A WATER POLLUTION INVESTIGATION

OF THE

DETROIT RIVER

AND THE

MICHIGAN WATERS OF LAKE ERIE

SUMMARY AND CONCLUSIONS

AND

RECOMMENDATIONS

U.S. Department of Health, Education, and Welfare
Public Health Service

Division of Water Supply and Pollution Control - Region V
Detroit River-Lake Erie Project

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SUMMARY AND CONCLUSIONS

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SUMMARY AND CONCLUSIONS

A water pollution investigation of the Detroit River and the Michigan waters of Lake Erie has been made by personnel of the Detroit River-Lake Erie Project of the Public Health Service, U.S. Department of Health, Education, and Welfare, under the authority of Section 8 of the Federal Water Pollution Control Act and at the request of the conferees of the Joint Federal-State of Michigan Conference on Water Pollution held in Detroit, Michigan, on March 27 and 28, 1962.

The investigation was conducted cooperatively with the State regulatory agencies to fill the gaps in existing technical information relative to water quality and extent of pollution in the area, and sources and quantities of wastes which affect this quality. This information will then be utilized in the preparation of a plan for improvement of water quality in the area. The area of coverage actually includes only the United States waters of the Detroit River and Michigan waters of Lake Erie. Through coordination with the International Joint Commission it was possible to extend certain aspects of this investigation into Canadian waters. Generally speaking, however, the comments contained in this report refer to only the Michigan waters of the Detroit River and Lake Erie.

The main body of this report contains a narrative description of all major activities, which is accompanied by appropriate maps, graphs, and tables to better explain the technical material and support conclusions and recommendations. All tables and figures are contained in the seven sections which constitute the main body of the report although they may be referred to in the section entitled "Summary, Conclusions, and Recommendations."

Three maps (Figures 1-I, 2-I, and 3-I) are located at the end of the report and are of special design which permits ready reference by the reader. These maps show the location of all regular sampling stations and the general area covered by the study.

Although conclusions are presented in the main body of the report they are summarized in this section for ease in comprehension and continuity.

Coordination was effected with other agencies of the Federal government including the Corps of Engineers, U.S. Geological Survey, and the International Joint Commission to prevent needless duplication of effort.

Assistance from many sources is acknowledged and special participation by personnel of the Michigan Water Resources Commission and the Michigan Department of Health recognized. Valuable assistance was also rendered by Public Health Service personnel from the Great Lakes-Illinois River Basins Project in Chicago, Illinois, and the Robert A. Taft Sanitary Engineering Center in Cincinnati, Ohio. After establishment of Project headquarters at the Grosse Ile Naval Air Station, operation was begun. Prior studies were reviewed and sampling stations in the Detroit River and Lake Erie selected (see Figures 2-I and 3-I). In addition to these stream sampling points, over 100 industrial waste outfalls were sampled on a "grab" basis throughout the study.

Intensive surveys were made of 6 municipal and 42 industrial waste sources to better ascertain the contribution of each to the waste loadings found in the waters under study. These surveys were joint efforts of the Public Health Service and the appropriate State regulatory agency. In the area of the industrial waste surveys, Michigan Water Resources personnel collected the samples and, after Public Health Service laboratory analysis,

evaluated the findings and made recommendations where appropriate. In some cases Project personnel felt additional recommendations desirable. Quantitation of Project data was effected by flow measurement and computation of loadings in the waste outfalls and in the receiving streams.

Special studies were made to determine the condition of the bottom in Michigan Lake Erie and the Detroit River. Distribution of flow in the River and current flow in the Lake were determined under varying environmental conditions using fluorescent dye and a fluorometer. Special investigation was made to determine the effect of overflows from combined sewers on water quality in the receiving waters. A cooperative study was undertaken in cooperation with the Michigan Department of Health to determine and compare the characteristics of overflows from combined sewers with those from separate storm sewers. Because of widespread interest and the complexity of the situation, an intensive survey was made on the bathing beaches at the Sterling State Park, which have been posted as unsafe for swimming due to pollution since 1961. Bacteriological, chemical, physical and biological determinations were made in the waters, and in some cases, in waste sources to determine current water quality and extent of pollution.

Internal controls were established to assure the reliability of both Project field and laboratory operations, as well as conclusions derived therefrom. A depth study was conducted which indicated that with the exception of dissolved oxygen in Lake Erie, surface samples were representative of water quality at varying depths at the same station. The results of this special investigation are summarized in Section I. Generally, all laboratory procedures were performed in accordance with "Standard Methods for the Examination of Water and Wastewater." Any deviations were based on proven

research described in the literature. In addition to following these procedures, precision and accuracy tests were performed for internal control of laboratory operation to assure the results were accurate, reproducible and reliable. The results of this extensive testing procedure are summarized in Section I of this Report. A comparison of coliform determination by both the membrane filter and multiple tube dilution method was conducted with the conclusion that not only is there a positive correlation between the two methods, but also the membrane filter technique is more consistent and describes coliform concentrations within narrower limits (see Table 9-I).

The services of a statistical consultant were frequently utilized to review evaluation procedures and recommend, when appropriate, additional or alternate methods. The consultant directed complex statistical approaches to better define Project field data and assure the maximum utilization.

The magnitude of the operation is attested to by the fact that over 25,000 samples were collected upon which over 135,000 determinations were performed, and over 50 separate sources of waste were investigated and their effect on the receiving waters evaluated.

Several prior investigations concerning water quality in the Detroit River have been made by governmental agencies and private consulting engineering firms during the last 50 years. Old reports described polluted conditions in the river due to the presence of inadequately treated municipal wastes, as indicated by the presence of high concentrations of organisms of the coliform group. Later reports mentioned undesirable effects in the receiving waters from industrial pollutants such as phenols, oil, ammonia, and iron. These later documents also suggested the hazard to water use in the Detroit River caused by overflows from combined sewers. The 1951

International Joint Commission Report sets up objectives for water quality in the international waters involved, which are referred to and used in the preparation of this Report. All prior reports studied and described in detail in Section I stress the progressive deterioration of water quality due to pollution from the headwaters to the mouth of the Detroit River.

Study of the results of sampling in the Detroit River by personnel of the City of Detroit during the past four years indicates a pronounced downward trend (as evidenced by median values) in coliform concentrations in American waters near the shore, especially during the years 1962 and 1963. While the median value for coliform organisms is a reasonable measure of central tendency of occurrence, it certainly tends to mask unusually high or low values - especially high concentrations.

Four years of operating records of several area water or sewage treatment plants were studied and evaluated. These results are summarized in some detail in Section I. These records indicate a substantial reduction in monthly geometric mean coliform concentrations during 1962 and 1963 compared with the preceding two years. This is especially true of the Detroit Sewage Treatment Plant. A corresponding reduction in coliform concentration at the Wyandotte Water Treatment Plant was observed in these two years, and Figure 15-I compares values at the two installations. Little change was noted in suspended solids in sewage plant effluent or effluent in area plants during the period. Figure 13-I depicts a consistent and significant increase in chloride concentration at the water intake of the City of Monroe equivalent to approximately 30 percent increase over the last four years. At the same time, this Figure shows chloride concentrations at the intake of the main water treatment plant of the City of Detroit fairly

constant at 6 - 8 mg/l. The 1964 chloride values at the Monroe intake in Lake Erie indicate a fivefold increase from the head of the Detroit River to this part of Lake Erie.

Monthly geometric mean values in several Detroit River sewage treatment plant effluents indicate substantial reduction during the past few years. However, in the case of Detroit, the geometric mean of several values collected during the day showed great variance with values frequently greater than 100,000 organisms per 100 ml during months with a geometric mean coliform concentration under 20,000 organisms per 100 ml (see Figure 11-I). Such erratic control of coliform organisms is not considered unusual when chlorination is practiced following primary sewage treatment.

The Detroit River is actually a strait connecting the waters of Lake St. Clair with those of Lake Erie. Its average discharge, based on United States Lake Survey records through April, 1964, is 182,000 cubic feet per second. During the study period the discharge averaged 170,000 cubic feet per second. A complete description of the Detroit River, including its geology, land use, and climate as well as hydrologic factors, is contained in Section I.

The Michigan waters of Lake Erie represent approximately 1 percent of the surface area of this international body of water. This is the shallowest of all the Great Lakes, and the greatest recorded depth in its Michigan waters is only 29 feet. The majority of inflow into Lake Erie originates from the Detroit River.

Records of the Weather Bureau of the United States Department of Commerce and Geological Survey of the United States Department of Interior

indicate the average annual rainfall in the Detroit area as 31.49 inches. The first year of survey operation (1962) was below average at 27.76 inches and the second and major operational year (1963) was the lowest of record from the standpoint of rainfall at 20.49 inches.

