukegan waterworks intake. A new waterworks intake was recently completed which is approximately 8,500 feet from the outfall. The Waukegan Water Treatment Plant began operation in 1930.

The monthly average raw water temperatures at the

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Waukegan Water Treatment Plant for the years 1930 to 1969 are shown on Exhibit A. (See Pp. 1648-1653) There is no substantial difference in monthly average raw water temperatures over the 40 years of record and, significantly, no discernible difference since the sewage treatment plant was placed in operation.

In Exhibit B (See P. 1654), the monthly average raw water temperatures at the Waukegan Waterworks for the period 1965 to 1969 are compared with the monthly average raw sewage temperatures at the Waukegan Sewage Treatment Plant. The maximum recorded water and sewage temperatures are also compared. The difference in temperature between the raw sewage and raw lake water varies substantially depending upon the season of the year. In the summer, the average sewage temperature is generally about 5 to 15 degrees Fahrenheit warmer than the average lake temperature. In the winter, the sewage may be more than 20 degrees Fahrenheit warmer than the lake. The difference between annual average sewage and water temperatures is about 15 degrees Fahrenheit for the 5 years reported in Exhibit B.

Waukegan beach water temperatures, reported in the Lake Michigan beach surveys by the Illinois Sanitary Water Board, were as follows: (See P. 1655)

WAUKEGAN FILTRATION AND PUMPING PLANT

MONTHLY AVERAGES OF RAW WATER TEMPERATURES IN DEGREES FAHRENHEIT

MONTH	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	AVERAGE
January	---	33.96	36.32	33.26	32.72	32.50	32.23	32.6	32.1	32.8	33.16
February	---	35.42	34.16	32.90	32.36	32.34	32.47	32.4	33.0	32.2	33.03
March	36.14	36.50	35.24	34.16	33.26	37.13	35.96	33.6	37.7	34.2	35.39
April	41.17	43.90	43.52	41.35	41.54	41.00	39.92	40.6	44.2	40.6	41.78
May	47.50	49.80	48.40	46.04	49.30	47.50	45.10	47.0	49.5	48.5	47.86
June	52.20	56.30	56.65	50.90	54.50	49.85	54.50	53.3	52.4	50.8	53.14
July	58.10	59.60	58.24	65.80	65.24	59.70	65.60	54.8	58.5	57.9	60.35
August	59.00	68.90	63.65	65.13	69.80	60.20	69.80	63.4	53.7	63.8	63.74
September	57.20	58.40	62.36	65.43	58.60	60.05	64.70	61.2	62.8	61.5	61.22
October	47.65	54.80	52.20	52.88	53.22	52.35	53.10	52.6	56.9	51.0	52.67
November	42.10	52.82	41.72	37.59	43.70	44.24	41.00	40.9	44.5	42.1	43.07
December	33.96	39.75	33.26	35.06	34.52	33.72	34.20	32.3	34.8	36.6	34.82
Average	47.50	49.18	47.14	46.71	47.40	45.88	47.38	45.4	46.7	46.0	46.69
Max. Day Reading	*69.8	71.6	70.4	72.2	75.5	73.2	73.0	72.0	67.3	72.0	

NUMBER OF DAY READINGS OF TEMPERATURES BETWEEN VARIOUS LIMITS

Degrees Fahrenheit	1930*	1931	1932	1933	1934	1935	1936	1937	1938	1939	Average 32---39
32 - 40	25	69	105	125	132	128	139	133	113	136	126.6
40 - 50	54	48	67	76	74	83	68	85	97	95	80.6
50 - 60	22	64	56	53	56	83	65	92	87	71	70.4
60 - 70	25	33	47	69	33	49	44	46	55	49	49.0
70 - 80	0	3	0	8	25	3	35	3	0	7	10.1
Total Days	126	217	275	331	320	346	351	359	352	360	336.7

* 1930 Incomplete - No readings before July

NSS - EXHIBIT A

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WAUKEGAN FILTRATION AND PUMPING PLANT

MONTHLY AVERAGES OF RAW WATER TEMPERATURES IN DEGREES FAHRENHEIT

Month	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	AVERAGE
January	32.0	32.5	32.8	32.2	32.7	32.0	33.5	32.4	32.2	33.6	32.8	32.6
February	32.2	32.2	32.2	32.8	33.0	32.2	32.2	33.6	32.6	32.7	32.4	32.5
March	32.8	32.7	36.0	34.2	33.4	38.3	37.9	34.0	35.1	34.9	33.4	34.8
April	40.3	42.6	40.9	42.7	38.2	46.5	44.9	40.7	43.5	42.5	39.1	41.9
May	47.6	48.2	48.7	47.6	45.4	46.7	47.3	47.0	47.2	48.2	47.2	47.3
June	52.1	56.2	56.7	48.3	47.3	50.4	51.5	49.2	52.1	51.6	50.1	51.4
July	55.5	63.2	56.7	57.1	57.5	54.8	58.4	60.0	60.1	62.1	54.9	58.2
August	61.4	68.1	61.2	60.2	58.9	64.6	65.1	61.6	61.8	67.2	64.0	63.1
September	63.9	50.9	59.0	52.3	51.1	54.5	57.2	54.7	59.1	54.7	64.6	56.5
October	57.6	45.8	51.8	52.3	54.8	52.7	53.1	49.9	52.5	50.9	55.6	52.5
November	42.7	43.6	43.7	40.3	46.7	44.8	45.4	44.8	46.7	41.8	43.3	43.9
December	32.9	37.2	32.9	33.9	34.6	33.7	36.7	33.5	36.0	33.7	32.8	34.3
Average	45.9	46.1	46.0	44.4	44.0	45.9	46.9	45.1	46.6	46.2	45.7	46.7
Max. Day Reading	71.0	77.0	71.0	73.0	70.0	71.0	73.0	73.5	71.5	75.7	68.3	

NUMBER OF DAY READINGS OF TEMPERATURES BETWEEN VARIOUS LIMITS

Degrees Fahrenheit	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	Average 40---50
32 - 40	161	131	126	143	145	117	117	143	125	140	147	139
40 - 50	60	123	90	127	113	141	116	130	113	128	78	111
50 - 60	85	53	105	61	69	71	88	43	80	57	76	72
60 - 70	50	34	31	29	31	32	37	33	45	16	63	36
70 - 80	4	24	3	1	---	1	7	13	2	2	---	7
Total Days	360	365	365	361	358	362	365	361	365	365	365	365

NSSD - EXHIBIT A

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WAUKEGAN FILTRATION AND PUMPING PLANT

MONTHLY AVERAGES OF RAW WATER TEMPERATURES IN DEGREES FAHRENHEIT

Month	1951	1952	1953
Jan.	32.2	32.10	33.66
Feb.	32.6	32.94	32.99
March	33.8	33.94	36.11
April	40.3	40.73	42.66
May	46.1	48.99	47.31
June	53.0	51.29	52.39
July	55.2	46.32	54.20
Aug.	61.2	56.88	66.53
Sept.	57.2	56.99	56.56
Oct.	49.0	51.08	56.13
Nov.	38.2	44.50	47.44
Dec.	33.1	35.58	36.29
Ave.	44.1	44.27	46.88
Max.	66.7	68.50	72.50

NUMBER OF DAY READINGS OF TEMPERATURES BETWEEN VARIOUS LIMITS

Degrees Fahrenheit	1951	1952	1953
32 - 40	160	134	111
40 - 50	80	116	116
50 - 60	80	69	92
60 - 70	45	47	31
70 - 80	0	0	15
Total Days	365	366	365

WAUKEGAN FILTRATION AND PUMPING PLANT

MONTHLY AVERAGES OF RAW WATER TEMPERATURES IN DEGREES FAHRENHEIT

Month	1954	1955	1956	1957
Jan.	32.49	33.30	32.40	32.34
Feb.	33.78	32.58	32.57	33.18
March	34.78	34.56	34.72	35.05
April	43.02	41.31	42.56	40.63
May	47.82	43.05	47.00	47.85
June	49.80	52.29	50.50	48.91
July	58.60	60.12	61.30	57.57
Aug.	68.92	68.33	62.87	67.31
Sept.	67.98	59.85	55.72	62.14
Oct.	56.06	51.65	54.02	55.84
Nov.	46.41	41.12	43.68	44.89
Dec.	36.44	32.89	34.09	35.09
Avg.	48.00	45.92	45.95	46.72
Max.	68.92	68.33	62.87	67.13

NUMBER OF DAY READINGS OF TEMPERATURES BETWEEN VARIOUS LIMITS

Degrees Fahrenheit	1954	1955	1956	1957
32 - 40	135	141	138	135
40 - 50	97	84	95	88
50 - 60	60	82	87	64
60 - 70	41	29	44	66
70 - 80	32	29	2	12
Total Days	365	365	366	365

[illegible]

[illegible]

[illegible]	1958	1959	1960	1961	1962	1963	1964	1965
Jan.	32.40	32.01	32.51	32.25	32.63	31.60	32.57	32.73
Feb.	32.46	32.71	33.63	33.57	32.49	31.60	32.61	32.89
March	36.19	35.69	32.96	36.35	34.16	35.28	35.68	33.19
April	43.25	43.51	41.53	41.80	43.16	45.11	42.48	40.62
May	47.96	46.03	47.72	47.20	46.20	48.65	50.13	47.01
June	51.57	54.87	54.61	53.23	51.50	52.05	55.56	52.41
July	54.27	54.12	60.68	57.34	64.33	59.21	62.77	69.11
Aug.	60.13	57.24	62.63	65.37	63.26	58.20	60.55	58.06
Sept.	53.57	58.56	63.15	56.44	58.16	62.73	53.13	55.47
Oct.	49.91	52.92	57.69	58.35	57.42	59.45	47.77	49.96
Nov.	44.84	39.03	45.13	44.96	45.40	49.50	45.44	44.92
Dec.	32.65	33.94	34.14	33.91	35.37	35.66	33.28	37.39
Av.	44.96	45.05	47.21	46.20	47.40	47.42	46.04	45.39
Max. Day	70.50	68.50	73.00	75.00	69.50	69.50	73.80	78.00

NUMBER OF DAY READINGS OF TEMPERATURES BETWEEN VARIOUS LIMITS

Degrees Fahrenheit	1958	1959	1960	1961	1962	1963	1964	1965
32 - 40	123	141	134	124	118	112	139	133
40 - 50	136	102	78	101	101	95	90	102
50 - 60	80	93	76	94	66	70	88	95
60 - 70	20	29	74	36	80	88	45	32
70 - 80	6	0	4	10	0	0	4	3
Total Days	365	365	366	365	365	365	366	365

WAUKEGAN FILTRATION AND PUMPING PLANT

MONTHLY AVERAGES OF RAW WATER TEMPERATURES IN DEGREES FAHRENHEIT

Month	1966	1967	1968	1969
Jan.	33.49	32.61	32.35	33.20
Feb.	33.24	32.35	32.55	33.44
March	37.05	32.61	33.00	35.40
April	41.21	44.52	45.40	40.48
May	47.19	51.91	47.17	46.94
June	51.52	56.32	48.41	49.64
July	64.48	[illegible]	51.77	59.53
Aug.	64.44	[illegible]	49.74	57.82
Sept.	65.63	62.29	51.06	62.53
Oct.	52.04	56.78	46.41	50.95
Nov.	42.93	43.32	48.41	43.78
Dec.	35.14	36.56	36.33	35.02
Av.	47.93	46.21	39.83	45.79
Max. Day	73.20	66.00	68.00	70.00

NUMBER OF DAY READINGS OF TEMPERATURES BETWEEN VARIOUS LIMITS

Degrees Fahrenheit	1966	1967	1968	1969
32 - 40	114	128	115	131
40- 50	99	73	175	106
50 - 60	70	103	64	76
60 - 70	71	61	12	51
70 - 80	11	0	0	1
Total Days	365	365	366	365

Comparison of Average Raw Sewage
and Average Raw Water Temperatures
at Waukegan, Illinois

Temperatures - ^{o}F

	1965			1966			1967			1968			1969		
Month	Sew.	Water	ΔT	Sew.	Water	ΔT	Sew.	Water	ΔT	Sew.	Water	ΔT	Sew.	Water	ΔT
Jan.	54	33	21	55	33	22	56	33	23	55	32	23	54	33	21
Feb.	51	33	18	52	33	19	54	32	22	54	33	21	54	33	21
Mar.	51	33	18	53	37	16	53	34	19	56	33	23	54	35	19
Apr.	52	41	11	55	41	14	55	45	10	59	45	14	55	40	15
May	58	47	11	57	47	10	58	52	6	62	47	15	60	47	13
Jun.	63	52	11	63	52	11	65	56	9	64	48	16	63	50	13
Jul.	68	69	-1	70	64	6	67	55	12	67	52	15	66	60	6
Aug.	70	58	12	72	64	8	69	59	10	70	50	20	71	58	13
Sept.	68	55	13	71	66	5	69	62	7	70	51	19	71	63	8
Oct.	65	50	15	67	52	15	67	57	10	67	46	21	--	51	--
Nov.	62	45	17	63	43	20	61	43	18	62	48	14	61	44	17
Dec.	57	37	20	55	35	20	58	37	21	57	36	21	58	35	23
Ann.Av.	60	45	15	61	48	13	61	47	14	62	40	22	61	46	15
Ann.Max.	74	78	-4	75	73	2	72	66	6	74	68	6	74	70	4

R. E. Anderson

1968	(1) Average	Maximum
	Temperature Degrees F.	
Waukegan-outer	62	70
Waukegan-inner	64	70
1969	**(2) Average**	**Maximum**
Waukegan-north	62	73
Waukegan-central	61	74

(1) Average for period 4-17-68 to 9-26-68.

(2) Average for period 4-7-69 to 10-14-69.

The Illinois Sanitary Water Board, in 1966 in SWB-7, established the present maximum allowable temperature for Lake Michigan at 85 degrees Fahrenheit. This temperature limit has not been exceeded by any discharge from the Waukegan Sewage Treatment Plant. The implementation and enforcement plan for SWB-7, adopted as Rule 1.06 of SWB-7 by the Illinois Sanitary Water Board, further states at paragraph 4:

"4. Drastic or sudden temperature changes will not be permitted. The Board will insist upon controlled changes in temperatuere not to exceed 2 degrees Fahrenheit per hour, nor more than a 5-degree cumulative change from natural water degree temperature."

Although the temperature differential between the treated Waukegan wastewater and Lake Michigan water is over 20 degrees Fahrenheit at certain times of the year, the relatively small amount of heat added to the massive volume of receiving lake water and the immediate diffusion and mixing which occurs in the generally turbulent shore waters result in a thermally controlled discharge which creates no significant cumulative change from natural lake water temperature.

Therefore, from the standpoint of the North Shore Sanitary District, the 85 degree Fahrenheit maximum allowable temperature and requirements for controlled changes in temperatures appear to be acceptable standards for Lake Michigan water. Furthermore, it seems reasonable to set the maximum temperature for any controlled wastewater discharge into the lake at the maximum allowable lake temperature.

It has been reported that the Federal Water Quality Administration may propose a thermal pollution standard for Lake Michigan which would require that the temperature of all wastewater discharges vary not more than 1 degree Fahnrenheit from the ambient lake water temperature at the point of discharge. The imposition of such a standard would generally require the cooling of the treated Waukegan wastewater before discharge to the lake. In some isolated instances, it would also require heating of the treated wastewater before discharge.

The data of Exhibit A demonstrate that the treated wastewater discharges to Lake Michigan from district facilities have not adversely affected the lake water temperature in the Waukegan area. We consider it unreasonable to require the cooling or heating of treated municipal wastewater before discharge to meet a thermal standard based upon a very small variation from ambient water temperature in the receiving water.

During the period of record of Exhibit A, Lake Michigan in the Waukegan area was receiving heated discharges from the Waukegan Electric Generating Station of Commonwealth Edison Company and heated industrial cooling waters in addition to the discharges from the North Shore Sanitary District. The data of Exhibit A clearly indicate that Lake Michigan may receive a substantial amount of heat from wastewater discharges without changing the lake water temperature. It is suggested, therefore, that comprehensive studies be undertaken to establish the total amount of heat which may reasonably be discharged to Lake Michigan from all sources, and that the allowable total amount of heat discharge so established be allocated among the four lake States.

Each State could then, in turn, allocate its heat discharge allowance to the several users of Lake Michigan waters in the State. It is suggested that in each State's management of its heat allocation, emphasis be placed on control of the large heat dischargers. Moderate adjustments of large heat discharges will obviate the need for any temperature adjustment of a small heat discharge such as the Waukegan Sewage Treatment Plant.

Adoption of a comprehensive program of acceptable heat discharges to Lake Michigan and reasonable management of each State's allocation of heat discharges appears to be in the best public interest and is urged for your consideration by the North Shore Sanitary District.

MR. STEIN: Thank you.

Who do you suggest do the heat allocation of the discharges to Lake Michigan?

MR. KUHN: I suggest that the Four-State Conference come up with the local and then allocate the portions to the four conferees.

MR. STEIN: Do you suggest this conference do the allocation?

MR. KUHN: Yes.

MR. STEIN: Are there any other comments or questions?

Anyone from the audience have any questions?

D. Schwarz

If not, thank you very much.

MR. KUHN: Thank you, Mr. Chairman.

MR. STEIN: Could we have David Schwarz, Director of Corporate Environmental Control, Abbott Laboratories?

STATEMENT OF DAVID SCHWARZ, DIRECTOR, CORPORATE ENVIRONMENTAL CONTROL, ABBOTT LABORATORIES, NORTH CHICAGO, ILLINOIS

MR. SCHWARZ: Mr. Chairman, members of the conference, ladies and gentlemen. My name is David Schwarz. I am Director of Corporate Environmental Control for Abbott Laboratories.

Abbott Laboratories is committed to doing everything necessary to achieve compliance with all legal environmental pollution control regulations. In most cases this commitment to compliance means the continuing expenditure of substantial sums of technical and monetary resources to meet changing and more stringent regulations. We have been able to interpret and live with all of the regulations proposed to date. In the case of thermal pollution, however, we at Abbott are concerned that a new thermal standard will be adopted which cannot in practice be met without extraordinary and unjustified expenditure of funds. We feel compelled to speak out to prevent the unnecessary economic hardship not only to ourselves but also to other industry and to society who will ultimately have to bear the cost.