Water Uses

An inventory of water use in the study area was compiled and is presented as Section II of this report. The tabulation and narrative show heavy and diversified use of these waters by many interests. Tonnage shipped through the Detroit River during a recent eight-month season exceeded the entire combined tonnage shipped through the Suez and Panama canals during an entire year. Dredging operations are carried on in the Detroit River and Lake Erie by the United States Corps of Engineers, both to enlarge navigable channels and maintain existing channels by removing settled deposits, a portion of which originate from waste discharges in the area. The offending industries on the Rouge River reimburse the Corps of Engineers for a portion of the cost of the removal operation. In 1963 Rouge River industries paid over $53,000 towards this cost.

Records of commercial fish catches by Michigan fishermen in Lake Erie indicate no noticeable decline in total pounds of fish caught during the 20 year period 1944 - 1963. The 1963 catch, however, decreased from 1961 and 1962 highs of 1,921,354 and 1,837,643 respectively to 1,332,464, and the 1963 value dropped to a low of $94,594.30 according to the records of the Michigan Department of Conservation.

The Detroit River is known as a major staging area for migrations of waterfowl. Estimated winter populations since 1950 ranged from a minimum

of 5,000 in 1961-1962 to 100,000 in 1963-1964. The Wyandotte Wildlife Refuge was established in August 1961 and is located on Grassy and Mamajuda Islands in the lower Detroit River.

Eighteen recreational areas and 63 marina facilities have been tabulated in this section of the inventory indicating the great interest in the people of the study area in this water use. Boat registrations for Wayne County alone exceeded 74,000 in 1962.

Heavy use is also made of the waters for industrial and municipal water supply and waste disposal. Forty-six industries and pertinent facts concerning their use are tabulated in the inventory. The major municipal user is the City of Detroit, which serves the water supply needs of over 3 million people both in Detroit and in adjacent communities. Three municipal water supply intakes are located in the United States section of the Detroit River and one in the Michigan waters of Lake Erie.

Over 100 combined sewer outfalls are located along the Detroit River or on its tributaries.

Population and Manufacturing Trends

A brief investigation was made into population and manufacturing trends with the assistance of personnel of the Public Health Service's Great Lakes Illinois River Basins Project. The significant findings from this investigation are shown in Section III of this Report.

These findings indicate that the major water using industries will increase by 150 percent between 1960 and 1980, and that demands upon the water resources of the area will increase by this amount unless adequate pollution control is effected. A 40 percent increase in population is

expected in the four-county study area between 1960 and 1980. This population growth will place greater demands upon the water resources of the area and, unless effective pollution control is acheived through more efficient municipal waste treatment, water quality in the Detroit River and Lake Erie can be expected to deteriorate from present levels.

Findings of Investigation - Detroit River

Description of Water Quality

A detailed description of water quality and extent of pollution in the waters under study are contained in Section V and Section VI of this Report. Many graphs, maps, and tables are included to assist in the understanding of the narrative material.

The Detroit River from its head to its junction with the old channel of the Rouge River (approximately 10 miles downstream) is considered satisfactory from the standpoint of pollution during dry weather conditions. The only exception to this general statement is an average concentration of phenols at the head exceeding the International Joint Commission objective of 2 µg/l (ppb). In the upper river these values averaged between 3 and 5 µg/l. During overflows from combined sewers the only part of the Detroit River free from pollution is that stretch above Conners Creek and mid-river downstream to the Rouge River.

All types of pollutants had a tendency to hug the United States or Canadian shores from their point of discharge and slowly extend outward into the main body of the river, resulting in a dip in the graphical representative of a quality profile of the River at a cross-section.

Description of bacterial concentrations in the Detroit River can best

be made during two circumstances - one during dry weather, and one during or following rainfall of significant intensity or accumulation to cause overflow from combined sewers.

Central tendency of coliform concentrations is often described by the median value but this measure was not generally used because it does not allow the statistical interpretation of the geometric mean which takes the magnitude of all values into account. Since International Joint Commission objectives for coliform concentrations are described in terms of the median value, these values were computed and compared with corresponding geometric mean values. No significant difference was found. The statistical consultant to the Project felt that geometric mean and median coliform values were comparable when distribution was log-normal. To achieve log-normal distribution expected of bacteria in waters, it was necessary to separate the values according to wet and dry conditions and compile two separate distributions. These were found to be log-normal.

During dry conditions the geometric mean coliform concentration in the upper Detroit River was under 500 organisms per 100 ml, with average values at the headwater under 100 organisms per 100 ml. Below Zug Island and the Rouge River the geometric mean coliform concentrations increased to values exceeding 5,000 organisms per 100 ml (see Figure 1-V), During wet conditions no change was noted at the head of the Detroit River, but below Conners Creek geometric means rose to approximately 7,000 organisms per 100 ml in the upper river, and further rose to geometric mean values exceeding 80,000 in the lower Detroit River. Figures 2-V and 3-V indicate that during wet and

dry weather almost all of the lower Detroit River has geometric mean values in excess of the International Joint Commission objective of 2,400 organisms per 100 ml, and most of the lower River exceeds 5,000 organisms per 100 ml during wet conditions.

Fecal coliform ratio or percentage gives additional insight into the sanitary significance of the water under study. The range noted during the study was 30 to 90 percent of the total coliform concentration, with higher values observed below the Rouge River and during wet conditions. Fecal streptococci were generally observed in concentrations less than either total or fecal coliforms (see Figures 5-V through 5-7).

Throughout the report, coliform concentrations in the Detroit River will often be shown on semi-logarithmic paper. Those more familiar with arithmetic or regular graph paper may find interpretation more difficult. This was done to allow presentation of low values on the same graph as well as very high values, since this type graph paper tends to compress the extreme values.

For example, if one desired to plot a value of 100 organisms per 100 ml on the same graph with a value equal to 100,000 organisms, and the arithmetic scale allowed one inch between the zero and 100 point on the graph, the distance from the bottom of the graph to the 100,000 point would be equivalent in height to an eight-story building.

Geometric mean concentrations depict only average conditions and tend to mask extremely high values which are important from the standpoint of many water uses, especially those affecting human health and welfare. Maximum values and those expected to be exceeded 5 percent of the time (95 percent values) are shown in Table 1-V. Maximum values during the survey ranged from 4,900 organisms per 100 ml at the headwaters to 770,000 organisms per 100 ml in the lower river. An overall picture of the increase in average coliform concentrations from the head to the mouth of the Detroit River is shown in Figure 9-V.

At the head of the Detroit River average total coliform concentrations were approximately the same during wet and dry conditions throughout the range. At all locations from just below Belle Isle to the mouth of the Detroit River average total coliform concentrations near the United States shore during wet conditions were 5 - 10 times higher than corresponding values during dry weather. At some locations the difference between the two values became less pronounced in the middle of the river and very little difference between wet and dry conditions was noted at locations near the Canadian shore.

Average phenol concentrations in the Detroit River increased from 3 - µg/l at its head to greater than 10 µg/l in the lower river, and 6 - 9 µg/l at the mouth (see Figure 10-V). Average phenol concentrations at all

ranges in the Detroit River exceeded International Joint Commission objectives during the survey. Records of the International Joint Commission indicate high concentrations in the St. Clair River below known sources of phenolic wastes in Sarnia, Ontario, Canada.

A substantial increase in suspended solids was noted in the Detroit River from its head to mouth with a range of 5 - 20 mg/l in the upper and 14 - 65 mg/l observed in the lower river. Settleable solids show a similar increase from a range of 5 - 10 mg/l to 10 - 24 mg/l.

Chlorides increased from uniform concentrations of 7 - 10 mg/l at the mouth to average values ranging from 9 - 69 mg/l. High values were observed in the Trenton Channel and at the mouth near the United States shore. (See Figure 4-V.)

Average iron concentrations in the upper Detroit River meet International Joint Commission objectives of 0.3 mg/l but quickly increase to average values above this level at 0.52 mg/l. The iron concentration at the mouth ranges from 0.47 - 0.63 mg/l.

Dissolved oxygen in the upper river is stable at 93 - 106 percent saturation but gradually diminishes to a low average saturation of 67 percent at the mouth in that section of the river most affected by the Trenton Channel. The minimum observed value during the Survey was 5.1 mg/l at the mouth. (See Figures 12-V and 12a-V.)

Nitrogen compounds show a significant increase from the head to the mouth of the river. Inorganic nitrogen (nitrates, nitrites and ammonia) increased from approximately 0.2 mg/l at the head to over 0.4 mg/l at the mouth of the river. Ammonia increases dramatically below the Rouge River and Zug Island from a range of 0.08 - 0.14 mg/l to 0.16 - 0.41 mg/l.

Phosphates (reported as phosphates) increased from average values of 0.03 - 0.30 mg/l at the head to 0.89 - 1.70 mg/l at the River's mouth. All but two soluble phosphate values in the upper Detroit River were less than 0.001 mg/l with the highest value located near the United States shore just downstream from the combined sewer outfall at Conners Creek. These values increased to a range of 0.176 to 0.204 mg/l at the mouth.

The concentration of ABS (Alkyl Benzene Sulfonate) was found to double in the river from its head to mouth, but all values were well within recommended limitations of 500 µg/l designed to prevent trouble with foaming.

Of all the toxic metals examined, only copper did not show any tendency to increase from the upper to the lower sections of the river. Average values of these constituents at the mouth ranged between 0.01 and 0.04 mg/l for lead, chromium, cadmium and copper while zinc and nickel averaged 0.01 - 0.60 mg/l.

Oil and grease were not quantitatively measured in the receiving streams but observed when visible and analyzed in the effluent from industrial and municipal waste sources to check adherence with International Joint Commission effluent recommendations of 15 mg/l.

Cyanide in concentrations greater than the Public Health Service drinking water standard of 0.01 mg/l and the limit of 0.025 mg/l considered detrimental for fish and wildlife propagation, was found in the lower Detroit River.

The waters of the Detroit River from head to mouth were found to contain low numbers of planktonic algae, with counts averaging 500 per ml. Low concentrations of animal plankton were also found. Plankton entering the river with water masses from Lake St. Clair were carried as a "standing

crop" downriver to Lake Erie with little change in density or species composition either vertically or horizontally across the river. The rate of travel is too rapid for the domestic and industrial wastes to appreciably alter the number of plankton.

The early spring diaton pulse in Lake St. Clair raises the plankton counts to levels averaging 2,000 per ml.

The observed turbid condition in the Detroit River was not associate with the concentration of living organisms in the waters since plankton populations were not dense enough to contribute appreciably to turbidity.

The sewage fungus Sphaerolitus was found, attached to bridge abutmen pilings, piers, buoys, etc, in abundant quantities in the Detroit River below the Rouge River and Detroit Sewage Treatment Plant outfall (Figure 13-V).

Composition of bottom organisms in the Detroit River changed from a pollution-sensitive population typically found in clean waters to a predominantly pollution-tolerant association in the lower areas of the river below Zug Island and the Rouge River. This change was especially pronounced along the United States shore. Zones where clean-water and pollution-tolerant organisms were found are shown in Figure 14-V. In the reach of the Detroit River from Zug Island to the mouth, habitats suitable for the support of a variety of bottom organisms have been destroyed by the deposition of organic solids and oils, especially in areas nearest the Michigan shore.

Clinging and burrowing mayfly nymphs, both pollution-sensitive organisms associated with clean bottom conditions, were found in the upper ranges of the Detroit River but were completely absent in the river below the Rouge River and Detroit Sewage Treatment Plant, and in the entire Michigan waters

of Lake Erie. This was true even in habitats where these organisms were once found thriving by prior investigation. Habitats in the lower Detroit River suitable for the support of this once abundant organism have been totally destroyed by pollution. Search of the literature compared with findings of this Project indicate an acceleration of the aging of Lake Erie.

Trends in Water Quality

Trends in water quality can be best illustrated by Figures 15-V through 17-V, which compare graphically the results of 1946-1948 International Joint Commission Survey with the current Public Health Service Survey. Improvement in average coliform concentrations, especially near the United States shore, is noted and little change was evident in chloride and phenol concentrations in the river. Table 5-V compares waste loadings from industrial sources in the two periods and shows improvement ranging from 22 percent to 79 percent reduction in the constituents measured. Current loading from domestic loading shown in this Table were not measured in 1948, but indicate these as significant and in some cases dominant for constituents such as oil and phenols normally associated with industrial sources.

Sources and Characteristics of Wastes

A complete discussion of the 5 municipal waste installations is shown in Section V, and the Federal waste installation at Grosse Ile in Section IV. The City of Detroit at its main plant is the major source of domestic waste, contributing over 95 percent of all constituents and flow as well as serving 91 percent of the people. International Joint Commission objectives for several constituents are exceeded in area plants discharging to the Detroit River and specifics will be discussed with recommendations for each plant.

Tables 6-V through 8-V tabulate the results of field surveys and indicates a discharge into the Detroit River of the following loadings of constituent from municipal sources.

1. Wastes equivalent in oxygen consuming capacity to raw sewage from a population of over 3 million persons.

2. Over 25,000 pounds of iron per day.

3. Over 600,000 pounds of suspended solids and almost 300,000 pounds of settleable solids per day.

4. Over 16,000 gallons of oil every day.

5. Over 1,200 pounds of phenolic substances every day.

6. Over 34,000 pounds of ammonia per day.

7. Over 52,000 pounds of nitrogen compound per day.

8. Almost 600,000 pounds of chloride per day.

9. Over 150,000 pounds of total phosphate and 70,000 pounds of soluble phosphate every day.

Generally speaking, bacterial control was excellent in area sewage plant effluents during the Public Health Service Survey, although long-ter records indicated erratic results at considerably higher levels than those found in the plant surveys.

Surveys were made by personnel of the Michigan Water Resources Commis sion and Public Health Service of 35 industries on the Detroit River.. Individual comment on each industry is listed with specific recommendation A total industrial waste volume of 1.1 billion gallons per day compared to a municipal volume of 540 million gallons per day. Detailed analysis of these surveys is shown in Section V and is emphasized by Tables 9-V through 17-V. Summary of the results indicate the discharge of the

following loadings into the Detroit River from industrial sources. (See Figure 14-V.)

1. Wastes having an oxygen consuming capacity equal to raw sewage from a population of over 1 million persons.

2. Over 3,000 gallons of oil per day.

3. Over 800,000 pounds of suspended solids per day.

4. Over 1,000 pounds of cyanide per day.

5. Over 1,400 pounds of phenol per day.

6. Over 8,000 pounds of ammonia per day.

7. Over 80,000 pounds of iron every day.

8. Over 2 million pounds of chloride every day.

9. Over 200,000 pounds of acid each day.

As in municipal waste installations, several industries discharged waste constituents into the Detroit River in concentrations which exceed International Joint Commission recommendations. The Ford Motor Company was found to be the principal source of industrial pollution on the Rouge River, except for the BOD discharged by the Scott Paper Company. The Great Lakes Steel Company was found to be the major source of pollution in the upper Detroit River except for solids contributed by Allied Chemical Corporation. The downriver industries which contributed significant quantities of pollution to the Detroit River were the Great Lakes Steel Corporation, Wyandotte Chemicals Corporation, Pennsalt Chemical Corporation, McLouth Steel Corporation, and Mobil Oil Company. Improvement has been noted in the quality of the effluent of several industries and will be discussed with individual recommendations.

Pollution also originates from pleasure and commercial boats and

shorefront homes, but no quantitative values which would add to the values contained in the 1962 Detroit Conference are available. Overflows from combined sewers also represent a significant source of waste affecting water quality in the Detroit River and will be discussed in detail in a separate section of this Report.

Special Studies

Several special studies were conducted to provide additional insight into complex problems and better tie together an effect of pollution in the waters under study with its source.

An investigation was made of the effect of pollution originating from unsewered homes or from inadequately functioning installations on Grosse Ile. The study revealed the bathing beaches on or near Grosse Ile were polluted and unsafe for swimming, and contribution to this pollution from the local sources was observed. This effect is, however, limited to the immediate area of Grosse Ile, and improvement of these sources alone would not result in raising the level of the beaches to acceptable limits for use because of the effect of the polluted Detroit River itself.

An investigation was made in the field and in the laboratory relative to regrowth and die-off of bacteria in the Detroit River. While conducting this the pattern of channeling of bacterial wastes in the River was determined. No significant regrowth or die-off of coliform bacteria was observed in the Detroit River. This may be due to the time of passage, which is less than 1 day from the major points of discharge to the River's mouth. Approximately 62 per cent of the bacterial pollution discharged at the Rouge River and the Detroit Sewage Treatment Plant followed the channels closest to the American shore.

A bypass of approximately 75 MGD of raw sewage for 10 consecutive days was effected by the City of Detroit during November 1963. This operation was required to permit renovation of a large raw sewage pumping station and was carefully controlled by the State of Michigan regulatory agencies and monitor

by the Public Health Service. It is deplorable that construction provisions were not made to cope with such emergencies to prevent discharge of this deleterious material to the watercourse. The City of Detroit carried out operations within the limitations specified by the State agencies.

After dispersion patterns of this material became well established, high coliform concentrations in the River below the point of discharge were noted. (See Figure 22-V.) Results at the mouth of the Detroit River indicated a band of high coliform concentrations (10,000 - 30,000 organisms per 100 ml) in a 7,000-foot band along the United States shore.

Near the termination of the Project activities in July 1964, the City of Detroit began a special testing operation required by the State to determine the effect on receiving water quality of bypassing treated effluent through the 800-foot alternate outfall to the Rouge River instead of through the regular 6,000-foot outfall to the Detroit River. The purpose of this operation was to allow shutting down and renovation of the regular outfall.