The Abbott plant at North Chicago uses between 12 and 20 million gallons of water each day in various process and utility operations. This water is pumped from Lake Michigan through the pumping facilities of the city of North Chicago, whose water intake extends about 1 mile into the lake. Our usage varies directly with the temperature of the water in the lake.

We have collected and plotted our inlet lake water temperature for the years 1965 through 1969 in a table appended. (See P. 1661) This temperature is measured by a continuous temperature recorder within the Abbott plant. Occasional spot checks have demonstrated that the temperature measured at the Abbott recorder is the same as measured at the North Chicago pumping station. Both temperatures represent the temperature of the open water at a point approximately 1 mile into the lake and at a depth of 30 feet.

One of the proposed amendments to the present thermal standards is known as the "State of Michigan Concept." Included in this amendment is the following:

D. Schwarz

"Lake Michigan shall not receive a heat load which would warm the thermocline or the hypolimnion, nor may any waters be warmed greater than 3 degrees above natural lake temperature nor above the maximum allowable temperature shown in the temperature limitation table, whichever is lesser."

When we compare the inlet water temperature at Abbott for the 5-year period with the Temperature Limitation Table we see the following:

Temperature Limitation Table

Month	Open Water Temp. Limit, °F	Shore Water Temp. Limit, °F	Abbott Inlet Mean Temp., °F	Number of Days in 5 Years That Inlet Temp. Was Above Shore Limits
Jan.	42	42	32.9	0
Feb.	37	37	33.2	0
Mar.	37	37	35.1	55
April	44	44	42.7	85
May	53	53	47.7	4
June	65	65	53.2	0
July	71	72	60.3	4
Aug.	74	77	60.9	0
Sept.	72	75	61.2	0
Oct.	65	65	57.7	0
Nov.	54	54	39.9	0
Dec.	50	50	36.2	0

In March and April with the temperature limits as proposed, the temperature of the lake itself frequently exceeds the limits. In February the water temperature is often so close to the limit that any heat input would frequently raise the discharge temperature above the limit.

D. Schwarz

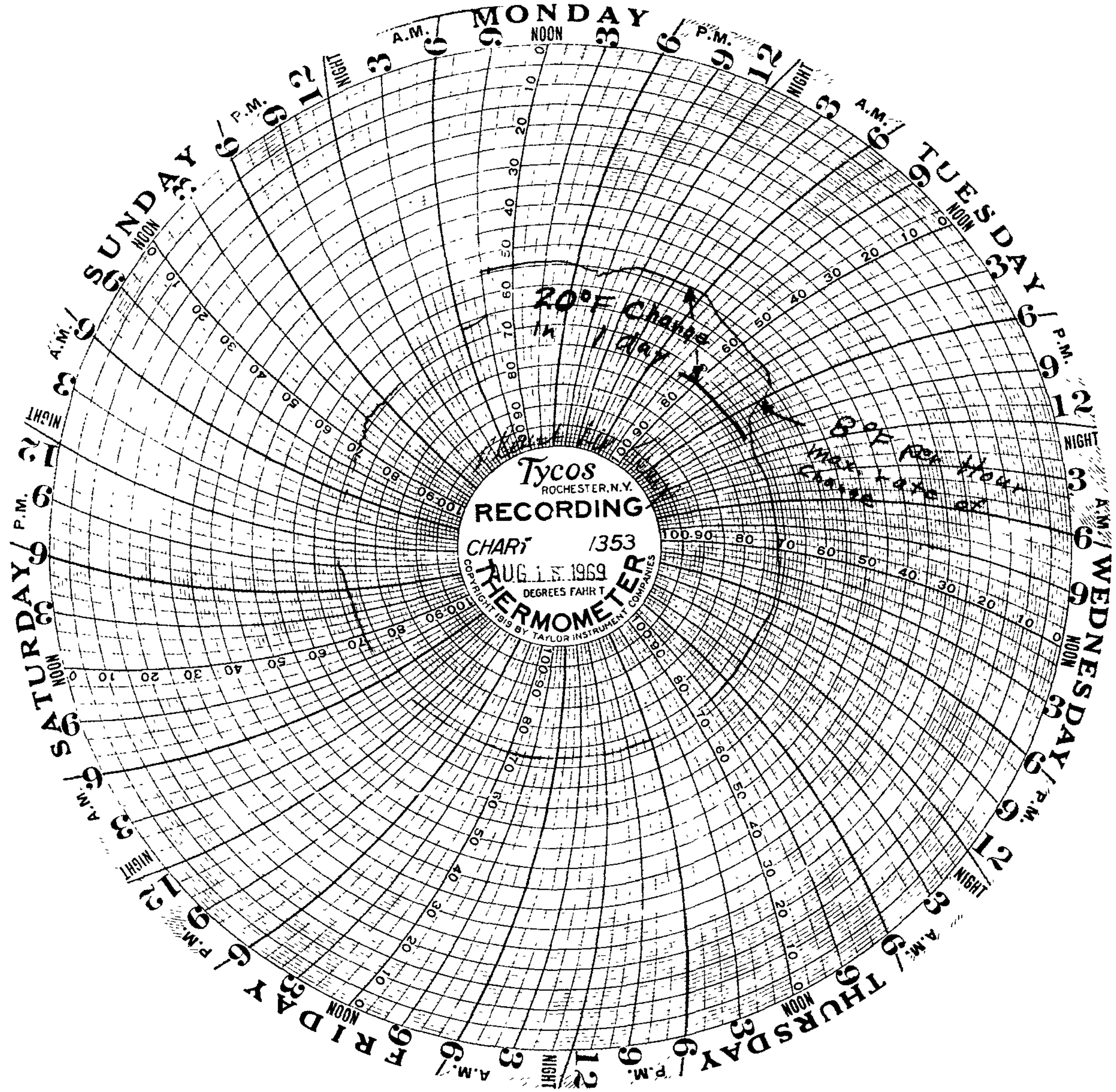
We must, therefore, raise the following question: Is there any logical basis for establishing temperature limits which are sometimes less than the natural water temperatures?

We must also point out in our data the large variation in daily water temperature in a given month. Our daily temperature charts show that the water temperature often varies by more than 10 degrees Fahrenheit in a 24-hour period and occasionally varies by more than 15 degrees Fahrenheit in just a few hours. These variations can be seen in the temperature charts appended. (See Pp. 1663a and 1663b) We would expect that similar and perhaps even wider fluctuations would be seen in the examination of the inlet water data from other industries and municipal water treatment plants on the lake.

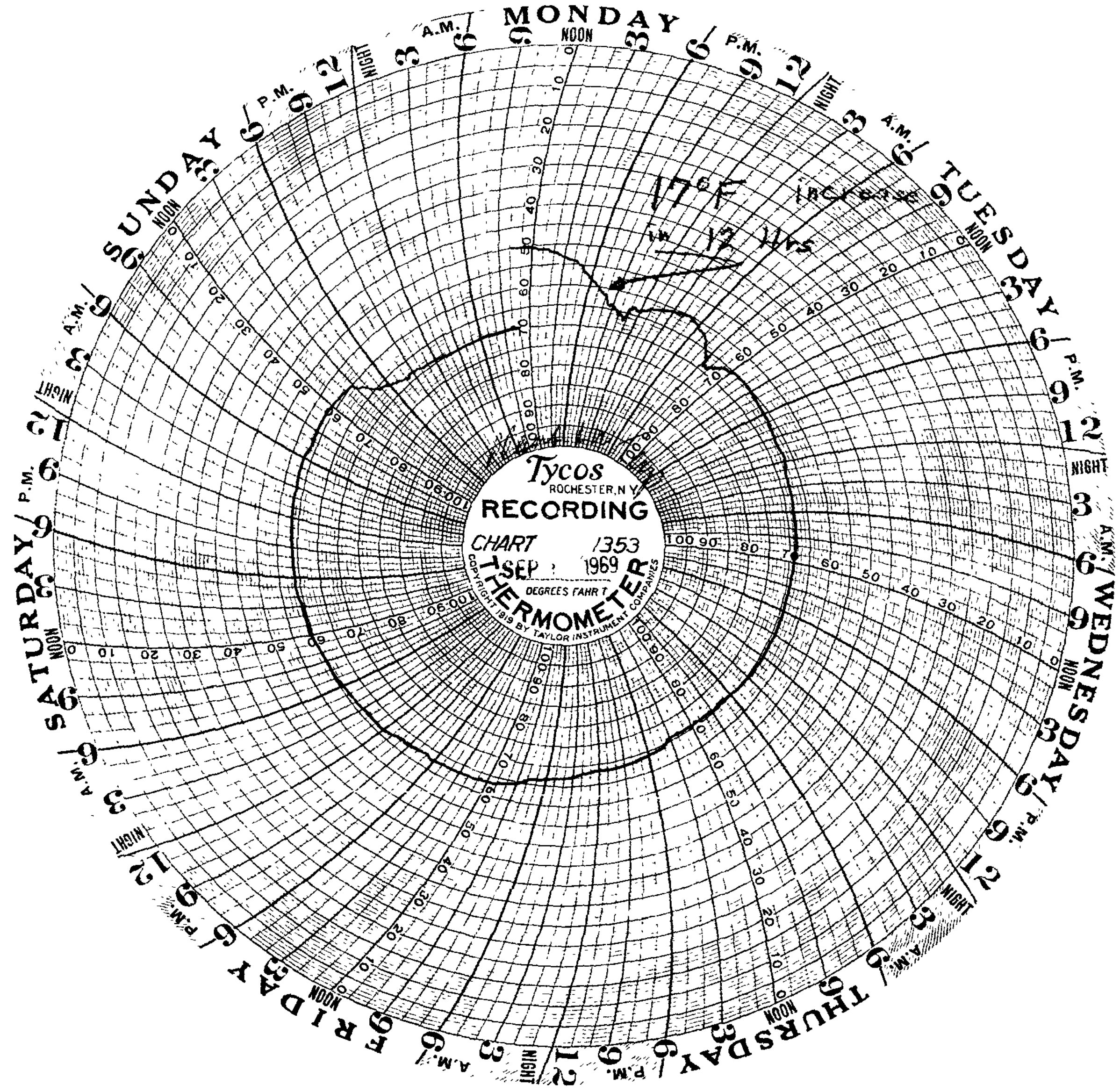
We must also, therefore, ask the following question: Why is there any concern with establishing standards which limit temperature changes to 3 degrees Fahrenheit or 5 degrees Fahrenheit when the organisms in Lake Michigan are naturally and frequently subjected to much greater temperature variation?

We have appended a report from Argonne National Laboratory entitled, "Effects of Man-Made Thermal Discharges on the Mass/Energy Balance of Lake Michigan." (See Pp.

INLET LAKE WATER TEMPERATURE
TO ABBOTT LABORATORIES, NORTH CHICAGO, ILLINOIS
Week of August 18-25, 1969
(DEMONSTRATES WIDE NORMAL TEMPERATURE FLUCTUATION)



INLET LAKE WATER TEMPERATURE
TO ABBOTT LABORATORIES, NORTH CHICAGO, ILLINOIS
Week of September 1-8, 1969
(DEMONSTRATES WIDE NORMAL TEMPERATURE FLUCTUATION)



1665-1690) This report concludes that the lakewide effects of manmade thermal discharges into Lake Michigan are negligible and will continue to be so for the rest of this century.

We have also appended a report entitled, "The Calefaction of a River," by Daniel Merriman in which thermal discharges into the Connecticut River were studied in detail. (See Pp. 1691-1701) This report states that industrial heating into this major river has so far had no drastic biological consequences. The levels of heating encountered may even turn out to have beneficial long-range results.

We can appreciate and we share the concerns for the protection of the lake. The data, however, existing today, about the effects of thermal discharges on the lake, are very sparse, very contradictory, and do not convey a justified sense of urgency for change at this time. As a corporation, we are committed to complying with the thermal standards, whatever they might be. We must urge, therefore, that we have an enforceable standard, with a precise definition of what compliance is, that we can use to design our equipment and measure our performance. We do not see these qualities in the proposed amendments to the existing standards.

ARGONNE NATIONAL LABORATORY
9700 South Cass Avenue
Argonne, Illinois 60439

Effects of Man-Made Thermal Discharges on the Mass/Energy Balance of Lake Michigan

J. G. Asbury

May, 1970

Center for Environmental Studies

TABLE OF CONTENTS

1.0 Mass/Energy Balance

Lake-wide physical effects of thermal discharges on Lake Michigan - particularly as these effects relate to the mass/energy balance - have been investigated.

The following is a summary of the philosophy, techniques, and conclusions of this study. A more complete report is in preparation and will soon be available.

1.1 Introduction

In the most general sense, the motivation for the study is the desire to contribute to the understanding of the physical qualities of Lake Michigan in order to improve their utilization and to insure their preservation by society. This study was specifically concerned with the heat assimilative capacity of Lake Michigan relative to present and projected man-made thermal loads. The methods developed for the Lake Michigan study are now being used in analyzing the heat assimilative capacities of the other Great Lakes.

The remainder of this report is divided into three sections: Conclusions, The Study, and Future Research.

1.2 Conclusions

It has been concluded that the lake-wide effects of man-made thermal discharges into Lake Michigan are presently negligible and will continue to be so for the rest of this century.

The average annual increase in water surface temperature for the whole lake has been determined to be $9.2 \pm 2.0 \times 10^{-4}$ °F per gigawatt of thermal discharge; the associated annual average increase in evaporative water loss, 10 ± 2 cfs per gigawatt of thermal discharge. The indicated uncertainties represent reasonable estimates of possible computational error. The most likely source of error is in the choice of the evaporation formula used in the analysis. We selected the Lake Hefner formula,[1] since it has been used with apparent success by other authors in calculating absolute rates of evaporation from the Great Lakes.[2,3,4,5]

Man-made thermal discharges can also be compared with the lake energy budget. A one-gigawatt advective input is equivalent to 0.13 BTU/(ft^2·day); the naturally occurring average rate of increase of lake content during the March-August warming season is 1100 BTU/(ft^2·day) .

The existing and projected effects on the lake's mass/energy balance are summarized in Table 4.

1.3 The Study

1.3.1 Thermal Discharges

The three principle man-made sources of thermal discharges are: electric utility generating stations, steel plants, and municipal waste-water treatment plants. With the exception of the treatment plants, these sources have been inventoried.

The thermal load imposed by municipal wastewater discharges can be shown to be less than 10% of that due to power generation on a per capita water use basis.. The percentage is less for the Lake Michigan Basin because the Chicago area discharges its wastewater into the Illinois River System while generating a significant portion of its power on the shores of the Lake. Treatment plant discharges have therefore been omitted from the inventory.

Steel plant discharges have been determined from FPC records of in-house power generation by steel companies and from estimates of heat rejection by other steel production processes. Steel mills in the Chicago-Gary area (representing over 96% of the Basins's steel capacity) generated in-house electrical power at an average annual rate of 320 megawatts during 1969. Total heat rejected by all processes is estimated to be 74 x 10^9 BTU/day. This is considerably less than the 147 x 10^9 BTU/day attributed to steel plants by H. G. Acres, Ltd. in its report "Thermal Inputs to the Great Lakes 1968-2000."[6]

Electric utility generating capacity has been inventoried and found to be 7.85 gigawatts - vs. 7.75 Gw obtained by H. G. Acres. Total heat rejected by all utilities is estimated as 450 x 10^9 BTU/day = 5.3 Gw .

Figure 1 shows the locations of existing and proposed electrical generating stations on Lake Michigan, and Table 1 gives present and projected (assuming a 7% per annum growth) generating capacities.

As is well known, nuclear plants are presently less efficient than fossil plants and therefore waste more heat to the environment. Table 2 compares the efficiencies and waste heat rates of fossil and nuclear plants. It should be noted, however, that nuclear reactor technology is in a relatively early stage of development. Nuclear plant efficiencies can therefore be expected to improve at a more rapid rate than fossil plant efficiencies.