Regular surveillance operations of the Project revealed exceptionally high coliform concentrations in the lower Detroit River, with dry weather values exceeding 600,000 organisms per 100 ml found at the range of the Detroit River near the City of Wyandotte water intake. In fact, concentrations at all stations at this range (DT 14.6) exceeded 200,000 organisms per 100 ml, with correspondingly high fecal coliform concentrations. Investigation revealed that the alternate bypass had actually begun and was further evidenced by coliform concentration at the mouth of the Rouge River exceeding 2 million organisms per 100 ml. This information was immediately transmitted to the State regulatory agencies, which contacted the City of Detroit, which, after sampling near the mouth of the Rouge, immediately cancelled the operation.

Since the Project was unaware of the exact starting date of this operation, arrangements were not made for a comprehensive investigation. Once the extremely high levels revealed themselves, all energy was devoted to getting the information to all parties concerned, in order that appropriate action might be taken to prevent a possible epidemic.

From this experience an important finding was made. This is the importance of adequate contact time following chlorination of primary effluent. It appears from available information that the main cause for the extreme coliform concentrations in the plant effluent was inadequate contact time since the regular line exceeds 30 minutes and may be as much as 1 hour, while the contact time in the 800-foot alternate is estimated to be less than 5 minutes.

Analysis was made of the condition of the bottom of the Detroit River as evidenced by physical and chemical characteristics of deposits. Large areas of sludge deposits, whose origin is in part from discharges of industrial and municipal waste discharges, were found in the Detroit River. Most of these were found in quiet waters downstream from sources of these wastes.

Although the age of all the deposits could not be accurately forecast, indication of recent deposits was evidenced from volatile solids analysis, and if suspended solids continue to enter the River from waste outfalls or other sources the deposition will continue as before and cause the same problems. The results were classified and the Detroit River divided into areas of poor, fair, and good condition according to bottom material quality shown by such analysis as odor, appearance, oil and grease content, iron content, nitrogen, or phosphorus, and per cent volatile material. (See Figure 23-V.) The areas indicated as poor represent areas where suspended solids have settled over

the natural bottom forming sludge banks which interfere with the propagation of fish. In shallow waters they are offensive to swimmers and boaters, especially when fluctuating water levels expose beds of these materials. There is also a potential problem that these deposits will be disturbed by boat movement and resuspended, causing increase in turbidity, taste and odor problems, and stimulate algal growth when nutrients contained in the solids are released to the surrounding waters.

Investigation was made to determine distribution of flow in the Detroit River. Figures 24-V and 25-V depict this information as streamlines or distribution of per cent flow across the Detroit River at various ranges.

Dye was placed in the effluent of several area sewage treatment plants and traced downstream. The results of these investigations are shown in Figures 26-V and 27-V. Dye from the unchlorinated wastes of the Belle Isle Sewage Treatment Plant stayed in midchannel but all other waste discharges tended to hug the United States shore for some distance downstream. The dye from the City of Detroit effluent appeared to miss the new southwest water intake, but a heavy concentration passed over the City of Wyandotte water intake. Further downstream the dye was traced to the east as well as the west side of Grosse Ile. All dye tracer studies from the City of Detroit plant effluent were conducted during dry weather, and it is likely that heavy rainfall in the drainage area of the Rouge River could produce conditions due to overflows from combined sewers which would in effect move the downstream water mass consisting of the Rouge River outflow and Detroit effluent further to the east. This is conjecture, however, since dye tracer studies were not performed under these conditions. The opinion is based upon observed

occasional high coliform values at the southwest intake and a hydrologic knowledge of the Rouge River.

Figure 26-V depicts the percentage of the Detroit River affected by the discharge of industrial and municipal wastes from the Michigan mainland.

Waste concentrations and corresponding River flows in each section of the Detroit River were combined to allow computation of waste loadings at the head and mouth of the River. This figure allows a better assessment of quantitative waste loadings on overall water quality and is helpful in predicting improvements after pollution abatement. Stream loadings for several measures of water quality in quantitative units are shown in Figures 29-V through 37-V. Table 39-V shows the increase in waste constituents in the Detroit River and Table 40-V compares these values with known quantities of wastes being discharged to the River.

When stream loadings are available it is possible to compute an average concentration of a waste constituent at each range in the River adjusted to flow in each section. This procedure makes possible the presentation of a single concentration representative of water quality at each cross section of the Detroit River. These adjusted average values are shown in Figures 38-V through 46-V.

In general the loadings and average concentrations show a significant increase in the lower Detroit River below Zug Island and the Rouge River. Adjusted average coliform concentrations increased from 46 organisms per 100 ml at the head to 7,250 organisms per 100 ml in the lower River. The increase in loadings of essential plant nutrients was quite apparent as both total nitrogen and phosphate doubled in quantity between the head and mouth of the River.

Of special interest was Table 39-V, which indicated the following loadings being discharged daily from the United States waters of the Detroit River into Lake Erie.

Waste Constituent	Daily Discharge into Lake Erie Pounds per Day - U.S. Waters
Chlorides	10,000,000
Phenols	2,100
Suspended Solids	8,600,000
Settleable Solids	7,200,000
Iron	260,000
Total Phosphate	218,000
Ammonia Nitrogen	133,000
Nitrate Nitrogen	109,000
Organic Nitrogen	72,600
Total Nitrogen	314,600

Intensive surveys were run on tributaries of the Detroit River thought to be of significance in the contribution of industrial or domestic wastes and subsequent deterioration of the main River. The results of these surveys are presented in Section V of this report.

The Rouge River was shown to be a major contributor of waste constituents originating in discharges from industrial and municipal outfalls. Bacterial control as evidenced by coliform concentrations improved markedly after the diversion of municipal wastes from the overloaded Dearborn system to Detroit. High values following heavy rainfall and occurrences of diversion of wastes to the Rouge by municipalities during dry weather were observed, however. Extremely low coliform concentrations were found during the winter of 1964 from regular sampling stations.

Most significant of the measures of Detroit River water quality affected by the Rouge River are coliform organisms, iron, phenols, suspended and

settleable solids.

Intensive surveys of other tributaries showed Monguagon Creek to be a major contributor of phenols from industrial waste discharges and Ecorse Creek to be a major source of coliform organisms following rainfall.

Intensive surveys on the Detroit River on an around-the-clock basis revealed no unusual conditions of waste discharges related to time of day or night. No significant difference was found on weekday-versus-weekend waste discharge.

Studies performed jointly with the Michigan Department of Health and the Michigan Water Resources Commission were made to compare the characteristics of discharges from separate storm and combined sewers. Samplers were installed in a combined sewer installation in Detroit and a separate storm sewer in Ann Arbor. The automatic sampler (a cooperative State-Federal venture in itself) automatically activated itself when overflow or discharge began and sampled at predetermined intervals throughout the duration of the storm. A detailed description of these activities and the results are contained in Section V.

Analysis was made to determine concentrations of total and fecal coliform organisms, fecal streptococci organisms, suspended and settleable solids, nitrogen and phosphorus compounds, phenols, and BOD in the discharge from the two types of sewers.

Careful study of the data summaries and individual results reveals several interesting facts, among which are:

1. Total coliform, fecal coliform, and fecal streptococci concentrations in the overflow from combined sewers many times approached values found in raw sewage. Coliform counts of over 100,000,000 organisms per 100 ml were found during summer months.

2. Bacterial concentrations in the combined overflows varied greatly with the season or time of the year. The highest concentrations were found during warmer weather and lowest results in the winter.

3. Total coliform concentrations in the separate system at Ann Arbor regularly exceeded 1,000,000 organisms per 100 ml. Average total coliform concentrations in the overflows from the Detroit combined system were approximately 10 times higher than those in Ann Arbor separate system. Fecal coliform concentrations in the combined sewer effluent were found to be approximately 30 times greater than similar values in the separate system, while comparable fecal streptococci levels were at least twice as high.

4. In the Detroit area, rainfall sufficient to cause overflows from all combined sewers (0.3 inch) can be expected to occur approximately 33 days each year. Rainfall sufficient to cause overflows from certain parts of the system (0.2 inch) can be expected to occur about 45 days each year.

5. Although the average duration of overflow from combined sewers was found to be 8.2 hours, discharges have occurred for continuous periods in excess of 24 hours. Two such overflows occurred during the month of August 1964.

6. Suspended solids concentration in the discharge from the separate storm installation at Ann Arbor was higher than in the combined overflows at Detroit.

7. Phenol, BOD, phosphate, ammonia, and organic nitrogen concentrations were two to five times higher in the combined overflow than in separate storm discharge.

8. Bacteriological results from the combined installations showed a slight tendency for higher values during the first sample but thereafter were relatively constant in nature throughout the duration of the overflow.

9. Bacteriological results at the Ann Arbor separate system were also comparatively constant during a storm - always remaining within one order of magnitude. Small changes in quality and flow were more noticeable at this installation, however.

10. Calendar year 1963 was the driest on record for the City of Detroit according to rainfall records of the U.S. Weather Bureau. Even during this year, the Conners Creek pumping station was observed to overflow 12 times during a 6-month period in 1963. During the first 12 months of operation of the automatic sampler, the Conners Creek installation overflowed and collected samples 23 separate times. Both figures exclude the period of raw sewage bypass from this station by the City of Detroit.