1.3.2 Mass/Energy Balance of Lake Michigan

The man-made thermal discharge rate must be viewed in context with the overall energy balance of the Lake. Figure 2 illustrates and defines the various terms entering into the energy balance equation. The change in lake heat content ΔH is seen to be the sum of the net heat exchange across the surface and the advective input. Since the advective term is typically

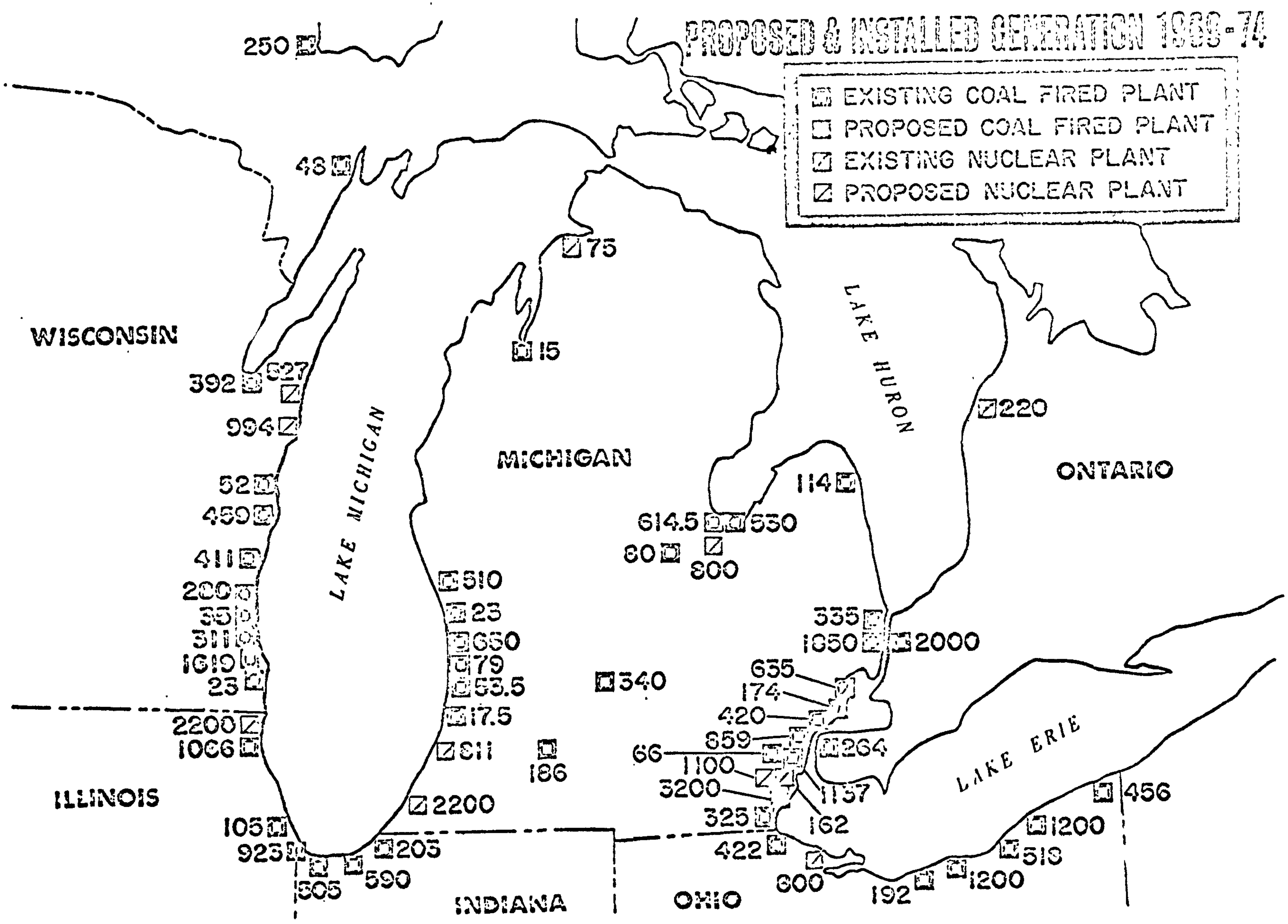


FIG. 1 (From: Wingert, W. L.; Michigan Governors Conference, July 1969)

TABLE I

GENERATING CAPACITY ON LAKE MICHIGAN

TYPE	EXISTING	PROPOSED (1975)	TOTAL (1975)	PROJECTED (1990)
FOSSIL	7.77 GW	0	7.77	9.0
NUCLEAR	0.075	6.78	6.86	32.0
TOTAL	7.85	6.78	14.63	41.0

TABLE 2

NUCLEAR VS FOSSIL PLANT EFFICIENCIES

PLANT TYPE	ENERGY				
	INPUT	ELECTRICAL	LOSSES		
			IN-PLANT	STACK	WATER
NUCLEAR	100	33	4	0	63
FOSSIL	100	40	4	10	46

PER UNIT ELECTRICAL ENERGY GENERATED, NUCLEAR PLANTS WASTE (63/33) = 1.91 UNITS TO CONDENSER COOLING WATER. CURRENT NUCLEAR PLANTS DISCHARGE (63/33) ÷ (46/40) = 1.67 TIMES AS MUCH HEAT TO CONDENSER COOLING WATER AS DO FOSSIL PLANTS.

LAKE ENERGY BALANCE

H_s = SOLAR RADIATION

H_{sr} = REFLECTED SOLAR RADIATION

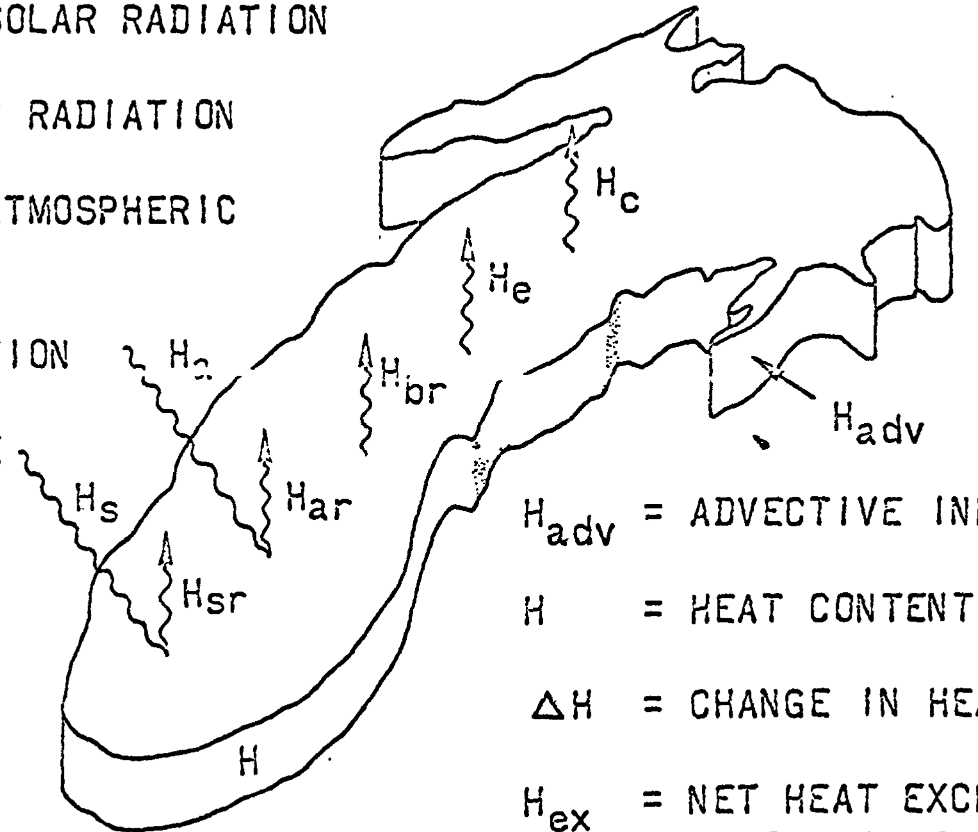
H_a = ATMOSPHERIC RADIATION

H_{ar} = REFLECTED ATMOSPHERIC RADIATION

H_{br} = BACK RADIATION

H_e = EVAPORATIVE HEAT LOSS

H_c = SENSIBLE HEAT LOSS



H_{adv} = ADVECTIVE INPUTS

H = HEAT CONTENT

ΔH = CHANGE IN HEAT CONTENT

H_{ex} = NET HEAT EXCHANGE ACROSS SURFACE

$$H_{ex} = \left[H_s - H_{sr} + H_a - H_{ar}\right] - \left[H_e + H_c + H_{br}\right]$$

$$\Delta H = H_{ex} + H_{adv}$$

FIG. 2

two orders of magnitude smaller than the surface exchange term, it is the latter which mainly drives the heat content. Figure 3 shows a Lake Michigan heat content curve developed by Church from his bathythermograph measurements.[7] (The BTU/ft^2 scale has been added to his figure to facilitate comparison with the discharge rates presented in this report.) The heat content of a mid-lake column is seen to increase by 50,000 cal/cm^2 = 185,000 BTU/ft^2 between the March minimum and the August-September maximum. During this period, therefore, heat is added to the Lake at average rate of roughly 1100 $BTU/ft^2/day$. By way of comparison, a 1-Gw advective input corresponds to 0.13 $BTU/ft^2/day$.

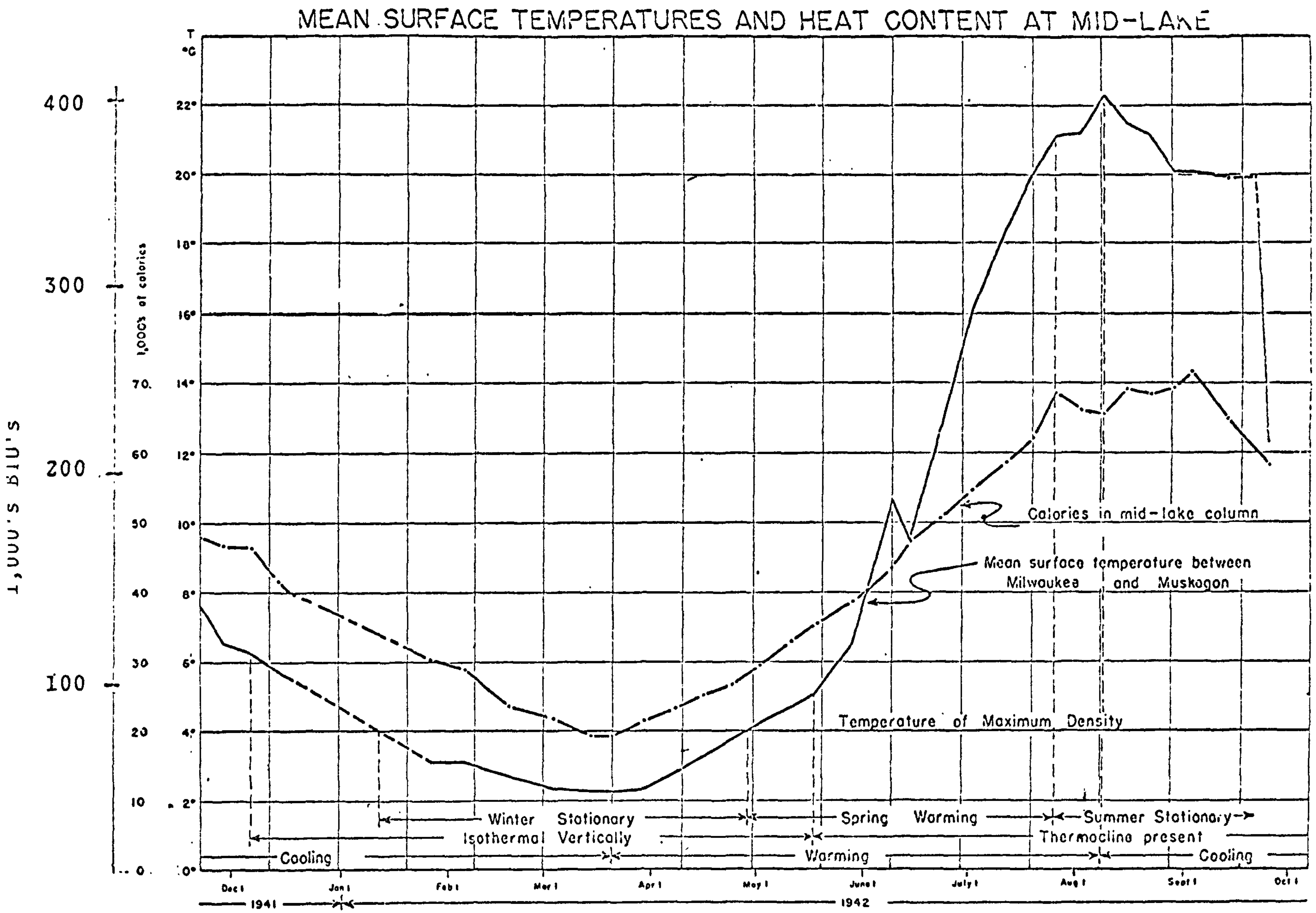
Increased evaporative losses can affect the water balance of Lake Michigan. Figure 4 illustrates the various terms in the water balance and Table 3 gives the annual average flows. The stated uncertainties in evaporation and Straits outflow represent extremes in the determination of these flows for Lake Michigan.[8,9,10,11] Due to lack of data regarding net flow through the Straits, evaporation rates determined from mass transfer formulae cannot be readily compared with rates deduced from a water balance calculation. Water balance methods can, however, be applied to the combined Lake Michigan-Huron system.

As will be shown below lake-wide evaporation is increased only 10 ± 2 cfs per Gw increase in advective input to the Lake.

1.3.3 Analytical Method

Figure 5 summarizes the analytical technique used in developing a heat exchange coefficient K . The exchange coefficient can be used to express, in a simple way, the difference between the rate of heat transfer across a water surface at temperature T_s' and one at T_s .

$$H_{ex}(T_s') - H_{ex}(T_s) = K(T_s' - T_s) \quad (1)$$



Mean surface temperatures and heat content at mid-lake.

FIG. 3

WATER BUDGET

P = DIRECT PRECIPITATION

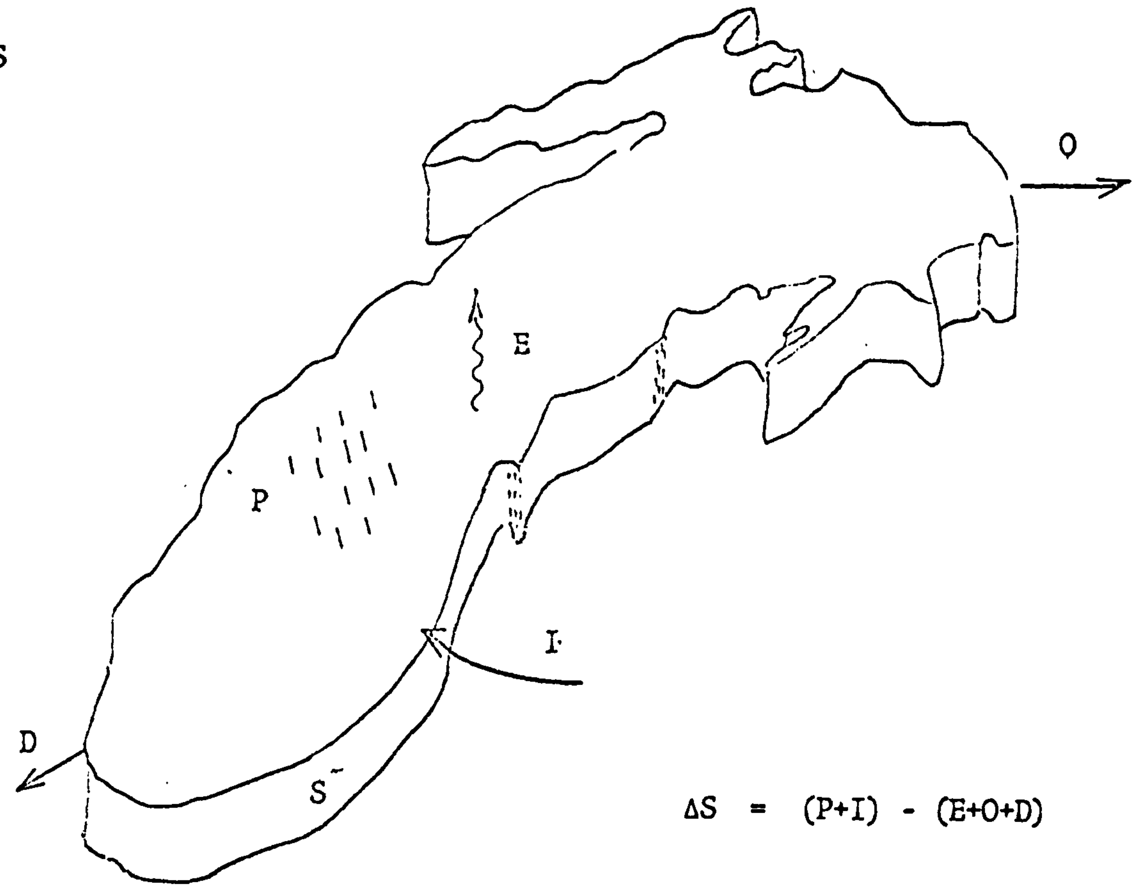
I = STREAM + SHORE RUNOFF

E = EVAPORATION

O = OUTFLOW THRU STRAITS

D = DIVERSION

S = LAKE STORAGE



$$\Delta S = (P+I) - (E+O+D)$$

FIG. 4

TABLE 3

LAKE MICHIGAN WATER BUDGET

WATER BALANCE TERM		AVERAGE FLOW (CFS)
INFLOW	Precipitation	50,000 ± 2,000
	Runoff	39,000 ± 1,000
OUTFLOW	Evaporation	40,000 ± 5,000
	Straits	46,000 ± 6,000
	Diversion	3,200

Surface Heat Exchange Equation:

$$H_{ex} = \underbrace{\overbrace{[H_s - H_{sr} + H_a - H_{ar}]}^{T_s \text{ Independent}}}_{H_R} - \overbrace{[H_e + H_c + H_{br}]}^{T_s \text{ Dependent}}$$

Ts Dependent Terms:

$$H_e = (e_s - e_a) f(W)$$

$$H_c = B\, H_e = \left[.26\left(\frac{T_s - T_a}{e_s - e_a}\right)\right](e_s - e_a) f(W) = .26(T_s - T_a) f(W)$$

$$H_{br} = \varepsilon\sigma(460 + T_s)^4 \approx \varepsilon\sigma(460)^4\left(1 + \frac{4T_s}{460}\right)$$

Subtraction:

$$H_{ex}(T_s') = H_R - [(\epsilon_s' - e_a) + .26(T_s' - T_a)] f(W) - \varepsilon\sigma(460)^4(1 + \frac{T_s'}{115})$$

$$H_{ex}(T_s) = H_R - [(e_s - e_a) + .26(T_s - T_a)] f(W) - \varepsilon\sigma(460)^4(1 + \frac{T_s}{115})$$

$$H_{ex}(T_s') - H_{ex}(T_s) = -[(e_s' - e_s) + .26(T_s' - T_s)] f(W) - 15.7(T_s' - T_s)$$

Let: $e_s = \beta\, T_s \qquad \beta = \beta\,(T_s)$

$$H_{ex}(T_s') - H_{ex}(T_s) = -[15.7 + (\beta + .26) f(W)](T_s' - T_s)$$

$$H_{ex}(T_s') - H_{ex}(T_s) = K\,(T_s' - T_s)$$

FIG. 5

The method summarized in Fig. 5 is essentially that of Edinger and Gyer.[12] The water surface temperature dependent terms H_e, H_c, and H_{br} have been parameterized in the usual way with the sensible heat term related to the evaporation term through the Bowen Ratio B. The wind speed function, temporarily, is left unspecified.

The final form of the exchange coefficient is -

$$K = -[15.7 + \beta f(w) + 0.26\ f(w)] \qquad (2)$$

where the three terms represent, respectively: black body radiation, evaporative heat transfer, and sensible heat transfer. $\beta = \beta(T_s)$ is the slope of the saturated vapor pressure curve evaluated at the water surface temperature; the Bowen Coefficient has been set equal to 0.26 . The units for the wind speed function $f(w)$ are BTU/(ft^2·day·mm H_g) ; for K , BTU/(ft^2·day· °F).