11. The volume of overflow at the Detroit installation during the survey varied from 40 million gallons to 509 million gallons. The greatest volume was observed during the overflow of longest duration. This volume, which originates from only 25 percent of the City of Detroit, is approximately the same as the daily discharge of partially treated sewage from all sewage treatment plants into the Detroit River.

12. Volume figures . . . indicate a discharge into the Detroit River of $4\frac{1}{4}$ billion gallons from the combined sewers serving the Conners System during the first year of operation of the sampling stations.

13. Overflow from the combined sewers occurred 3 - 4 per cent of the time during the survey period. Rate of discharge per hour from the combined sewers varies with the intensity of the storm making an exact ratio of sewage from the Conners gravity system to the discharge to the Detroit River impossible. Within the limits observed during the study, 50 - 80 per cent of the raw sewage normally reaching the treatment plant is spilled over into the River during the overflow. By combining the average range of these two figures, approximately 2 per cent of the total raw sewage contributed to the Detroit area plants reachesthe Detroit River each year. This is over 5 billion gallons of raw sewage contributed to the Detroit River from this source each year. This figure should be considered conservative since the Conners system is designed for more storage capacity than many other combined sewers in the Detroit and downriver collection systems.

Several times special field investigations were made to determine the effect of overflows from combined sewers upon the Detroit River during or following rainfall. This was accomplished by collecting bacteriological samples above and below combined sewer outfalls during and following rainfall and comparing results from these analyses with dry weather data. Investigation was made during nine storms, during which overflows occurred, in the period April 23, 1963, through August 15, 1964. Total coliform, fecal coliform, and fecal streptococci determinations were made on samples collected during this period. Five ranges from the head to the mouth of the Detroit River were selected for this special sampling program to minimize the impact on the laboratory and get the most significant results with minimum effort.

Figure 48-V graphically depicts the change in bacteriological concentrations, during July 1963, following three storms of sufficient magnitude to cause overflow from combined sewers. Figure 49-V shows the increase in total coliform concentration from the headwaters to the mouth during a typical overflow. The value at the station nearest the United States shore is shown in Figures 48-V and 49-V.

Study of Figures 48-V and 49-V and individual Project and municipal data reveals several facts:

1. Coliform, fecal coliform, and fecal streptococci concentrations increased in the Detroit River, following an overflow from combined sewers, 10 to 50 times over the values found during dry weather conditions.

2. Coliform concentrations in the Detroit River following an overflow often exceeded 300,000 organisms per 100 ml and at times exceeded 700,000 organisms per 100 ml.

3. All high bacteriological values in the Detroit River during or following an overflow were found below Conners Creek. Bacteriological concentrations above this point stayed fairly constant during wet and dry conditions. Conners Creek represents the most upstream location of many combined sewer outfalls which extend to the mouth of the River.

4. Analysis of the City of Detroit sampling records reveals individual analyses exceeding 800,000 organisms per 100 ml in the Detroit River on the day following significant rainfall.

5. High bacteriological concentrations following overflows were found at both the City of Wyandotte water intake and the new City of Detroit intake near Fighting Island. The Wyandotte values exceeded 100,000 organisms per 100 ml and the Fighting Island values 10,000 organisms per 100 ml.

6. The effect of overflows on water quality in the Detroit River has been observed as long as 4 days after the rain that caused such overflows subsided. A storm which showed this effect occurred on August 11, 1964.

7. Results from each of the nine storms individually investigated demonstrated a severe effect on water quality in the Detroit River as evidenced by increased bacterial concentrations. This effect was also noticed in statistical evaluation of regular data by wet or dry conditions.

8. The length of the effect of overflows of combined sewers upon water quality in the Detroit River varies from 1 to 4 days after the beginning of the actual discharge.

9. The greater the rain the longer the period of overflow and more severe the effect on the Detroit River.

10. While bacteriological analysis was used to compare normal conditions with those found during or following an overflow, other observations were made by field personnel in the area during heavy rains which indicated the deleterious effect of the overflows upon water quality in the River. Field notes on these occasions described debris and garbage as well as excrement floating down the Detroit River.

11. Analysis of rainfall, overflow, and stream quality records reveals that during a 9-month period in 1963 (March - November) overflows from combined sewers affected water quality in the Detroit River during part or all of 88 days. This represents 32 per cent of the days in the 9-month period. This phenomenon occurred during the year of lowest accumulated rainfall and could represent an even greater effect on Detroit River water quality during a year of normal rainfall.

Another factor which adds to the pollutional effects of overflows from combined sewers is malfunctioning regulators. These devices are designed to automatically divert combined wastes into the water course when storms occur and revert the entire flow to the sewage treatment plant when the need for overflow has passed. These regulators have malfunctioned and stayed in the open position long after the storm had subsided, thus discharging raw sewage to the Detroit River. This usually continued until the agency involved was notified by the Michigan Water Resources Commission to remedy the situation.

Findings of Investigation - Lake Erie

Description of Water Quality

A detailed description of water quality and extent of pollution in the Michigan waters of Lake Erie is presented in Section VI of this report. As in the section covering the Detroit River, liberal use is made of maps, graphs, and tables to assist in the understanding of the narrative presentation.

Michigan Lake Erie has two major polluted zones - one in the vicinity of the mouth of the Detroit River, and one near the mouth of the Raisin River. These waters are polluted as indicated by bacteriological, chemical, physical, and biological measures of water quality as is the condition of the bottom in these areas.

Water quality in Lake Erie is visually presented in several graphs depicting quality profiles for geometric mean coliform concentrations and average concentrations of chloride, dissolved oxygen, nitrate, nitrogen, ammonia, organic nitrogen, inorganic nitrogen, total phosphate, and soluble phosphate.

An area with geometric mean coliform concentrations exceeding 2,400 organisms per 100 ml extends from the mouth of the Detroit River south 2 to 3 miles. Another small area of high coliform concentrations radiates out from the Raisin River approximately 1 mile. (See Figure 1-VI) A large area was found in the Lake with geometric mean coliform concentrations less than 500 organisms per 100 ml. Maximum coliform values showed a similar pattern of disbursement with individual values exceeding 100,000 organisms per 100 ml found near the mouths of the Raisin and Detroit Rivers.

Fecal coliform concentrations ranged from 5 to 30 percent of the total

values and geometric mean fecal streptococci were less than 80 organisms per 100 ml at all locations.

All bathing beaches along the Michigan shore of Lake Erie (see Table 2-VI) showed geometric mean coliform concentrations less than 1,000 organisms per 100 ml, except Maple Beach (B1) located in the influence of the Detroit River. Geometric mean coliform concentrations at Sterling State Park beaches approached 1,000 organisms per 100 ml but here the relatively low concentrations are misleading due to high values which appear under certain conditions of wind and weather. These high values (some exceeding 100,000 organisms per 100 ml) are masked in either median or geometric mean approaches to data summary. Fecal coliform and fecal streptococci concentrations along the Lake Erie beaches were noticeably higher than corresponding values in the adjacent lake waters.

Tributaries, especially Plum Creek and the Raisin River, had high geometric means, all exceeding 1,500 organisms per 100 ml. (See Table 3-VI.) Fecal coliform or fecal streptococci concentrations were correspondingly high.

Bacteriological concentrations in Lake Erie from the mouth of the Detroit River to a point 2 to 3 miles to the south indicate the water is polluted to the extent that it cannot safely be used for recreational purposes. Furthermore, following heavy rainfall in the Detroit area, the zone of polluted water extends southward to Stony Point. (See Figure 2-VI.) Both the International Joint Commission objective of 2,400 coliform organisms per 100 ml and 1,000 organisms per 100 ml commonly used as a standard pertaining to recreational use of water are exceeded in zones of Michigan Lake Erie influenced by the Detroit and Raisin Rivers. Other areas are of suitable

bacteriological quality for all uses. This statement is especially applicable to the bathing beaches just below LaPlaisance Creek to the Ohio State line. The waters of either the Detroit or Raisin Rivers do not appear to seriously affect or interfere with water use at the City of Monroe water intake off Stony Point.

Average phenol concentrations ranged from 1 to 16 µg/l, with 17 of 24 lake stations averaging less than the International Joint Commission objective of 2 µg/l (ppb). No pattern of high values was evident. Of all tributaries, only Plum Creek and the Raisin River average above 5 µg/l. There is no evidence that phenols in the Michigan waters of Lake Erie constitute a real or even potential interference with water use.

Average chloride values in the Michigan waters of Lake Erie ranged from 18 to 44 mg/l, with the higher values along the Michigan shore and near the mouth of the Detroit River. The influence of the Trenton Channel of the Detroit River is clearly shown in Figure 3-VI, and is felt as far south as Stony Point. While present levels do not interfere with water use, the year by year increase at the Monroe water intake is noted (see Figure 13-I) with alarm as a warning of future problems.