Equation (1) above can be used to calculate the average annual increase in water surface temperature due to an increase in advective input. If $\bar{q}$ represents the annual average of the additional advective input,

$$(1\ \text{year}).\ \bar{q} = \oint K\ (T_s' - T_s)dt \qquad (3)$$

where $(T_s' - T_s)$ is the water surface temperature increase required to dissipate the increased heat load. Since K is nearly constant over the annual cycle (see below) -

$$\bar{q} \div \bar{K} = (T_s' - T_s)\ .$$

Once K is know, the annual average increase in water surface temperature can be determined.

We have evaluated K according to Eq. (2) using the Lake Hefner wind speed function

$$f(W) = 11.4\ W \qquad \mathrm{BTU/(ft^2 \cdot d \cdot mm\ H_g)} \quad W \text{ in mph} \tag{4}$$

We have chosen this particular formula because it has been used with apparent success by other investigators in determining rates of evaporation from the Great Lakes.[2,3,4] Figure 6 shows a number of other wind speed formulae.[13]

Substituting Eq. (4) into Eq. (2) gives

$$K = -[15.7 + (\beta+0.26)\ 11.4\ W] \tag{5}$$

Church's water surface temperatures (see Fig. 3) and wind data acquired from the Illinois State Water Survey were used to calculate month-average values of K. The wind data are presented in Fig. 7 where monthly wind speeds from 6 weather stations have been averaged together and plotted. The stations are located in Chicago, South Bend, Escanaba, Muskegon, Sault Ste. Marie, Green Bay, and Milwaukee. The smooth curve shown in Fig. 7 is an eye-ball fit to the data. Before use in Eq. (5), these data were multiplied by the wind speed correction factor of Lemire[14] and Richards[15] in order to take into account the systematic monthly variation between lake and land wind speeds.

Month-average values for the exchange coefficient are shown in Fig. 8. The annual average value of K is 141 $\mathrm{BTU/(ft^2 \cdot day \cdot °F)}$.

For an advective input of one Gw = 0.13 $\mathrm{BTU/(ft^2 \cdot day)}$, the average annual increase in water surface temperature is (0.13) ÷ (141) = 9.2×10^{-4} °F This temperature increase is somewhat larger than the 8.5×10^{-4} °F given in ANL Report No. 7679. The annual average value of K quoted in the latter report

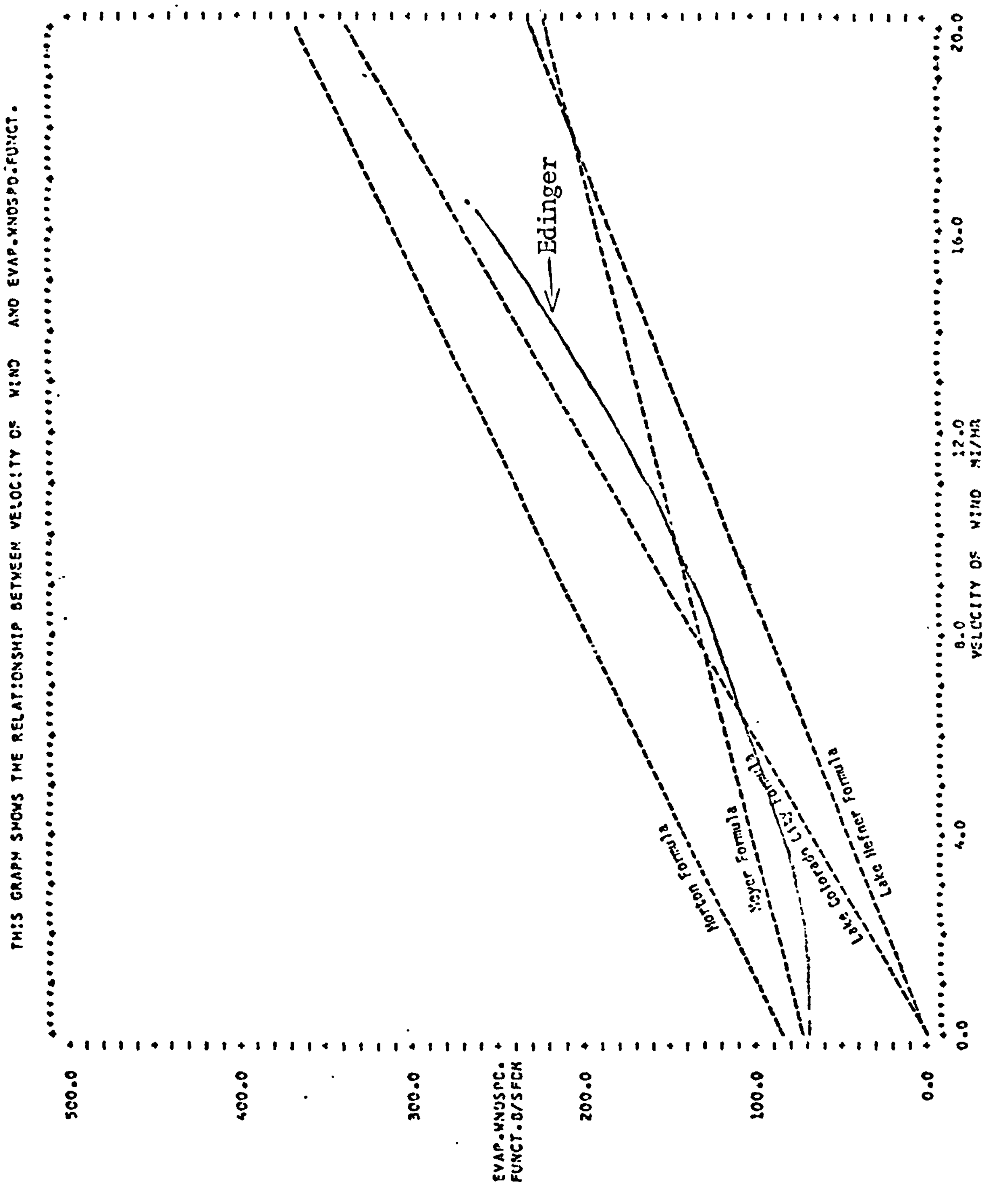


FIG. 6 Comparison of Evaporation Formula Windspeed Functions

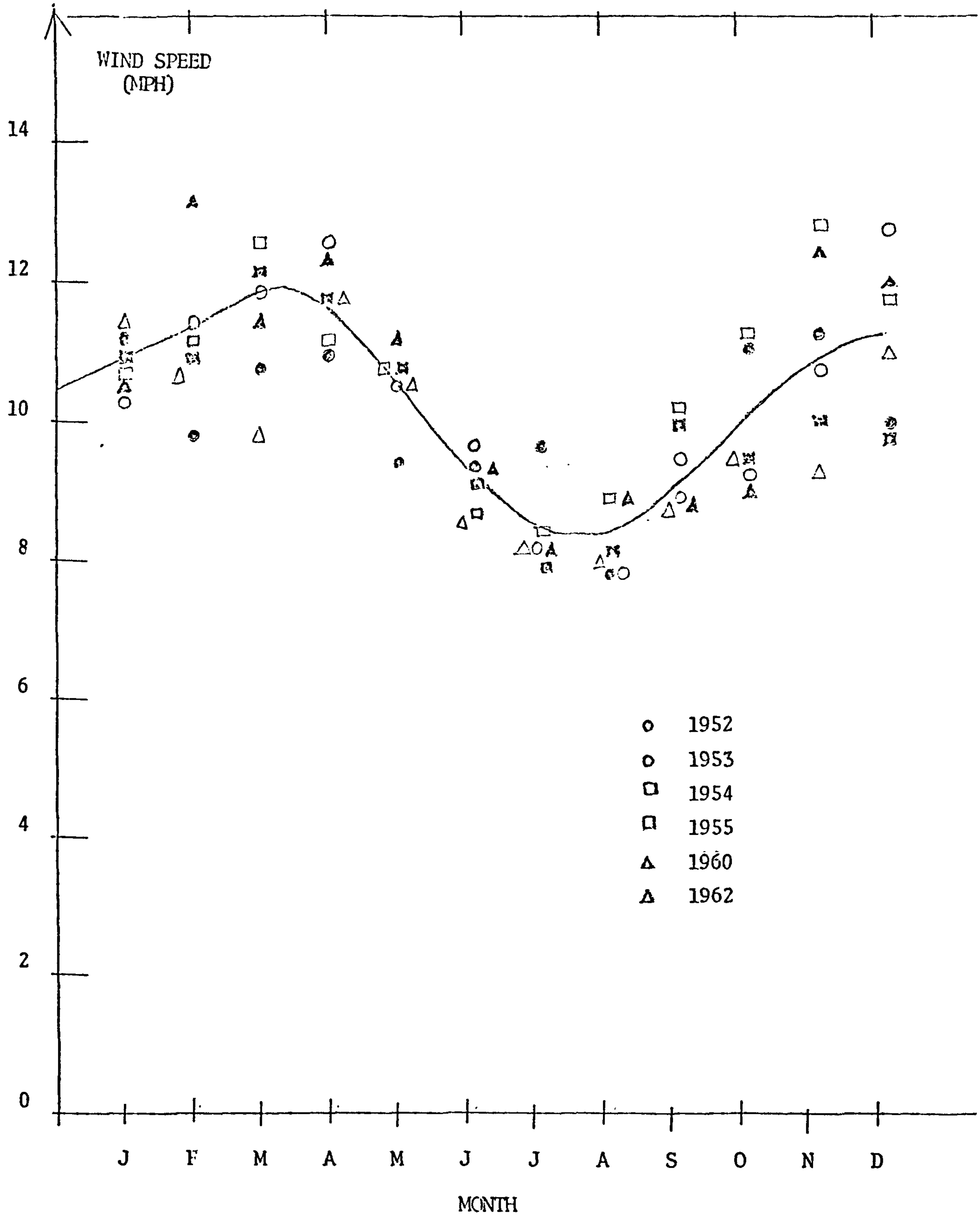


FIG. 7 MONTH AVERAGE WIND SPEEDS

was 152 BTU/($ft^2 \cdot day \cdot °F$) . This value was obtained using the Meyer Formula for evaporation rather than the Lake Hefner formula.

The evaporative water loss can be obtained by separating the evaporative contribution to K from those due to the other two exchange mechanisms.

$$K = K_\epsilon + K_c + K_{br} \ .$$

Month average values for each of the terms on the right-hand side are plotted in Fig. 8. The water loss Q_e due to evaporation is easily calculated -

$$Q_e = \frac{1}{L} \frac{\bar{K}_e}{\bar{K}} (1 \ \mathrm{Gw}) \cdot$$

where L is the latent heat of evaporation. Since $\bar{K}_e$ = 70 BTU/($ft^2 \cdot d \cdot °F$) (= 0.5 $\bar{K}$) , Q_e = 500 lbs/sec = 8 cfs. This rate of water loss is somewhat low because it is based on the lake-wide average value of the ratio $\bar{K}_e/\bar{K}$. The actual loss is greater, because the ratio $\bar{K}_e/\bar{K}$ increases slowly with water surface temperature and is therefore greater near the discharge points. A more refined calculation, which will be reported later, takes this factor into account and yields Q_e = 10 ± 2 cfs per Gw of advective input.

The above determinations for water surface temperature increase and for evaporative water loss can be applied to present and projected rates of thermal discharge. The results are summarized in Table 4. The Table 4 discharge versus generation rates for 1975 reflect the greater rate of heat rejection to the condenser cooling water for those nuclear plants now under construction (see Table 2). The temperature increases reported here are lower than those reported earlier:[16] (1) because the lake/land wind speed

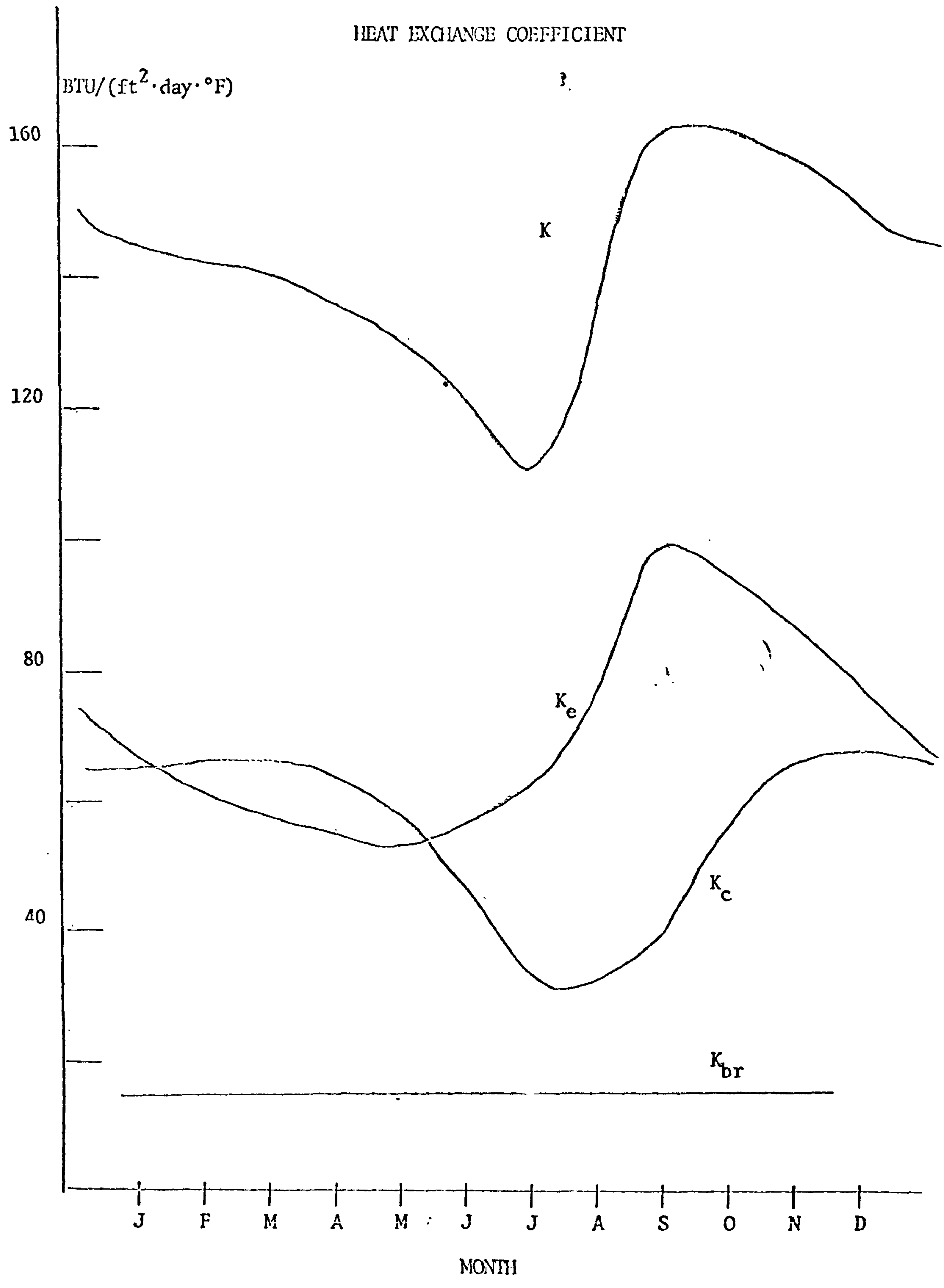

HEAT EXCHANGE COEFFICIENT
BTU/(ft²·day·°F)
160
120
80
40
K
K_e
K_c
K_{br}
J
F
M
A
M
J
J
A
S
O
N
D
MONTH

TABLE 4

LAKE-WIDE EFFECTS OF MAN-MADE THERMAL DISCHARGES

Year	Utilities		Discharges		$\bar{q}$ (BTU/ft^2/day)	ΔT_s (°F)	Q_e (cfs)
	Generating Capacity (Gw)	Average Generation (Gw)	Utility Discharge (Gw)	Other (Gw)			
1969	7.9	4.8	5.3	0.8	0.8	0.0055	61
1975	14.6	7.8	11.9	0.9	1.6	0.012	130
2000	75	53	75	1.4	9.9	0.070	760

correction factor of Lemire and Richards was applied to the wind speeds and (2) because utility discharge rates were calculated from generating rates rather than from generating capacities.

The degree of mixing between the North and South Basins of the Lake over an annual cycle is not known. It is therefore useful to estimate the surface temperature increase of the South Basin assuming no mixing. Taking into account relative surface areas and present and projected distributions of thermal discharges, we estimate the South Basin water surface temperature increases to be 1.8 times the whole-lake temperature increases given in Table 4. The North Basin temperature increase is, of course, correspondingly lower.

1.3.4 Future Research

The analytical method described above is immediately applicable to the other Great Lakes. The data necessary for the analysis are all available and are currently being acquired. Several inventories of thermal discharges now exist and have been reported.[17] Water surface temperatures for the four other Great Lakes are available from the Canadian Center of Inland Waterways. Results for the other lakes should be available by the end of fiscal year 1970.

The important problem of "interfacing" the far field region of plumes with the main body of lake water is far from solved. The rate of heat dissipation by the plume to atmosphere is known to be small. The plume decay factor due to heat dissipation to the atmosphere is general and simple: $\exp(-t/\tau)$, where t = time and $\tau = (dc_p\rho)/K$ is the "lifetime" of the heat content of the plume. For an average plume depth d = 20 ft and exchange coefficient K = 141 BTU/(ft^2·day·°F), τ = 8.9 days!

The current structure experiment recently proposed by Mortimer should yield considerable information concerning the plume/lake-water interaction in the far field region. One of the experiment's specific goals is to determine whether or not a mixing inhibiting thermal bar is established at the Oak Creek outfall during the winter months.

Mortimer's data may prove useful in another way. Palmer has recently developed a methodology for constructing plume "dispersion patterns" from a continuous history of current data at a particular location. We have incorporated his method into a more general model which predicts average concentrations (temperatures) at arbitrary points in the far field region. The model, which is current data limited, could be tested at the Oak Creek outfall.