Suspended solids concentrations near Lake Erie bathing beaches ranged from 80 - 165 mg/l indicating turbid water. Michigan Lake Erie itself had concentrations far less at 11 to 25 mg/l. Suspended solids in Lake Erie were highest near the mouths of the Raisin and Detroit Rivers, and have reached levels which interfere with water uses by settling out on the lake bottom in areas near the shore. These sludge deposits can blanket the bottom killing fish eggs and fish-food organisms, thus destroying spawning beds and inflicting damage to aquatic life.

Cyanides were found only at the mouth of the Raisin River and once at Sterling State Park nearby. Cyanides in this limited area of Michigan area of Lake Erie pose a threat to water supply, and fish and wildlife propagation.

Average iron concentrations exceeding the International Joint Commission objective of 0.30 mg/l were found in Michigan Lake Erie only near the mouth of the Detroit and Raisin Rivers. Away from this immediate influence iron values were uniformly low. The greater influence of the two rivers appears to originate from the Raisin River.

All toxic metals, except cadmium, were detected in Michigan Lake Erie above 0.01 mg/l. The greatest concentration was in that part of the Lake influenced by the Raisin River. At this time the concentrations of toxic metals found in Michigan Lake Erie are not expected to interfere with water use, but maximum values of chromium and lead in the vicinity of the mouth of the Raisin River indicate a possible future problem.

Average dissolved oxygen levels in Michigan Lake Erie are depicted in Figure 4-VI as a percent of saturation. Most of the waters of Michigan Lake Erie display high levels of dissolved oxygen - sufficient to prevent interference with any water use. Two areas of low values were found near the mouths of the Detroit and Raisin River with the more widespread effect radiating southward from the mouth of the Detroit River. In the immediate vicinity of the mouth of the Raisin River complete depletion of oxygen was found, but within one-half mile into the Lake the levels recovered. Values as low as 4.8 mg/l and 58 percent saturation were found in the area south of the mouth of the Detroit River. Here the area of depressed values extend southwest 4 - 6 miles.

It can be said that all dissolved oxygen values in the Michigan waters

of Lake Erie exceed 4.8 mg/l or 58 percent saturation. It should be stressed, however, that the Michigan waters represent only 1 percent of the entire Lake and conditions in this section are not necessarily indicative of conditions in the remainder of the Lake.

Variation in dissolved oxygen with depth was most pronounced in the deeper Michigan waters with a 24-foot depth reading of 5.6 mg/l compared to a corresponding surface reading of 11.9 mg/l.

Levels of dissolved oxygen in all parts of Michigan Lake Erie (excluding the immediate vicinity of the mouth of the Raisin River) are sufficient at this time to prevent interference with water use.

Figures 5-VI through 8-VI indicate average concentrations of several nitrogen compounds in the Michigan waters of Lake Erie. A pattern of higher concentrations radiating outward from the Detroit River again has occurred, except in the dispersion of nitrates. High levels of nitrates ranging from 0.35 to 0.50 mg/l were found in Brest Bay. Ammonia concentrations exceeding 0.30 mg/l extended down into the Lake approximately 10 miles from the mouth of the Detroit River. Inorganic nitrogen exceeds 0.30 mg/l (see Figure 8-VI) in over 85 percent of the Michigan waters of Lake Erie.

Areas of high total phosphate concentration (0.20 - 0.50 mg/l) extended from the Detroit River south to Stony Point (see Figure 9-VI). Soluble phosphate values shown in Figure 10-VI indicated three areas of soluble phosphate exceed 0.10 mg/l as phosphate or 0.03 as phosphorus. One extended 6 - 8 miles south from the mouth of the Detroit River, one radiated out 1 - 2 miles from the Raisin River, and the third extended upward 3 - 4 miles from the Michigan-Ohio State line near Toledo.

Average ammonia concentrations of 0.20 mg/l near the City of Monroe water intake could cause water treatment difficulties and excessive dosage of chlorine to achieve adequate disinfection in domestic water treatment processes. Over 85 percent of the Michigan waters of Lake Erie contain inorganic nitrogen and soluble phosphates in concentrations sufficient to cause undesirable algal blooms and a subsequent serious interference with water use due to premature nutritive enrichment or eutrophication of this body of water.

Massive colonies of the filamentous slime bacteria Sphaerotilis or "sewage fungus" and filamentous green alga Cladophora were found in the Michigan waters of Lake Erie (see Figure 11-VI). Cladophora was found at most stations in Lake Erie and along the bathing beaches near Bolles Harbor. In addition, Sphaerotilis was found in the Brest Bay area indicating the polluted condition of these waters.

Waters of the lake study area were found to be rich in plankton with counts as high as 22,425/ml. The lake area nearest the shore especially supported dense populations of plant and animal plankters.

Collections near the mouth of the Detroit River had phytoplankton counts throughout the season 4 - 7 times lower than those of the lake reflecting the plankton-poor water masses passing from the Detroit River and heading eastward into other waters of Lake Erie. Density levels in general increased with distance from the Detroit River mouth. Average values for the whole season were 2,500 organisms/ml for the outshore locations and 4,200 organisms/ml for the inshore stations (see Table 7-VI).

The shallowness of the western basin of Lake Erie, coupled with wind and current action, brings about almost uniform vertical distribution of

temperature and nutrients which creates an optimal environment for growth and reproduction of plankters.

In Michigan Lake Erie, a study of the bottom animal associations revealed polluted areas adjacent to the Raisin River and Sterling State Park, (Figure 12-VI, Table 8-VI) and also at the mouth of the Detroit River extending in the shape of a fan out into the Lake. In between the two polluted areas, an association of bottom forms containing sensitive, intermediate, and tolerant specimens was found.

Samples from the river below sources of pollution and from the Lake did not contain a single burrowing mayfly.

Sources and Characteristics of Wastes

A complete discussion of the results of a survey of the Monroe Sewage Treatment Plant is made in Section VI of this Report. Tables 9-V and 10-V summarize the results of this investigation. Primary treatment plus chlorination during summer months is provided, and operation found to be outstanding for this type installation. Removal efficiency of waste constituents found during the survey and as indicated by plant records are very high and indicate excellent operation and proper loading. Although Monroe has separated its sewer system, a portion of the sanitary sewers still receive runoff from roofs during and following rainfall. This has resulted in hydraulic overloading at the plant with subsequent drop in efficiency, especially in maintenance of a chlorine residual in the effluent to effect

adequate reduction of coliform organisms. Bacterial control during summer months was generally very satisfactory.

Most waste loadings discharged to the Raisin River and subsequently to Lake Erie from the Monroe plant are significantly less than those from industrial sources in the area during the summer months. During non-chlorination months the municipal plant is the main source of coliform organisms to the Raisin River. Nitrogen and phosphorus compounds discharged to the Raisin River originate in almost equal proportions from industrial and municipal sources.

A tabulation of the results of a survey of several industries on the Raisin River conducted by personnel of the Michigan Water Resources Commission and the Public Health Service is shown in Tables 11-VI and 12-VI. The loadings indicate discharge to the Raisin River and subsequently to Lake Erie of:

1. Wastes equivalent in oxygen consuming capacity to raw sewage from a population of 225,000 persons.

2. Over 23,000 pounds of suspended solids, including 7,800 pounds of settleable solids per day.

3. Over 1,000 gallons of oil per day.

4. Over 1,000 pounds of cyanides per day.

5. Over 1,000 pounds of phosphates per day.

6. 16,000 pounds of chlorides per day.

Of special significance was the level of coliform concentration in the effluent of several paper mills on the Raisin River. The Consolidated Paper Company (South Plant) had geometric mean coliform concentrations in their effluent during the survey exceeding 1-1/2 million organisms per 100 ml. In

a later survey of the Raisin River, spot sampling of paper mill effluents revealed concentration at the Monroe Paper Products plant exceeding 3 million organisms per 100 ml. Fecal coliform concentrations were also high, with all values exceeding 15,000 organisms per 100 ml, and those from Monroe Paper Products exceeding 100,000 organisms per 100 ml. Fecal streptococci geometric mean concentrations from the two signify contributions exceeding 51,000 organisms per 100 ml.

Other sources of wastes in the area include wastes from shorefront homes, wastes from unsewered homes entering surface drainage channels, and the effect of polluted tributaries.

In addition to the Detroit River, several tributaries to Michigan Lake Erie act as waste contributors. Tributaries studied during this Project include the Huron River, Swan Creek, Stony Creek, Sandy Creek, the Raisin River, Plum Creek and LaPlaisance Creek. The Detroit, Raisin, and Huron Rivers constitute the major sources of inflow into Lake Erie from Michigan. Of the smaller tributaries, several were found to be polluted as indicated by excessive coliform concentrations (Table 3-VI) especially Plum Creek. The small flow involved, however, minimizes their effect on Lake Erie, and the problems involved are local in nature, affecting the area in the immediate vicinity of the tributary. The major cause of the high concentration in the small tributaries was concluded to be drainage into the water course of sewage (raw and effluent from improperly functioning septic tanks) originating from homes in unsewered areas.