In addition to studying the effects of man-made thermal discharges on the lakes proper, it is also necessary to assess possible meteorological and climatological effects. "While this amount [man-made discharges] of heat is small compared to natural processes (sunshine, natural evaporation, etc.), it does not necessarily follow that the meteorological consequences (both long-term and short-term) will also be small."[18] Progress in determining meteorological consequences of thermal discharges will, of course, be very dependent upon progress in understanding the micrometeorology of the Great Lakes' air-water interface.[19]

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17) See reference 6) and the Field Studies section of this Report: Steam Electric Power Plants Sited on the Great Lakes and Interconnecting Bodies of Water.

18) Carson, J., "Meteorological and Climatological Consequences of Thermal Pollution from Nuclear Power Generating Stations," (to be published). It should be pointed out that Carson, using a somewhat different approach, has also concluded that thermal discharges will not significantly affect the mass/energy balance of Lake Michigan.

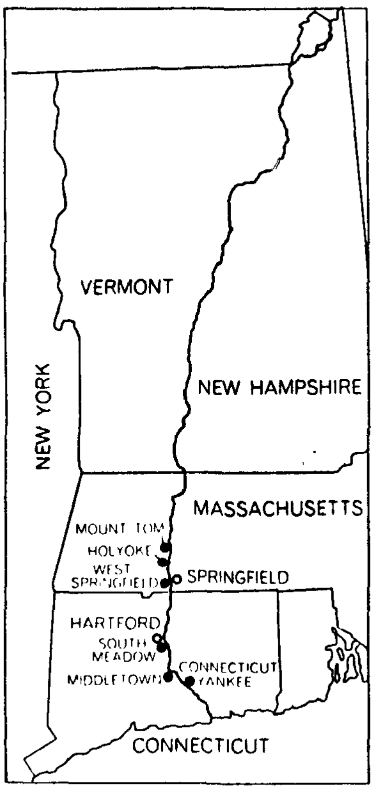
19) Frenzen, P., (private communication). Frenzen emphasizes that the micrometeorology of the Great Lakes' air-water interface is not well understood. As pointed out in the text, macro-scale, long-term-average rates of evaporation have been calculated with apparent success by investigators using the Lake Hefner formula (see references (2), (3), (4), and (5).) This is no guarantee, however, that this formula, or any other, developed from studies of smaller lakes accurately reflects the micrometeorology of the Great Lakes. Frenzen proposes to measure such quantities as net radiation, Bowen ratio, and rate of evaporation at a Lake Michigan site.

The Calefaction of a River

Calefaction means warming, and the industrial warming of rivers and other waters is a cause of concern. A study of the warming of the lower Connecticut River, however, reveals no drastic effects

by Daniel Merriman

In recent years there has been much concern that the waste heat being discharged into rivers, lakes and seas by industrial activities is having a catastrophic effect on the populations of fishes and other organisms that live in these waters. This concern is eminently justified; clearly there is an upper limit to the amount of heat that can be introduced into such waters without harmful results. It is now possible, however, to view the biological effects of heating with some degree of perspective. A long-term study in which I am participating, for example, has shown that industrial heating in a major river of the northeastern U.S. has so far had no drastic biological consequences. The levels of heating we are encountering may even turn out to have beneficial long-range results. In such circumstances the term "thermal pollution," which is currently in wide use, is misleading because it suggests that any amount of heating is harmful. A better word is "calefaction," which is simply defined as the state of being warmed.



CONNECTICUT RIVER divides Vermont from New Hampshire, crosses Massachusetts and Connecticut and then empties into Long Island Sound. The Connecticut Yankee Atomic Power Company's generating plant (*color*) is one of six power plants on the Connecticut that use its water for cooling.

The river being investigated in our study is the Connecticut, which flows generally southward some 400 miles from its source in northeastern New Hampshire, collecting the runoff from a good part of central New England before emptying into the eastern end of Long Island Sound. The study is focused on a five-mile stretch of the river above and below Haddam Neck, a site 15 miles from the mouth of the river where the Connecticut Yankee Atomic Power Company has built a nuclear power plant. The steam condensers of this plant (not the nuclear reactor) are cooled by water from the river.

The study has been under way since 1965, and it will continue at least until the end of 1972. It was undertaken at the expense of the power company as one of the conditions set by Connecticut state authorities for approval of the Haddam Neck plant's construction. Our investigations started about 30 months before the plant began to return to the river water that was 20 degrees Fahrenheit warmer than when it was withdrawn. As a result we can now begin to compare conditions then with conditions today, at the end of a roughly equal span of plant operation.

The effluent from the Haddam Neck plant is now discharged at an average rate of 828 cubic feet per second (almost 372,000 gallons per minute). At this point the Connecticut is a tidal river with a maximum depth of 30 feet at low tide and a maximum width of more than 2,000 feet. Flood tides in Long Island Sound push water of diminishing salinity upstream as far as East Haddam, a few miles south of the plant, and raise the level of the river as far north as Hartford, 45 miles inland. The difference between high and low tide in the vicinity of the plant is about 2½ feet.

Seasonal variations in river temperature range from the winter low of freezing to a summer high that seldom exceeds 86 degrees F. The flow of water in the river is at its peak from March through May, as the river is fed the runoff from melted winter snow. In summer the river dwindles, even though the average monthly precipitation is about the same throughout the year. (Monthly precipitation at Hartford, for example, averaged between three and four inches from 1900 through 1939) The summer shrinkage of the river is the result of evaporation and of the uptake of rainfall by plants during the growing season. Over the past five decades the average daily rate of flow of the Connecticut, as recorded by the U.S. Geological Survey, has been about 16,000 cubic feet per second. During this period the maximum flow was 282,000 cubic feet per second (recorded on March 20, 1936); the minimum was 968 cubic feet per second (recorded on October 20, 1963), a scant 140 cubic feet more than is now diverted to the Haddam Neck plant. These measurements were made well above the zone of tidal influence. In the vicinity of the power plant the daily average tidal flow has a minimum rate of 15,000 cubic feet per second.

The calefaction of U.S. rivers, lakes and coasts is certain to increase as the power industry meets the rising national demand for electricity. The generating capacity of power plants in the continental U.S. (Alaska excluded) is estimated by the Edison Electric Institute to have been 315,000 megawatts at the end of 1969 and is expected to reach 576,000 megawatts by 1980. Nearly 1.5 billion megawatt-hours of electric power was produced in 1969; the Edison Institute forecasts an output close to three billion megawatt-hours in 1980 and between six and 10 billion megawatt-hours by the year 2000.

The average daily natural runoff of water in the continental U.S. (again excluding Alaska) is about 1.2 trillion gallons. We use perhaps 10 percent of this amount, or 120 billion gallons, for cooling the condensers of steam-turbine power plants. These plants, whether fired with fossil fuels or nuclear fuels, are rapidly growing in number. It is possible to forecast a daily requirement of more than 200 billion gallons of cooling water by 1980 and of 600 billion gallons, or 50 percent of all the available water, by the year 2000. If calefaction is ecologically harmful, quite a lot of harm lies just over the horizon.

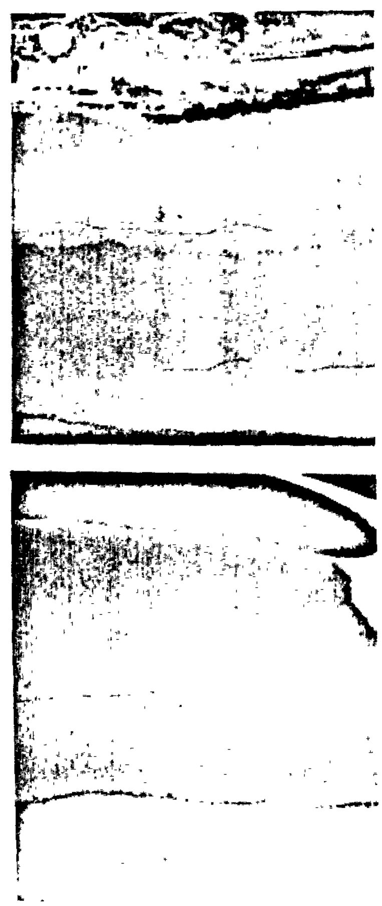
Haddam Neck is a low-lying tongue of land on the east bank of the river just above the point where a tributary, the Salmon River, joins the Connecticut [*see illustration on preceding page*]. The Connecticut Yankee Atomic Power Company completed acquisition of a 500-acre tract at Haddam Neck in August, 1963. Hearings on the issuance of a final construction permit were held before the Connecticut Water Resources Commission in the summer and fall of 1964. Earlier the U.S. Atomic Energy Commission had granted the various approvals that lie within its jurisdiction, and the U.S. Army Corps of Engineers, which oversees the navigability of the river, authorized the dredging necessary to allow construction of a water-intake area upstream of the plant and an effluent-discharge area downstream.

The Water Resources Commission hearings afforded an illuminating example of the extent to which public concern about environmental degradation can be quite innocently misdirected. After the first hearing, in July, 1964, I received a number of telephone calls from people who were genuinely alarmed by the prospect of a fission-powered generating plant being built in their vicinity. No amount of reassurance I could offer them on the improbability of radioactive pollution of the environment lessened their concern about a neighboring atomic plant. Not until the second hearing, in September, did attention become focused more appropriately on the effect on the ecology of the river of the heated effluent from the plant. Thereafter the fear of radioactive pollution began to abate. I suppose, however, there will always be those who will point an accusing finger at the plant when any unusual natural phenomenon occurs on the lower Connecticut, in spite of the fact that radiological monitoring of the river's water, its sediments and its plant and animal life has revealed nothing but the normal background radioactivity in the 30-odd months since the plant began operation.

On October 21, 1964, the Water Resources Commission approved the planned intake of river water for cooling purposes and the return of the warmed water to the stream on the condition (among others) that the power company finance a thorough study of the river environment throughout the start-up and early operating stages of the plant and for a period of five years after the level of full operation was reached. A further condition of approval was that, should the study reveal adverse effects on the river attributable to calefaction or other aspects of plant operation, it would be the company's responsibility to take remedial action.

The Connecticut River Study was set up in January, 1965, with myself as director and Lyle M. Thorpe, recently retired as director of the State Board of Fisheries and Game, as associate director. We established our base at the Essex Marine Laboratory, a nonprofit private institution, and began a series of ecological observations that extended from the mouth of the Connecticut to the dam across the river at Enfield, some 60 miles upstream near the Massachusetts border. Our staff has varied seasonally from 10 to 15, including technical and part-time help. From its inception the study has had the benefit of counsel from a five-man advisory committee representing several scientific disciplines; this committee has met with us at least twice a year. We have made progress reports to the Water Resources Commission at six-month intervals, beginning in July, 1965. The cost of our study to the power company for the five years through 1969 has been approximately $750,000. Other contributions of company personnel to the study have been substantial. We have also had support from the U.S. Bureau of Commercial Fisheries and the Connecticut State Board of Fisheries and Game, and we have had the help of faculty members of the University of Connecticut, both at the Storrs campus and at the university's marine research laboratory in Noank. In addition specialists at the British Museum (Natural History), the Smithsonian Institution and the Museum of Comparative Zoology at Harvard University have identified various invertebrate specimens for us. Other specimens were identified by H. B. Herrington of Westbrook, Ont., a student of freshwater mollusks.

The river water that is used to cool the steam condenser at the Haddam Neck plant leaves the plant at a temperature 22.4 degrees F. above the temperature of the river water. It then flows through a mile-long canal on the east bank, where heat exchange with the atmosphere serves to reduce its tempera-



DISCHARGE OF WARM WATER from the Haddam Neck canal is shown at different tidal stages in these two aerial ther-

NUCLEAR POWER PLANT occupies the light-colored area near the center of this aerial photograph, at the head of a canal that was dug at Haddam Neck to carry warmed river water back to the Connecticut after it has been used to cool the plant's condensers.

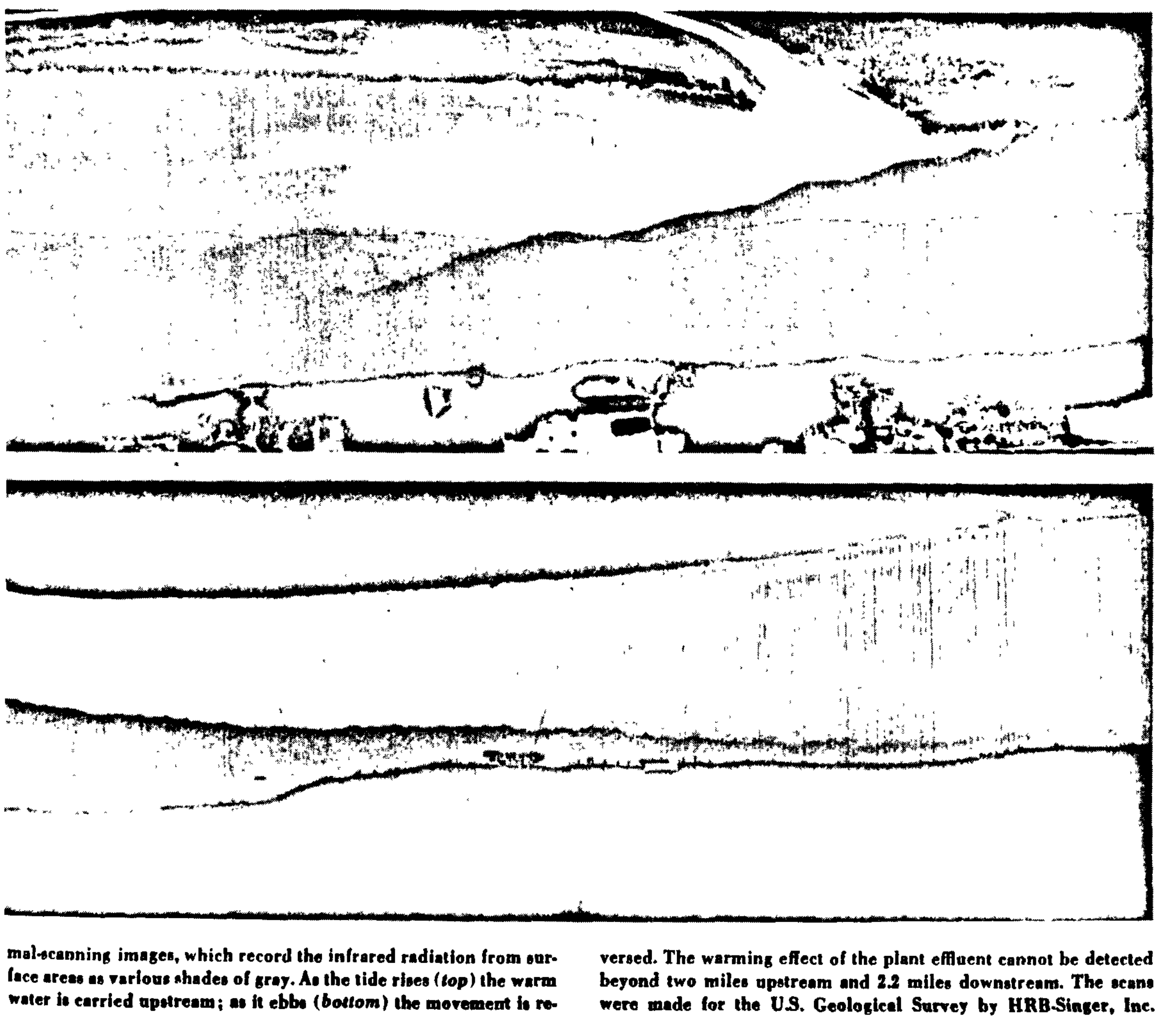
ture to an extent dependent on the seasonal temperature of the air. The canal has a fan-shaped mouth that lowers the velocity of discharge into the river and also tends to keep the effluent near the surface of the river water. Depending on the tide, the plume of warm water moves either upstream or down. On the ebb tide the plume is indistinguishable from other river water with respect to the temperature of the first three feet of water below the surface by the time it reaches the East Haddam bridge, some three miles downstream. On the flood tide the plume becomes indistinguishable a little above Haddam Island, or two miles upstream from the plant [*see illustration on next two pages*].

The shape of the warm plume, both at the surface and at certain subsurface levels, varies widely in response to variations in river flow between one high-water stage and the next, and also in response to differing weather conditions and seasonal circumstances. The warm water not uncommonly occupies the entire surface of the river in the vicinity of the canal mouth, so that the effluent reaches the west bank of the river. This does not, however, produce a "thermal block" in the river, because the warm effluent does not extend to the bottom of the river, which here lies some 15 to 30 feet below the surface.

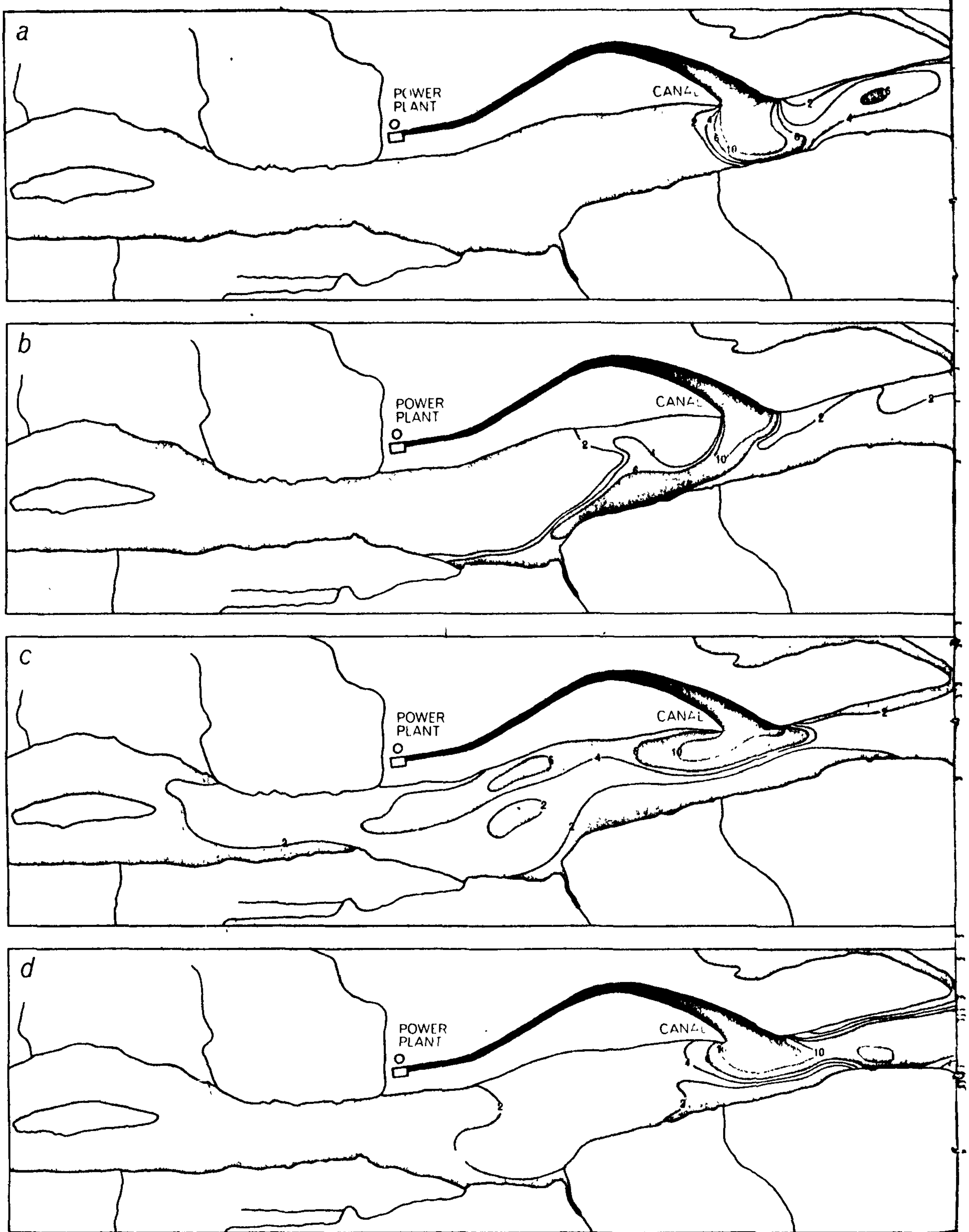
Early in our study we decided to establish five monitoring stations along the river to record continuously such data as rate of flow, temperature of surface and subsurface water, variation in electrical conductivity (which reflects the relative salinity of the water), oxygen content of the water and so forth. Two of the stations were located well outside the area that was to be influenced by the effluent when the plant began to operate; these served as controls. A third station was set up on the west bank of the river opposite the plant and the other two were situated somewhat upstream and downstream respectively from the plant. The stations were designed and their construction was supervised by William A. Boyd, director of the Essex Marine Laboratory; all five were in full operation by the end of June, 1966.

In the period before plant operations began we established a number of facts about this section of the Connecticut. Variations in water conductivity, for example, showed that water from Long Island Sound made its way above the East Haddam bridge only at times when high tides coincided with a low level of river flow.

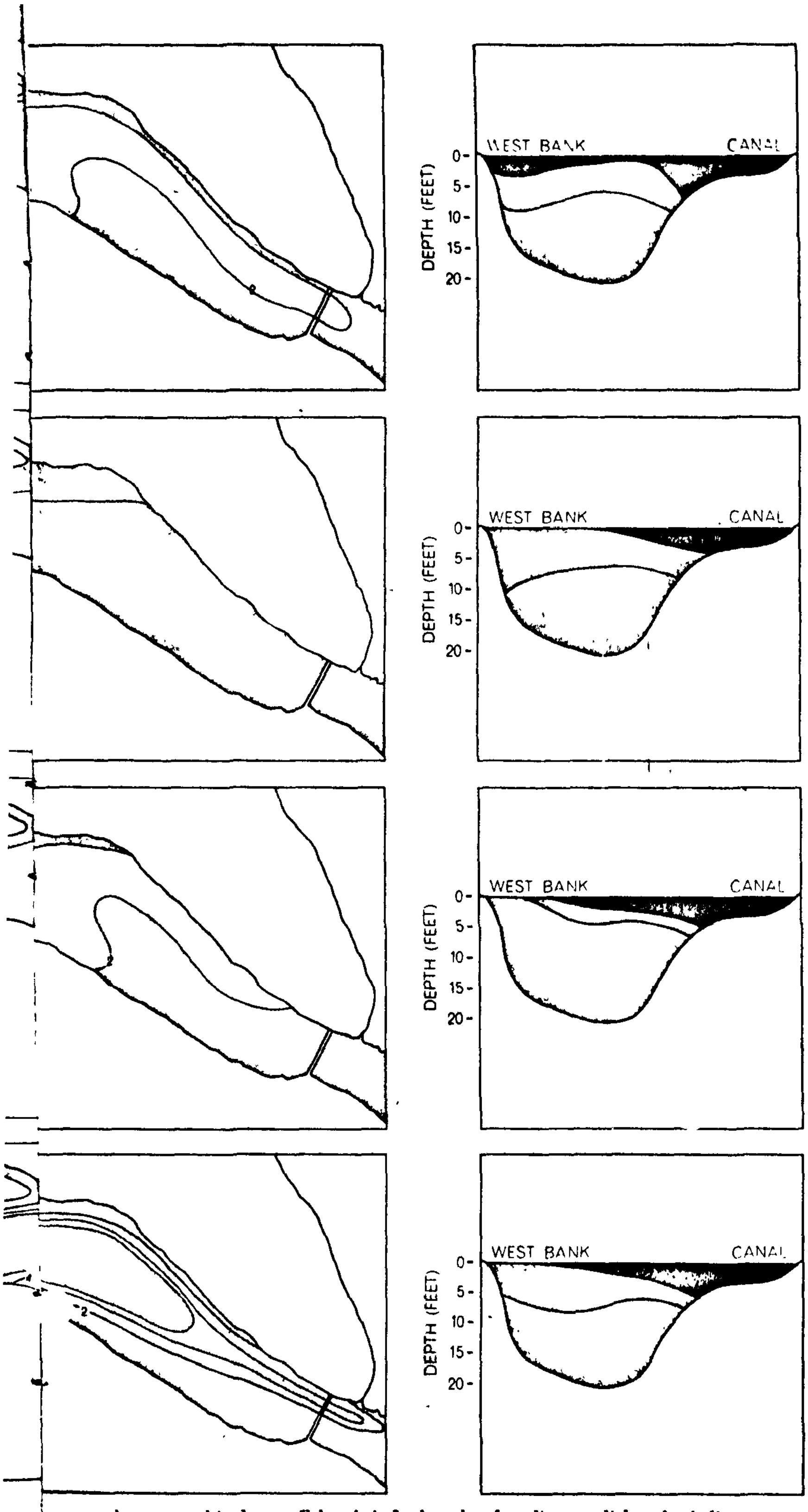
In October, 1967, the Haddam Neck plant completed start-up procedures and began to generate power at less than full capacity. The instruments at our monitoring stations promptly recorded



mal-scanning images, which record the infrared radiation from surface areas as various shades of gray. As the tide rises (*top*) the warm water is carried upstream; as it ebbs (*bottom*) the movement is reversed. The warming effect of the plant effluent cannot be detected beyond two miles upstream and 2.2 miles downstream. The scans were made for the U.S. Geological Survey by HRB-Singer, Inc.



TEMPERATURE INCREASES produced by the discharge of warm water from the Haddam Neck canal were measured in September, 1968, when the Connecticut was near its seasonal low and the water temperature was near its seasonal high. Readings were made at low slack water (*a*), at mid-flood (*b*), at high slack (*c*) and at mid-ebb (*d*). Surface temperatures are shown in the diagrams above, subsurface temperatures at far right. Shades of color indicate water warmer than normal river water; numbers indicate temperature



above normal in degrees Fahrenheit. In the subsurface diagrams light color indicates water up to five degrees F. warmer than normal, dark color more than five degrees. No "thermal block" was formed at Haddam Neck, although warm water often covered the surface of the river. The channel is more than 20 feet deep; the water below 12 feet was not heated.

the addition of the warm effluent to the river. The station opposite the plant, for example, logged increases in temperature that persisted from an hour to an hour and a half before the plume was carried away from the west bank by the effect of rising or falling tide. On several occasions the temperature of the surface water near the west bank was raised by 10 degrees F. above the ambient temperature of the river, and at a depth of four feet the temperature rose four degrees. Similar (although smaller) effects, together with a reduction in oxygen content, were recorded at the stations two miles upstream and 1.8 miles downstream from the discharge canal. It was apparent by October, 1968, 15 months after start-up, that the plume of warm water was quite sharply defined in terms of temperature: it streamed downriver during ebb tide, spread across the river during the reversal from ebb to flood, streamed upriver during flood tide and then spread across the river once more at the reversal from flood to ebb.

At this stage the power company ordered an independent survey of variations in river temperature to determine how calefaction under actual operating conditions compared with the predictions made by the engineering firm of Stone & Webster before construction. Temperatures were taken at mid-ebb, at low slack water, at mid-flood and at high slack water; while the survey was in progress the flow in the Connecticut was near its seasonal low and the water temperature was near its seasonal high.

The survey confirmed the readings made at our own stations and provided additional information. When the warm plume reached the west bank, for example, the heating of the subsurface water did not exceed two degrees F. at a depth of 12 feet. The survey set the upstream limit of the plume at two miles above the canal (which agreed with our study) and the downstream limit at 2.2 miles (several hundred yards below our monitoring station in that area). Last summer we conducted plume studies of a rather more complex design than the company's 1968 study, and we hope to conduct as many as 10 more such studies this year.

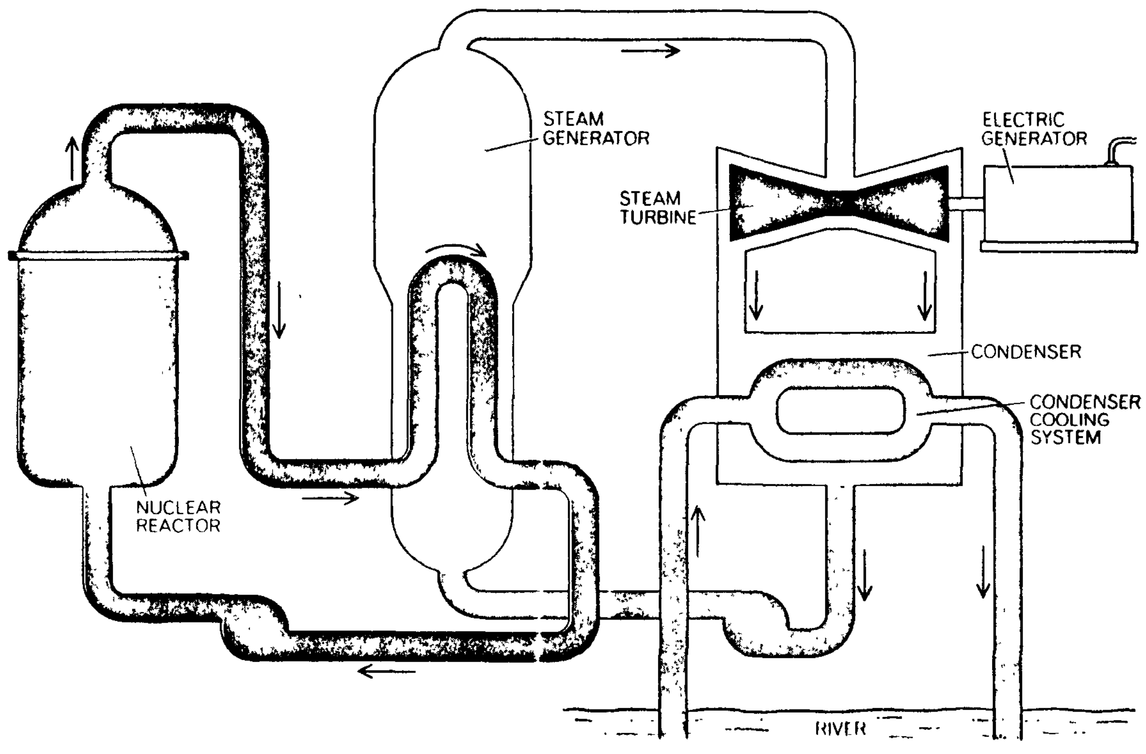
From 1966 through 1968, in addition to hydrological work in the immediate vicinity of the discharge canal, we conducted more than 24 surveys that extended from the mouth of the river to a point well upstream from the plume. Eighteen stations were established, and at each station we recorded the temperature, salinity and oxygen content of the river water near the surface, near the bottom and at an intermediate level under varying tidal circumstances and rates of river flow. Over this three-year period, which started before the plant went into operation and ended nine months after operation at the commercial level had begun, the surveys have shown essentially identical results.

Having generally established the nature and extent of the thermal disturbance in this area of the Connecticut, we now faced the question of its biological effect. In the realm of microbiology we soon learned that a series of studies was already in progress under the direction of John D. Buck and his associates at the marine research laboratory of the University of Connecticut with the support of the Federal Water Pollution Control Administration. Sampling the river water in the vicinity of the power plant every three weeks or so, Buck's group observed seasonal fluctuations in river bacteria. They found no alterations that appeared to be attributable to calefaction except in the immediate vicinity of the canal mouth. There the diatoms that normally dominate the river phytoplankton, the species *Melosira ambigua*, yielded that role to blue-green algae. This change in flora does not seem to portend obnoxious conditions either in the discharge area or farther downstream, although it is important to emphasize that we are dealing here with short-term observations.

Because Buck's extensive microbiological studies covered that area of research, we turned to investigating the river's bottom-dwelling fauna and its populations of fishes, some of them resident and some transient. In order to study the bottom community we established 17 stations spaced along a zone extending from four miles below the point of effluent discharge to four miles above it. At fortnightly intervals we sampled the river bottom in as many as 10 places at each station over a period of more than two years before the power plant began operations. In 1969 we added 12 new stations to this bottom-study network, all of them within the canal that carries the effluent to the river.

It had been our original plan that, once the tedious task of identifying the members of the bottom community was complete, we would undertake to determine the presence or absence of the more than 100 bottom-dwelling animal species with respect to a range of water temperatures from two degrees Celsius (35.6 degrees F.) to 38 degrees C. (100.4 degrees F.), or roughly seven degrees F. above the water temperature usually considered fatal to fishes of the Temperate Zone. It soon became clear that considerations other than temperature, among them the amount and velocity of river flow and changes in the composition of bottom sediments, were of equal concern with respect to the well-being of these mainly sedentary animals.

The dominant animal species of the Connecticut bottom sediments are an aquatic worm of the genus *Limnodrilus* and, where the bottom is sandy, a freshwater clam of the genus *Pisidium*. The larvae of two insects—the midges *Procladius* and *Cryptochironomus*—are the next most abundant animals under normal river conditions. During the first 11 months that the power plant was in operation it became increasingly evident that the areas adjacent to the effluent discharge harbored a greater variety of organisms than they had before. The newcomers included the larvae of beetles, dragonflies, damselflies and other insects. This diversity has remained high in the area where the canal water enters the river. Both the degree of diversity and the total numbers in the populations of this area, however, have declined sharply on several occasions. These changes were apparently related to a



TEMPERATURE of river water is raised 20 degrees Fahrenheit as it flows through a condenser (*right*) where the steam that drives the power-plant turbine is cooled. At the seasonal peak of river temperature, effluent temperature can exceed 108 degrees F.

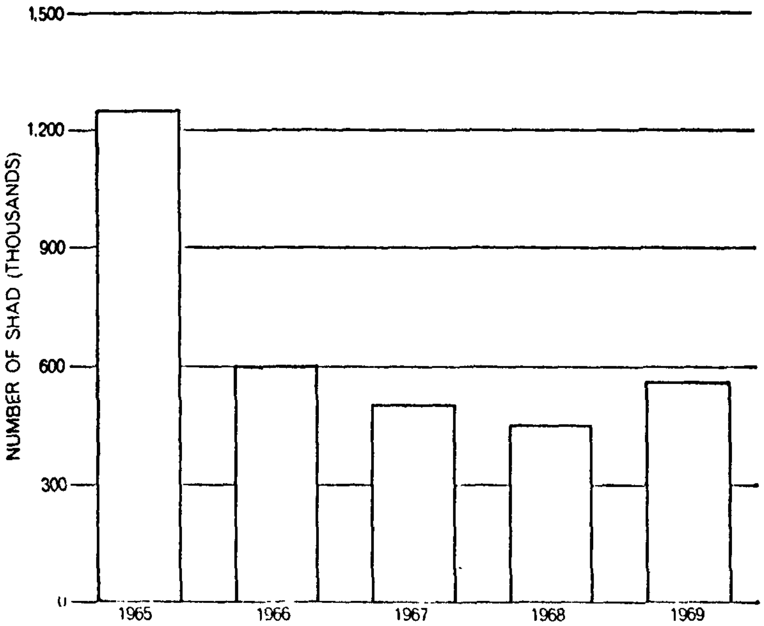
shutdown of the plant in March, 1968, which halted the flow of effluent, and to the spring freshets in May of the same year.

Near the water intake of the plant conditions are the opposite. Here both diversity and numbers show a substantial decrease. Evidently the velocity of the water as it is pumped from the river is high enough to wash away the silt and sand of the river bottom, together with the organisms dwelling in them. The bottom in this area is now gravel and cobblestone, wholly unsuitable for the worms and clams that formerly inhabited it.

The river bottom near the discharge canal, which was formerly sand covered by a thin layer of silt, has been changed to loosely consolidated silts that in places are several inches deep. This is a highly suitable habitat for the worms and also for insect larvae; hence the abundance and diversity of the newcomers. At the same time it is not a good habitat for the clams, because the silt tends to cover their siphons; as a result the population of clams in the area has substantially decreased.

Our interest in these bottom-dwelling animals arises from their role as an integral link in the river's food chain. Most of them are eaten by the fishes that live in the river the year round (as opposed to migratory fish populations): catfishes, perches, pickerels and other species. In any particular part of the river the density of the bottom-fauna populations influences the abundance of fish, not only at certain seasons but also throughout the year. The striped bass, for example, is a seasonal inhabitant of these waters, but it is known to spend the winter in a number of northern localities where warm effluents have made the winter environment tolerable both for the bass and for the bottom organisms they eat. Since 1968 increasing numbers of striped bass have been taken in waters near the mouth of the Haddam Neck effluent canal.