The Huron River is shown to contain significant quantities of coliform organisms, nitrates, and phosphates. This survey was unable to demonstrate an adverse effect on the Michigan waters of Lake Erie from the Huron River.

The Huron River discharges into a large marsh at Pointe Mouillee with no clear picture of dispersion into the Lake from this point. The marsh is subject to backwater from the polluted waters of the Detroit River discharging into the Lake and any possible effect of the Huron is masked by this phenomenon. Retention in the Pointe Mouillee marsh further complicates the picture from the standpoint of nutrient loadings. Two small sewage treatment plants of the primary type are located a few miles upstream from the mouth of the Huron which may contribute to the bacterial pollution, but the comparatively stabilized form of the nutrients in the Huron indicates either a secondary effluent or agricultural fertilizer contribution. After sources of pollution in the Detroit River have been eliminated or substantially controlled, the actual contribution of the Huron River and its effect on water quality in Lake Erie may be determined. Coliform loading in the Huron River represent less than one-half of one percent of the total sources going into the Lake from Michigan, while phosphates represent approximately 2 percent and nitrates less than 1 percent respectively.

Several surveys were made of the Raisin River to determine its condition and effect on the Michigan waters of Lake Erie. Details of these investigations are described in Section VI of this Report. It was found that the two-mile stretch of the Raisin River immediately above its mouth receives large quantities of industrial and domestic wastes, and is not only grossly polluted, but also effects an area of Lake Erie near its mouth. Waste constituents discharged to the River are high in coliform, suspended solids and cyanide concentrations and include large quantities of oxygen-consuming substances as evidenced by the discharge of 49,000 pounds per day of BOD (equivalent in oxygen consuming capacity to the untreated wastes of a

population of over 200,000 persons). The lower Raisin River is frequently completely devoid of dissolved oxygen resulting in a continuous state of putrefaction during the summer months. All uses in the Raisin River, except waste disposal and navigation, have been eliminated by pollution and deposition of settleable solids. At the mouth navigation occurs interference with [illegible] to the extent that annual dredging is required to remove the material and keep the channels open for ship movement. Bacterial counts in the lower river are excessively high and represent interference with any possible recreational use of water from that standpoint. The effect of the Raisin River upon Lake Erie is seen in the enrichment of the waters of the western basin and coliform levels at bathing beaches near its mouth (including Sterling State Park).

The degradation of the Raisin River and subsequently certain areas of Michigan Lake Erie described above is due primarily to the discharge into the River of large quantities of inadequately treated wastes from the paper mills located along the banks. To a much lesser degree, part of the problem is due to the effluent of the Monroe Sewage Treatment Plant.

Summation of all waste sources reveals that the United States section of the Detroit River contributes to Michigan Lake Erie over 95 percent of the pollutional load originating from Michigan sources.

Special Studies

Several special investigations were made to provide additional information on the relationship between sources of wastes and their effect on the Michigan waters of Lake Erie.

A special study was made to determine the influence of the Trenton Channel of the Detroit River on Lake Erie beaches. The results of this investigation indicated that the influence of the Detroit River is felt as far south as Stony Point with the water adjacent to these beaches found to be higher in quality (as indicated by coliform concentrations) than waters further offshore. The beaches near the mouth of the Detroit River were found to be polluted sufficiently to prevent their safe use for swimming. Below Stony Point coliform concentrations indicated higher quality water in the Lake water offshore than in the waters adjacent to these beaches.

Analysis of bottom deposits was made in the Michigan waters of Lake Erie in a similar manner as the investigation in the Detroit River. Figure 14-VI depicts the condition of the bottom as evidenced by chemical and physical characteristics of the deposits. Areas of good, fair and poor condition were found in the Michigan waters of the Lake. From the mouth of the Detroit River to Pointe Mouillee the bottom was found to be in poor condition with this zone extending as far eastward as the Detroit River Light. From Pointe Mouillee to Stony Point the bottom was in fair to poor condition, as were the bottom conditions from Stony Point to the Raisin River. In this latter section of the Lake poor areas of bottom condition were found in the center of Brest Bay and directly east of the mouth of the Raisin River. The condition of the bottom was very poor at the mouth of the Raisin River.

Below the Raisin River extending south to Otter Creek the bottom

conditions were fair to poor. From Otter Creek to the south end of the Michigan water, the bottom was typified as fair to good condition.

Special hydrologic studies were conducted in the Lake Erie to determine dispersal patterns of the Detroit River into the Lake under varying wind conditions. Lake currents outside of the influence of the Detroit River were also studied. Wind is the primary factor influencing water movement in the open water sections of Lake Erie. The response of surface waters to wind changes is very rapid.

The Detroit River outlet into the Lake is a strong factor influencing currents in the immediate area of its debouchment, diminishing rapidly beyond the Detroit River Light. Wind effects are noted as far north as Project sampling range DT 3.9, although the river current is by far the greater influencing force at this point. South of Pointe Mouillee wind forces predominate over Detroit River current. Figures 15-VI through 18-VI depict current patterns in the Michigan water of Lake Erie under varying wind conditions. As a result of these investigations it was concluded that:

1. In open water sections of the Lake Erie study area, away from the mouth of the Detroit River, currents were generally found to move with the wind prevailing during the period of observation.

2. At the mouth and in the debouchment, the Detroit River current is most important in determining patterns of water movement. The usual south-to-southeast-to-east path traced by water moving from the river mouth into the debouchment, and finally out into the lake, is modified somewhat by east, southeast, and south winds, however. Under the influence of these winds, a counter-clockwise circulation pattern is set up in the area east of the East Outer Channel.

3. Along the beaches from Point aux Peaux north past Swan Creek, two types of current patterns occur. When winds are from the west, north, and east, which is approximately 50 percent of the time, water movement is southerly, directly from the Detroit River. For southeast through southwest winds, flow alongshore is northerly. For a southeast wind, and possibly for a south wind, also, results suggest that the northerly current movement along the beaches is part of a clockwise circulation pattern extending from shore to the West Outer Channel. Thus Detroit River water can affect water quality along the beaches in the vicinity of Swan Creek, 75 to 85 percent of the time.

4. The possibility of direct water transport from the mouth of the Detroit River into Brest Bay does exist but is probably not significant from a sanitary standpoint. Winds from the northeast and east, occurring approximately 20 percent of the time, could accomplish this if they blew steadily for two days or more, which would be a rare occurrence.

5. At Sterling State Park, northerly water movement may be expected to occur regularly for south through west winds. Thus, at least 40 to 45 percent of the time, Raisin River water can reach the beach areas to the north. For northwesterly and northerly winds, which occur 20 percent of the time, currents along the beach are southerly. Currents along the beach at Sterling State Park are variable and unpredictable when winds are from the northeast, east, and southeast, and also for calm or near calm conditions.

6. Approximately 45 percent of the time, wind conditions are prevalent which disperse a major portion of the Detroit River current (with its heavy loadings of waste constituents) into Canadian waters (and to a lesser extent Ohio waters), and away from the Michigan waters of the Lake. This statement

includes a great deal of the waters originating from the United States half of the River.

The great interest shown by many parties in the bathing beaches and the Sterling State Park, and the complex nature of the pollution problem which caused the beaches to be closed, resulted in a special investigation of these beaches. Several stations were sampled regularly throughout the survey with the result that geometric mean or median coliform concentrations indicated the beaches were safe for swimming. A sanitary survey of the area revealed many nearby sources of wastes capable of polluting these waters. A few samples collected at these beaches exceeded 100,000 coliform organisms per 100 ml, which was far above the maximum range normally associated with the average values.

Intensive sampling at a number of points was undertaken (see Figure 19-VI) and the results indicated:

1. The water quality of beach waters in the Brest Bay area is primarily affected by local sources of pollution rather than the Detroit River.

2. Based on the current studies, bacteriological data, meteorological reports, and hydrological data, the Raisin River is the primary cause of beachwater pollution at Sterling State Park.

3. Wind-driven water currents can be expected to move along the beach in a northerly direction 45 percent of the time, in a southerly direction 20 percent of the time, and variable and unpredictable about 35 percent of the time when the lake is free of ice cover.

4. When water currents move along the beach in a northerly direction (a phenomenon expected to occur 45 percent of the time) the effect of the Raisin River is evident at the park beach. When the currents move in a

southerly direction overflow from storm pumping stations, polluted tributaries, and shorefront homes north of Sterling State Park have a dominant effect on sanitary water quality at the beaches.

5. Generally the water quality, measured in terms of coliform and fecal streptococci organisms, at the lake stations opposite Brest Bay were of satisfactory quality for swimming purposes. The bacteriological quality of water representing beach waters adjacent to Sterling State Park were unacceptable at times for swimming purposes and the quality varied considerably.