We are now investigating which bottom organisms are important as food for which fishes. We are also assessing what happens to organisms that are drawn into the power plant with the cooling water and involuntarily travel through the condenser system. We know from observations made early in 1969 that invertebrate organisms such as worms and clams survive the 6,000-foot trip in spite of a rise of more than 20 degrees F. in water temperature. Live invertebrates have also been found in the canal during the summer when the water temperature



NUMBERS OF SHAD that have entered the Connecticut to spawn in each of the past four years have not changed significantly since the Haddam Neck power plant began start-up procedures in July, 1967. The abundance of shad in 1965 is attributable to above-average spawning success in 1960. Shad are the river's economically most important natural resource.

was above 100 degrees F., which is some 14 degrees above the maximum summer temperature of river water. Further analysis of the bottom populations in the canal should help to clarify the picture.

In analyzing the fish populations of the Connecticut we have worked our way from the mouth of the river to as far north as Northampton, Mass., 90 miles upstream. In the first three years of our study, before the Haddam Neck plant had gone into operation, we made collections with bag seines and trawls in three depth zones: from the surface to five feet, from three feet to 10 feet and from 20 feet to as much as 40 feet in places where the depth of the river allowed it. A total of 364 separate collections proved to contain representatives of 36 species of fish.

The most common resident fishes in the Connecticut are the white and brown bullhead catfishes (*Ictalurus catus* and *I. nebulosus*), the white perch (*Roccus americanus*), the yellow perch (*Perca flavescens*), various sunfishes (*Lepomis*), the spottail shiner (*Notropis hudsonius*), the darter (*Etheostoma olmstedi*), the white sucker (*Catostomus commersoni*) and the killifish (*Fundulus diaphanus*). The common eel (*Anguilla rostrata*) is also an inhabitant of the river, but it spawns in the ocean and is therefore not strictly a resident fish. Since it spends most of its young and adult life in fresh water, however, we include it among the river residents. Censuses of the fish caught by fishermen during 10 months of the year from 1965 through 1969 show that 85 percent of the catch in the Haddam Neck area consists of catfishes, perches, eels and sunfishes.

The operations of the Haddam Neck power plant do not seem to have significantly affected the small but relatively stable catch of resident fishes. At the mouth of the Salmon River, about a mile below the mouth of the plant's discharge canal, however, the catch rate showed an increase in 1969; this may be correlated with the presence of the warm-water plume nearby. Indeed, a number of fishermen now prefer to fish near the mouth of the canal.

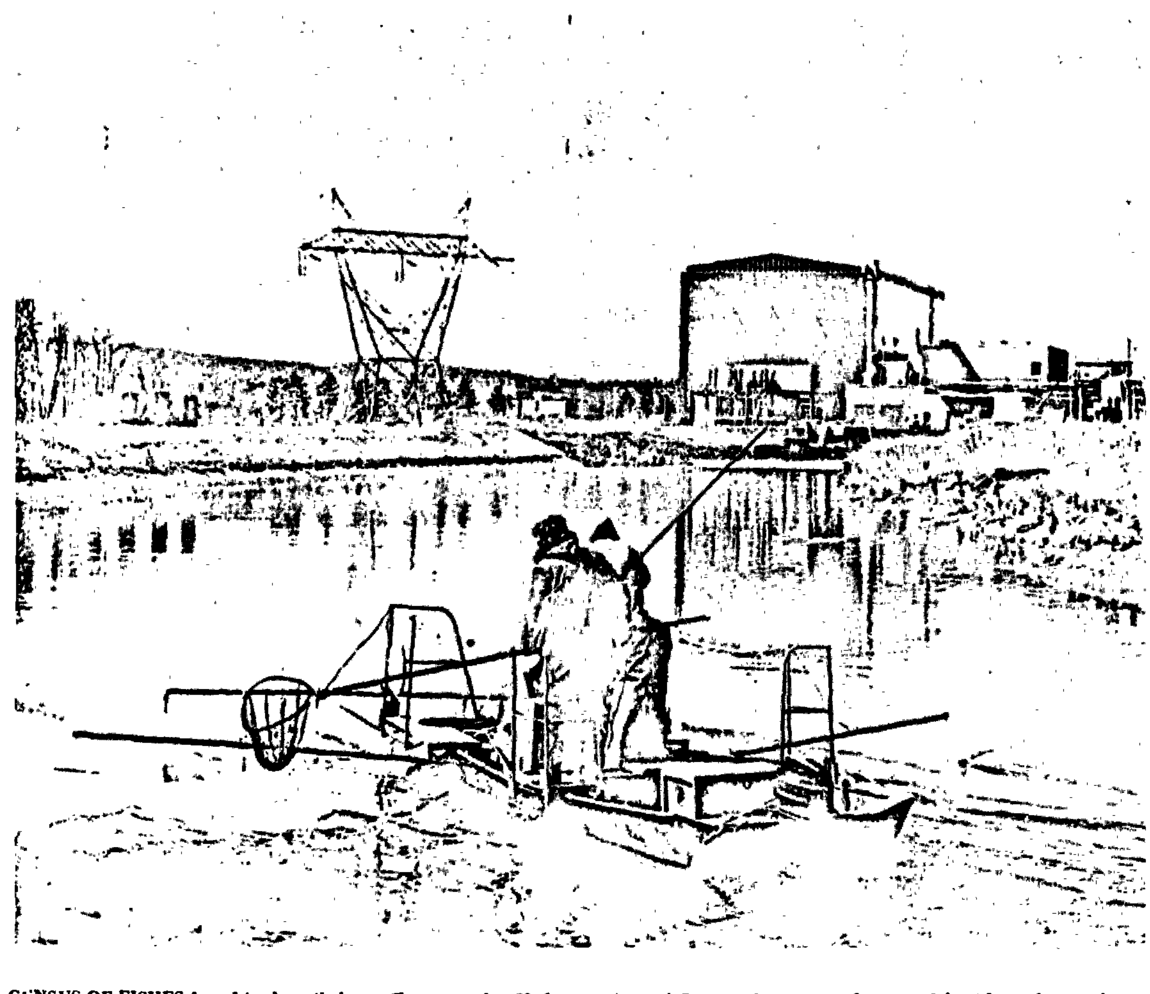
In studying the catfishes and perches we tagged more than 1,000 of these fishes in 1968 and some 5,000 of them in 1969. The object of the study is twofold: to provide information on the fishes' rate of growth and to trace the movements of the fishes upstream, downstream and in and out of the discharge canal. Tag returns in 1969 ran above 10 percent, and significant information from this work is already emerging. For example, representatives of both catfish species and of the yellow perch have been recaptured from 35 to 40 miles upstream of the power plant and from six to 15 miles downstream.

The fishes that have moved from the river into the discharge canal are now being studied intensively. A preliminary estimate of their numbers indicates that in winter between 12,000 and 21,000 brown catfish and between 3,000 and 7,000 white catfish are present in the canal. In spite of the greater availability of food in the canal area the condition of the canal catfishes is considerably poorer than the condition of river catfishes living beyond the influence of the plume. The factors responsible for this appear to include the fishes' higher rate of metabolism in the warmer water, the increased expenditure of energy required to cope with the relatively high rate of flow in the canal and the effects of crowding.

Young schooling fishes, such as shiners and killifish, have been taken in the canal when the water temperature was 98.6 degrees F.; their condition appeared to be good. The upper limit of water temperature tolerable for the adult fish, on the other hand, is only slightly above 93 degrees, a temperature that is frequently surpassed in the canal during the summer months. It is of interest in this connection that observations made in 1968 and 1969 showed that adult fish will move from the cooler river back into the canal when the temperature of the effluent has fallen less than two degrees F. below the upper limit. It may well be that the knowledge gained in these studies will be useful in fish farming.

The migratory fishes that are dominant in the Connecticut are three members of the genus *Alosa:* the glut herring (*A. aestivalis*), a summer spawner; the alewife (*A. pseudoharengus*), basically a spring spawner, and the American shad (*A. sapidissima*), also a spring spawner and one of the most delectable of all fishes to eat. The three species are not easy to tell apart when they are adults, and it is even more difficult to do so when they are juveniles. When they are larvae, it is only possible to distinguish them by counting muscle segments under the microscope.

Of the three migrant species the shad is the most important economically. The commercial shad fishery on the Connecticut has an annual capitalized value of some $7.5 million and the sport fishery an additional value of $14 million. The fish spawn in fresh water and the



CENSUS OF FISHES found in the mile-long effluent canal at Haddam Neck utilizes a launch that belongs to the State Board of Fisheries and Game and is equipped to stun fish with an electric shock. Netmen on the launch and on following craft retrieve the stunned juveniles go to sea some five months later. They remain at sea for four to five years, and little is known of their movements and habits during this interval. When they have reached maturity, they return to spawn in fresh water. They come back to the stream in which they developed, apparently with the same high degree of precision exhibited by the salmon of the Pacific. Some shad are single-time spawners; others are repeaters. The fish that find their way back to the sea again, known as "runners," are emaciated and debilitated.

One of the several shad studies we undertook was to locate the areas in the Connecticut River where the shad spawn. This involved day and night visual observations from the shore and from boats, and the collecting of eggs in towed and stationary plankton nets. Because shad swim in a characteristic circular pattern when they are spawning, with their fins and backs out of the water, visual observations are not difficult. In June, 1967, for example, we observed shad swimming over a period of nearly a week in a circular pattern 150 feet from the west bank of the Connecticut 1½ miles south of the Windsor Locks bridge above Hartford. The spawning area was a gravel bottom at a depth of from three to four feet. When we towed plankton nets in this area, we collected numerous shad eggs in a relatively early stage of development.

fish for examination and tagging. Census is conducted by the Connecticut River Survey.

We rigged stationary bottom nets, attached to buoys to allow for tidal changes, at 31 points from Essex upstream to Thompsonville, 18 miles above Hartford. On the basis of the number and the age of the eggs collected in these nets we were able to conclude that the shad spawning areas were far more numerous above Hartford than below. We obtained eggs both in May and in June, when the temperature of river water ranged from a low of 50 degrees F. to a high of 73.4 degrees; the majority of the eggs were collected when the water temperature was at the upper end of this range. Eggs were found in both fresh and tidal water. We discovered that, compared with the major shad spawning areas north of Hartford, spawning in the vicinity of the Haddam Neck power plant was minimal.

One of the critical periods in the early life of the shad is when the juvenile fish move downstream en route to the sea. This procession starts in the latter half of August and continues into November; the fish are from three to five inches long. We wanted to learn something about their rate of movement downstream and whether or not their passage would be impeded by the plume of warm effluent from the Haddam Neck plant. As a first step we marked 18,000 juvenile shad by clipping their fins and 7,000 more by spraying them with a fluorescent dye. Since we were unable to recapture any of these fish, we rigged gill nets that extended to a depth of 16 feet in the vicinity of the plume and then checked the catch at intervals that enabled us to compare the depths at which the fish traveled by day and by night. We found that the fish swim in deep water by day and nearer the surface at night. Even at night, however, they apparently pass under the plume at depths below four feet, the level where a five-degree temperature rise is encountered. There is no evidence that the juvenile shad suffer any detrimental effects in traversing the river region affected by the effluent.

In an attempt to learn more about how juvenile shad react to rapid changes in water temperature we conducted a series of experiments in 1966 and 1967 at the Essex Marine Laboratory. The preliminary tests showed that an instantaneous rise in temperature to 91 degrees F. (more precisely, a rise over a range of from 16 degrees above an ambient water temperature of 75 degrees to nine degrees above an ambient 82 degrees) was lethal to the young shad within five minutes. Later experiments showed that the juvenile fish actively avoided water characterized by such severe temperature gradients. In this connection, larval fishes appear to have a greater immunity to the effects of calefaction than juveniles. A plankton-net tow made in the discharge canal in July, 1968, when the water temperature was 93.2 degrees F., yielded more than 650 *Alosa* larvae; they were mostly at the late yolk-sac stage, which suggests that they were the product of upstream spawning. They had apparently entered the plant intake and passed through the condenser unscathed.

Midsummer fish kills are not uncommon in the lower reaches of the Connecticut. We have observed three since the beginning of our investigations, all before the Haddam Neck plant went into operation: on July 2 and July 13 in 1965 and on July 4 in 1966. The size of the second kill in 1965 was estimated at 100,000 fish and the 1966 kill at 50,000 fish. In all three instances the principal fatalities were glut herring (99.9 percent of the kill in 1966) and alewives. Shad, catfishes, white suckers, eels and white perch were killed in far smaller numbers. The kills were apparently the result neither of toxic effluents nor of a parasitic infestation. Their most probable cause appears to be the combination of low river flow, water temperatures in excess of 80 degrees F., a depleted supply of dissolved oxygen and, in the case of the summer-spawning glut herring, the stress associated with spawning activity. In many areas that we sampled the water contained less than five parts of oxygen per million, a level that is generally considered unfavorable for fish life. Our samples were taken in daylight; since the photosynthetic activity of aquatic plants is reduced at night, the oxygen content must have been even lower in the predawn hours when spawning activity is greatest.

We needed to establish other facts about the shad. What is the rate of the upstream migration in the spring? How many fish return each year to spawn? Might the plume of warm water from the plant keep the mature fishes from traveling upstream to their usual spawning grounds? To answer these questions we instituted another intensive shad-tagging program. So far more than 18,000 migrating shad have been marked by setting a "spaghetti dart"—a short barbed rod with a long bright-colored streamer—in the back muscles of the fish. Another 200 fish have been "force-fed" small sound transmitters so that the details of their upstream movements can be monitored by hydrophone. We found that the speed of upstream migration ranged from less than a mile per day to five miles or more once the shad had moved upstream from brackish water to fresh. There seems to be no "normal" speed of migration; instead the rate of the fish's progress appears to depend on the temperature and salinity of the water.

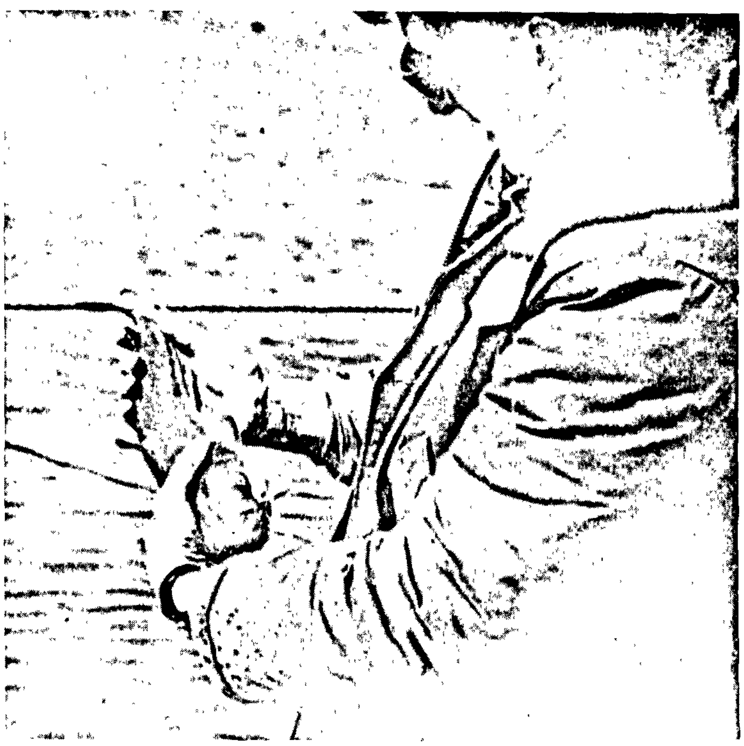
It appears that the effluent from the plant has no significant retarding effect on the shad's upstream progress. The fish follow the river channel, which is close to the west bank in the area affected by the plume, and sonic tracking shows that within the channel they tend to move along its west side. They either pass through or under the plume without apparent difficulty or significant hesitation. Under the environmental conditions existing during the shad runs of 1968 and 1969, two years when the power plant operated at nearly full scale, there has been no thermal blockage of the Connecticut. At the present level of plant operation, assuming that environmental conditions remain the same, no blockage is anticipated.

The return of spaghetti tags, in combination with other data, has provided the basis for good estimates of how many shad return to the Connecticut each year. We estimate that in 1965 the number was more than a million; this appears to reflect an unusually successful spawning season five years earlier. From 1966 through 1969, we estimate, the number of returning shad has fluctuated around the half-million mark [*see illustration on page 49*]. The population trend in future years remains to be seen.

The shad fishery is the Connecticut River's only major economic resource at present. The alewife and the glut herring, however, are a resource that, although it has suffered from mismanagement in the past, could well be rehabilitated given the proper incentives. Under prudent control the stock of these river herrings could withstand heavy harvesting (as in fact it did in the earlier part of the century, when the overall catch along the East Coast of the U.S. ranged from 30 to 60 million pounds per season). When the problems besetting the production and marketing of fish-protein concentrate are surmounted, these fishes should be exploitable in the Connecticut and in other Eastern rivers.

How can our studies of the Connecticut up to the present be summarized? First of all, it is necessary to avoid anticipating the final conclusions of the comprehensive study; the collecting of data for that report will not be finished before the end of 1972. Anything we can say at this stage must be accepted as a short-term evaluation. Not only will several more years of intensive research be needed to lay a firm foundation for future decisions about heating the river but also continued testing and observation are necessary if we are to detect subtle long-term ecological effects that are not now even predictable. It is nevertheless possible to report that the operation of the Haddam Neck power plant and the consequent calefaction of the Connecticut River in the vicinity of the plant has had no significant deleterious effect on the biology of the river. There have been changes in the flora near the plant, in the bottom fauna at the point of effluent discharge and in the condition of the bottom habitat near the plant intake. Of the river's fishes, the catfish that enter the discharge canal do not fare as well as those that do not enter. These effects can hardly be regarded as being calamitous, and in the long run the calefaction may even prove to be beneficial in one way or another.

It is currently recalled that two centuries ago Edmund Burke declared that "the public interest requires doing today those things that men of intelligence and good will would wish, five or ten years hence, had been done." Where the calefaction of streams, rivers and lakes is concerned, what must be done is not only to squarely face the ecological problems that the rising demand for power are creating but also to accompany programs of construction with programs of environmental research so that the most favorable possible conditions are achieved. Such a course requires rational give-and-take and a willingness of strong-minded people on both sides of such problems to bend enough to arrive at the optimum balance of interests.



CATFISH FROM CANAL is examined by Barton C. Marcy, Jr., of the Connecticut River Survey staff. Because the higher temperature of the effluent increases the fishes' rate of metabolism while the rate of effluent flow forces them to swim more vigorously than when in the river, the condition of the canal catfish is relatively poor in spite of more plentiful food.

MR. STEIN: Thank you, Mr. Schwarz.

Any comments or questions?

While Mr. Fetterolf is getting set up, this is just for clarification. I wish you were here the last 3 days when the Fish and Wildlife people were here because I have heard the questions you asked, asked of them many times. These are questions that were asked by several people with thermal problems throughout the country., I think they have considered these and they do have answers to them.

I wouldn't like to, as Chairman, try to give you a summary of the answers, but what I can say is that I have heard these questions asked and answered many times.

MR. SCHWARZ: Thank you.

MR. FETTEROLF: Mr. Schwarz, relative to the amendment which the staff submitted to the Michigan Water Resources Commission on temperature standards, I don't know what date was on the copy which you had, so that you would include these figures. But I have a copy dated September 1970 which we presented to our commission and which they gave us permission to use on a written basis with the other States and with the Federal Government, and you will find that the figures have been adjusted.

MR. SCHWARZ: I will appreciate a copy of it.

MR. STEIN: Are there any other comments or questions?

While you are here I wonder if possibly you or Mr. Klassen can indicate how does the Abbott Corporation stand in meeting their other requirements for abatement of pollution in Lake Michigan?

MR. SCHWARZ: Well, I could respond to that if it is acceptable, Mr. Klassen.

MR. KLASSEN: It is all right with me. You are under litigation. I would prefer that you would reply.

MR. STEIN: If that is the case I will withdraw the question.

MR. SCHWARZ: Our suit with the Attorney General has been settled, Mr. Stein.

MR. STEIN: Do you feel free to talk? If he is under litigation -- you know, I am often in the same position myself. There are loads of cases I can talk about and we have got cases filed that I don't talk about, and if this is under litigation, I will withdraw the question.

Are there any further comments or questions?

If not, thank you very much, Mr. Schwarz.

MR. SCHWARZ: Yes.

MR. STEIN: May we have Byrd F. Parmelee? Is

C. F. Riefstahl

Mr. Parmalee here? I guess not.

Do we have Mr. Riefstahl? Do you want to make a statement?

While Mr. Riefstahl is coming up, I would like to read a telegram sent to us today:

"I urge you to give serious consideration in your deliberations at the Chicago Thermal Pollution Conference to the views of Michigan citizens which are scheduled for presentation Friday. The protection of Lake Michigan's fragile aquatic and shoreline environment should be the primary aim of this conference. The Federal Department of the Interior and consérvation organizations in Michigan have spent much time and effort researching and studying this problem. These views warrant the most careful consideration during the conference." Signed Senator Sander Levin.

Will you proceed, Mr. Riefstahl?

STATEMENT OF CHARLES F. RIEFSTAHL,

SKOKIE, ILLINOIS

MR. RIEFSTAHL: My name is Charles F. Reifstahl, 8132 Kolmar Avenue, Skokie, Illinois. I am a concerned citizen and I wanted to make a statement here.

C. F. Riefstahl

I would like to relate to you a personal experience at the consumer end of the electrical industry, or at the convenience outlet in my house. A short time ago I had occasion to use the drop cord in my shop and I found that the 50-watt rough service bulb was burned out. I went to the local utility replacement bulb outlet and requested a 50-watt rough service bulb to replace the burned out one. Imagine my consernation when I was told that the 50-watt bulb was no longer manufactured and I would have to take a 75-watt rough service bulb. An item of information like this is usually lost to the public and to the regulatory bodies since they happen to be a member of the silent majority. I am slowly finding my voice.

The electric utility industry has had some comments about advertising and natural load growth. It seems to me that it is another case of say it often enough and people will believe it, and as for doubling electrical demand every 10 years I can only say that my personal expenditure for electricity over the last 23 years has increased about 10 percent and I have all the things that most households have but there is little waste. We turn off lights and turn the television on when there is a program we wish to see, then we turn it off.

Mr. Stein mentioned the seeming trend to the same

C. F. Riefstahl

conclusions as this meeting has progressed, and I feel obligated to display my ignorance and ask about the trend to 1000 MWe turbines and generator sets. Why not 5-250 MWe turbine generator sets? It seems to me that at a load factor of 65 percent as mentioned in one of the recent papers, three of the sets could be operating and one idle. The electric utility people no doubt have explored this avenue of approach and decided that they can live with the effects of a major interruption when one of the large units inadvertently drops out of the power pool. I am not as concerned with this problem as I am with one which I read just last week.

Mr. Stein, I would like to interject that I was reading my thermal pollution file and finally got to the bottom and this article was on the bottom.

I continue. I would like to read to you Page 15 of a paper called "Thermal Pollution, Its Sources, Control and Costs," by Dean E. Abrahamson, M.D., Ph.D., University of Minnesota, Minneapolis, Minnesota, presented at the "Workshop on Eutrophication," University of Minnesota, Duluth Branch, September 21, 1968, sponsored by the Minnesota Chapter of the Izaak Walton League of America and the Sears Foundation.

On Page 15, the title is "Thermal Pollution of

C. F. Riefstahl

Lake Superior."

"At present there is relatively little thermal pollution of Lake Superior at least from Minnesota. It is not surprising, however, that Lake Superior attracts the attention of industries which require copious quantities of clean, cool water. It has been reported that the Atomic Energy Commission is considering the construction of a very large plant on the North Shore of Lake Superior. This plant would produce uranium fuel for nuclear reactors, and would require large quantities of cooling water. In addition, the plant, which would be of the gaseous diffusion type, would require electrical energy equivalent to approximately 10 to 15 generating plants each the size of the Monticello reactor plant or the Clay Boswell fossil-fueled plant.

"If this gaseous diffusion plant and its associated source of electrical power were the equivalent of fifteen reactor plants each the size of the Monticello plant, then the total heat which could be discharged to Lake Superior would be approximately 1.5×10^{12} B.t.u.*(6) per day or 10.5×10^{12} B.t.u. per week. This is sufficient heat to raise the temperature of a cubic mile of water by 1 degree Fahrenheit each week of operation.

*(6) 1.5×10^{12} could be written as 1,500,000,000,000.

C. F. Riefstahl

The resultant effect on Lake Superior, which may be one of the most sensitive bodies of water in the world and which is a major cold-water fishery, can only be contemplated with considerable apprehension!

"The effects of this quantity of heat on Lake Superior would depend on complex interaction of many factors, and could not be predicted without considerable study. It must also be remembered that Lake Superior is classified as a cold-water fishery. The proposed standards relating to thermal discharges is that 'There shall be no material increase in temperature.' It would seem highly unlikely that large thermal discharges would be permitted by either State or Federal water quality regulations."

The facts concerning the environment are hard to come by and the lack of any publicity in connection with fuel for all the proposed reactors is glaringly absent. The reason, I suppose, is defense security and the fear that an unfriendly power could conceivably profit from the knowledge of this country's capability. I had begun to lose faith in some of our public officials when I discovered just 2 years ago that the power industry and the FEPC and well meaning men starting in 1933 built dams and hydroelectric plants in such proliferation in the Columbia River watershed that this once great river is now only a

1200-mile long lake. This in 37 short years. (Reference "Crisis on the Columbia" by Oral Bullard Library of Congress Catalog Card No. 68-57012.)

I sincerely hope that you, Mr. Stein, and the other men on this panel and all persons truly concerned with the preservation of Lake Michigan and, in fact, all the Great Lakes do not lose your dedication.

Thank you for the opportunity to speak and I hope that we all will be successful in our continuing effort to preserve our priceless heritage.

Thank you.

MR. STEIN: Thank you.

You know, I said just one thing, and I hope people don't go away with the wrong impression. Do you know what the cubic feet per second flow on the Columbia River is? That is the fastest flow of any lake I ever ran into.

MR. RIEFSTAHL: Well, that I will admit. However, I was concerned that from all indications these dams for 1200 miles has had a very, very deleterious effect on the salmon run. It has been documented and there are prognostications that within 10 years the salmon run will be immeasurable it will be so low.

MR. STEIN: By the way, I am not sure of that, but I think you do raise a point. I have done a considerable amount of work on this. Perhaps our Fish and Wildlife people who are here can assist us on the Columbia River. Do we still have Mr. Tichenor here? What is the rate of flow of the Columbia? Is it 200,000 feet a second? I hesitate to give the figure. Other than the Mississippi, I don't know where we have a flow like that anywhere in the country. But I think this is the question that we have with the salmon runs.

We have fish passage devices which have cost us a lot of money and a tremendous amount of research. We have diseases appearing in the salmon -- fungus diseases and other problems that I don't think we realized were there when we changed the regimen of that river. I think while we have to deal with the Columbia River -- and I don't want to deprecate any of the water projects that we have had there, and I don't think we are going to lose the salmon run because I think the salmon are going to increase going up the Columbia -- but we have had to pay quite a price to keep those salmon up. In fact, in some places we find it easier not to have them go up a fish ladder or passage device, but we put them in a tank car and drive them up and then release them.

I believe what has happened in rivers like

C. F. Riefstahl

that is the kind of thing that gives purpose in not authorizing tremendous changes in the environment, when someone says, "Well, we are not sure," or "We don't know," and "Let's try it and see."

Now, again, I guess when we went to school years ago in the thirties and we had a little different type education than we have now, we used to study these philosophic principles. One of the most famous and most hoary ones I think was the principle that the simplest explanation was likely the one to be the most correct. Then we had another one that we studied in those days, at least in the primitive stages of biology, that when you tinkered with nature the results were rarely beneficial.

I think your analogy of the Columbia River is one that I know I am keeping very much in mind when we are thinking of changing what we are going to do to Lake Michigan.

Are there any other comments or questions?

If not, thank you very much, sir.

Are there any other questions, or does anyone else want to make a statement? This about exhausts the list for today. I know tomorrow we are going to have a very full day, from the look of it, and if anyone wants to volunteer and make his statement today, he would be welcome.

Do you want to? Come on up. This is Mr. Byrd Parmelee.

STATEMENT OF BYRD F. PARMELEE, SALES ENGINEER, TECHNICON INDUSTRIAL SYSTEMS, TARRYTOWN, NEW YORK

MR. PARMELEE: My name is Byrd Parmelee. I work with Technicon Industrial Systems, a division of Technicon Instruments Corporation, and I know how important your time is so I will be very brief in explaining how these terms are synonymous.

Recently it has become apparent to many people that we have water quality problems. It has been suggested that one solution to the problem is source monitoring. I don't know what you think about Technicon Corporation. I don't know what you think about it as a result of past experience with Technicon Corporation. But we have now formed a new division called Industrial Systems. We believe that it is a new ballgame. We believe our future lies in industry, and those of us involved with this particular job are enthusiastic about the ability of our company now to meet the needs for source monitoring.

A few examples where source monitoring has shown the business man a cost reduction -- a sugar-manufacturing plant in Brooklyn found by monitoring continuously plant effluent for sugar loss that he was surprised to find short-term sugar losses. By eliminating these losses, he was able to save money.

An ammunition production facility in the United States found by monitoring continuously for sulphate, nitrate, and nitrite, they were able to detect intermediate losses that created a cost reduction step.

I am here primarily to invite each of you to participate and attend our congress in New York on November 3 where the subject of how to solve our water pollution problem by source monitoring will be discussed. The meeting will take place at the Hilton in New York, and it is, we think, a good opportunity to share with those who want to solve problems some of the opportunities for continuing to solve these problems.

MR. STEIN: Thank you very much.

You know, I thought I did my share for Technicon by agreeing to coming up and speaking at your meeting, but I am not sure we are available for commercial plugs here in addition. Thank you very much.

Murray Stein

We have a statement here from the City Offices, Petoskey, Michigan, from the City Clerk, which will be entered into the record without objection.

And a statement from the Lake Michigan Thermal Study Committee, by Russell C. Mallatt, whom you all know, and I will put that in the record. Mr. Mallatt was here to give this personally when we were supposed to have these committees go on but, as you know, he has a very demanding position in the petroleum industry and he had pressing other business and he just left the statement to be read. Without objection this will be put into the record.

(The statements above referred to follow in their entirety.)

City Offices Petoskey Michigan

CITY CLERK

VIRGINIA HUBBARD

Sept. 15, 1970

RECEIVED

SEP 18 1970

WATER RESOURCES COMMISSION

Ralph W. Purdy, Executive Secretary
Department of Natural Resources
Stevens T. Mason Building,
Lansing, Michigan 48926

The following is a copy of a resolution adopted by the Petoskey City Council, in Special Session Assembled, on the 14th day of September 1970.

"WHEREAS, the land area surrounding the Great Lakes is prime recreation land, and

WHEREAS, the Great Lakes are vital resources of the area if the Great Lakes Basin is to remain prime recreation land, and

WHEREAS, all reports indicate that the Great Lakes Basin is in great danger of becoming irreversibly polluted unless sever and immediate action is taken, and

WHEREAS, the City of Petoskey, Michigan is a community located on the shoreline of Little Traverse Bay on Lake Michigan and desires that all means and controls are utilized to abate the pollution of Lake Michigan and the other Great Lakes,

NOW THEREFORE BE IT RESOLVED, that the City of Petoskey hereby proposes:

1. That new and more stringent regulations be enacted covering the discharge of effluent into the Great Lakes and its tributaries, requiring as a minimum the use of tertiary treatment on all municipal and industrial discharges.

2. That equally stringent standards be established for all commercial vessels operating on the Great Lakes and that these standards be rigidly enforced.

3. That all resort and subdivision development on the Great Lakes and its tributaries be required to provide adequate sewage treatment facilities.

BE IT FURTHER RESOLVED, that copies of this resolution be sent to the Governor of the States of Michigan, Wisconsin, Illinois, and Indiana, the State Senators of these four states and the Water Resources Commission, State of Michigan, for presentation at the Federal Conference on Pollution of Lake Michigan and its Tributary Basin, Third Session, convened in session at Chicago, Illinois, September 28 to October 2, 1970."

Sincerely,

Virginia F. Hubbard

Virginia F. Hubbard, City Clerk

STATEMENT OF THE LAKE MICHIGAN THERMAL STUDY
COMMITTEE AT THE LAKE MICHIGAN FEDERAL ENFORCEMENT CONFERENCE
SEPTEMBER 28, 29, 30, OCTOBER 1, 2, 1970

My name is Russell C. Mallatt and I am here to present a short statement on behalf of the Lake Michigan Thermal Study Committee.

The Lake Michigan Thermal Study Committee consists of representatives of a number of diverse industries located along the western shore of Lake Michigan in Northwest Indiana. These companies have a mutual concern about the whole question of thermal inputs to Lake Michigan and share the belief that there is a definite lack of knowledge regarding the effects of thermal additions to the lake.

This concern is precisely why the committee is prepared to initiate a program of research. It will begin with the commissioning of Limnetics, Inc. of Milwaukee, Wisconsin, to undertake a one year thermal study of that portion of Lake Michigan which lies in the Calumet region of Indiana if the conferees agree with the opinion of the committee that data to be derived from such a study are necessary prior to the adoption of new regulations pertaining to thermal discharges.

Until additional information is made available, members of the committee believe that the present standards provide sufficient and necessary protection for the Lake Michigan environment. We presently do not know of any basis in fact that will support the Department of the Interior's proposed limitations of 1°F. above ambient. We believe this proposal to be most unrealistic. It might thwart present progress towards improving water quality. In fact, it might make obsolete some recent investments in effluent treatment facilities. It might also divert future funds away from other more beneficial effluent quality improvement projects.

The committee has organized cooperatively the proposed study to provide information and the basis for recommendations that can affirm present water quality standards or that will suggest needed changes or new regulations.

To aid in the solicitation of study proposals from several interested research and academic institutions, the committee formulated the following study objectives, which outline the scope of the proposed research:

1. Review and summarize objectively the effects of thermal discharges on the fresh water aquatic biota which is typical of southern Lake Michigan. It is anticipated that this will require a comprehensive literature search and will yield the information necessary to prepare a well-founded policy statement on thermal pollution.

2. Determine and summarize existing thermal dispersion patterns in the Calumet area of Lake Michigan under a variety of meteorological and hydrographical conditions. This will involve the collection of outfall inventory data and data on surface and subsurface currents and dispersion patterns in the lake. It is expected that the data collection will involve a combination of field measurements and aerial thermal mapping surveys. The portion of Lake Michigan which is of interest to the participating companies extends from the Indiana-Illinois line up to the eastern boundary of Gary, Indiana. The area of study is tentatively defined as being within $1\frac{1}{2}$ miles of shore.

3. Study the influence of natural effects, including daily and seasonal variations in wind, cloud cover, sunlight, air temperature, and land runoff on short- and long-term temperature variations in the lake. These natural effects will be compared to the influence of the man-made heat discharges quantified under item 2.

We are not in a position to present definitive recommendations in regard to thermal standards at this time; however, we will be ready to present the conclusions from our study to the state of Indiana upon its completion in approximately one year. In addition, data from additional studies of which committee members are aware should also be available by that time. It is our conviction that meaningful revisions of the present water quality standards must be predicated on need and based on fact. Since the standards now in effect afford reasonable protection and since additional facts will be forthcoming, it is our recommendation that the setting of new thermal standards for the southern portion of Lake Michigan be held in abeyance for at least one year.

MR. STEIN: Are there any other statements or comments?

If not, I will thank you very much, and we will stand recessed until 9:00 o'clock tomorrow, and I hope you will tell everyone to keep their statements brief tomorrow if we are going to get through.

We stand in recess.

(The conference adjourned at 3:40 p.m.)

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