6. The Raisin River is highly polluted with coliform bacteria throughout the year, with the primary sources being the paper mills in the Monroe area, and the Monroe Sewage Treatment Plant. The predominant effect originates from industrial sources during summer months (June through September) and from municipal sources during the remainder of the year.

7. Septic tank effluents enter Lake Erie directly to a limited extent by waterfront homes in communities north of Sterling State Park, and to a much greater extent indirectly by discharge to drainage ditches and storm water collection systems. The pollution enters the lake intermittently during periods of rainfall and runoff at storm water pumping stations.

8. Because of the high coliform counts experienced and the proximity of the storm water pumping stations to the Sterling State Park area, the discharge of polluted storm water constitutes a health hazard in their immediate vicinity and the northern part of the park during heavy runoff. The severity of this source as a health hazard to Sterling State Park depends on prevailing currents along the shore of Lake Erie in Brest Bay.

9. Sources of pollution above the Detroit-Woodland Beach areas, Stony Creek, and a small boat inlet, have high coliform counts, but the volume of

flow is small and they are located approximately one and one-half miles north of the park. Because of the prevailing currents and location, it is believed that these sources affect the water quality on local beaches rather than the Sterling State Park area.

10. The waters of Sandy Creek pose a threat to the quality of water on the north end of the park. Because of the reverse flow of the creek at the mouth resulting from water withdrawal by several major industries, the effect of this source of pollution on water quality at the park beaches is realized only during periods of high runoff or during rapid fall of water level in Lake Erie.

11. To improve the quality of water offshore from Sterling State Park, primary consideration should be given to measures which will improve the quality of water discharged to Lake Erie from the Raisin River. The lower reach of the river is in a continual state of gross pollution as evidenced by the water quality in terms of bacteriological parameters.

Rooted aquatic vegetation was observed in abundance during the summer of 1964 along the shoreline of Grosse Ile in the Detroit River and Lake Erie. These prolific growths were pronounced this year primarily due to low water levels. The waters off the shore are shallower, allowing greater light penetration to stimulate growth. This factor, coupled with warmer summer temperature and an abundant supply of essential plant nutrients (soluble phosphorus and inorganic nitrogen) in the adjacent waters or bottom muds, contributes to this problem.

These growths are not only undesirable from the esthetic standpoint, but also interfere with boating by fouling propellors. Later in the season the vegetation will die and their decomposition, accompanied by strong odors,

will add to this undesirable situation.

A review was made of the literature concerning commercial fish catch records to determine if any trends were present relating to the abundance and variety of fish in Lake Erie. Two facts emerge from a great divergence of opinion:

1. The total poundage and value does not show a steady decline during the past 20 years. In fact, 1961 was one of the most productive years on record from the standpoint of Michigan fishermen in Lake Erie. A decline was noted in 1962 and 1963 but no consistent pattern exists.

2. There has been a steady decline in the catch of certain species of fish during the past 20 years, including the whitefish and yellow pike. Others such as carp show a definite rising trend in the catch.

Beyond these two generally accepted facts there exists great controversy in a suitable explanation for the cause of the decline of certain species. Generally speaking, the species which have declined are highly prized while those which have thrived are pollution-tolerant. On the other hand, many other possible explanations are pointed out by several investigations for the decline which are not associated with pollution. These explanations include marketing difficulties, overfishing, increase in gear, reliability of catch statistics, and the general exploitation of a particular species by the fishermen themselves.

It is true that no evidence exists from fish catch statistics which clearly associates pollution with the decline of highly prized species. The declining populations have occurred among those species both sensitive and tolerant to pollution. Certain species tolerant to pollution have prospered. This leaves open the possibility of a pollution-associated phenomenon, but such a conclusion

should be made on the basis of physical evidence of pollution in the Michigan waters of the Lake capable of producing such an effect.

Investigations by fisheries and biologists in progress may establish that disappearance of the mayfly from Lake Erie has been a factor in the abundance of certain valued fishes.

Discussion

Water quality at the head of the Detroit River is satisfactory for all water uses. Phenol concentrations do slightly exceed International Joint Commission objectives for international waters, but every other criteria investigated to delineate high quality water is met at this point.

Water quality in the upper Detroit River above Zug Island is similarly satisfactory during dry weather conditions except for deposits of sludge near the United States shore below combined sewer outfalls. The polluted condition along the shore is also indicated by the presence of sludge worms in predominant percentages of bottom organism populations. In the upper river during or following periods of rainfall, whose total accumulation in a 24-hour period is greater than 0.2 - 0.3 inches, water quality as indicated by coliform concentrations is degraded and the waters are polluted to the extent of interference with recreational use and water supply.

The lower Detroit River from Zug Island to its mouth is severely polluted as indicated by many measures of water quality including coliform organisms, phenols, suspended and settleable solids, iron, nitrogen compounds, and phosphates. Excessively high concentrations of bacteria (especially following overflow from combined sewers) degrades the lower river where its use for a domestic water supply or for recreational purposes is a threat to the health of the user.

Large areas of sludge banks are present and are particularly extensive near the mouth of the river as it empties into Lake Erie. These deposits of sludge are indicative of the effects of pollution from the suspended and settleable portions of municipal and industrial wastes discharging into the Rouge and Detroit Rivers. These bottom conditions caused by pollution

represent unfavorable environmental conditions for the propagation of game fish and contribute to the interference with this water use by limiting the variety to those species capable of survival and propagation in polluted water. Sludge deposits along the shoreline and in marinas interfere with recreational use and the esthetic enjoyment of water. Pollution in the form of these deposits interferes with navigation requiring annual dredging operation to unblock channels. Evaluation of bottom fauna in the Detroit River from its headwaters to its mouth indicate a change from a community of clean-water associated organisms to a community of predominantly pollution-tolerant organisms.

Excessive iron and phenol concentrations in the waters and bottom muds of the Detroit River contribute to the overall polluted condition of the River by posing threats to fish and other aquatic life and representing a potential interference with domestic and industrial water supply.

Essential nutrients for plant growth including inorganic nitrogen compounds and phosphates increase significantly from the headwaters to the mouth of the Detroit River. Excessive concentrations of these constituents from waste sources can materially speed up the aging processes of Lake Erie with its concomitant undesirable manifestations. The net result would be loss of the water for almost all legitimate uses.

To a lesser degree, the polluted condition of the Detroit River is indicated by BOD and oil. While the present oxygen level in the lower Detroit River is high enough to prevent interference with water use, the drop from 100 percent saturation in the upper river to 67 percent in the lower is a warning of dire consequences in the future unless appropriate action is taken. Exceptional oil pollution control during wildfowl over-wintering periods has

been effected by State regulatory agencies. The continued presence of excessive quantities of this pollutant in waste effluent poses a constant threat, not only to fish and wildlife, but also to recreational use of water. Oil spills during the Project were observed causing this undesirable effect and oil was involved in fish mortalities in the area.

Change in the mineral content of the Detroit River from head to mouth is indicated by increases in chloride concentration. Not yet significant enough to cause major interference with water use, nevertheless the doubling of chloride loadings in a 30-mile stretch of the River is alarming. Future action may be necessary to prevent an undesirable situation. This is a particularly complex problem due to the difficulty in removing chlorides from water or otherwise disposing of this deleterious material without injury to the receiving stream.

A significant improvement in the overall bacterial quality of the Detroit River was noted in 1963 compared to 1962 and preceding years. (See Figure 18-V.) No significant improvement in any other measure of water quality was observed however.

The Detroit River changes from a body of water in a basically clean state at its head to a severely polluted condition in its lower reaches due to the discharge of large quantities of polluted material in the wastes from municipal and industrial effluents. The Detroit River is polluted now and will deteriorate further unless effective action is taken immediately. Propagation of fish or wildlife is being adversely affected. Recreational use of water in the lower river is severely hampered or is being carried on at risk to the health and safety of the user. Pollution poses a threat to two water intakes located in the lower River and serving the downriver area

and makes their continued use without pollution abatement hazardous.

A major contributor to the degradation and subsequent pollution of the Detroit River is the overflow from combined sewers. The year 1963 was an all-time low year from the standpoint of rainfall, and water quality in the river was effected during 32 percent of the days of that year, and over 17 percent of the total time. Following overflows, especially after storms of greater intensity, coliform concentrations increased from 10 to 100 times normal levels.

Generally speaking, the more intense the storm the greater the duration and magnitude of the overflow, and the more pronounced the effect upon the Detroit River. In addition to high bacterial levels, observation made during the highest intensity storm, which occurred during the two-year survey, revealed large masses of floating debris and fecal material carried out into the Detroit River from these combined sewer outfalls.

The total volume of raw sewage from combined sewers in the Detroit area is estimated as 2 percent of the total annual discharge based on study of data collected on the Conner Gravity System.

Fecal coliform concentrations during dry and wet conditions indicate the presence of organisms from fecal sources rather than the less harmful soil organisms which may contribute to total coliform levels. The ratio of fecal coliform to fecal streptococci in the river, especially following a combined overflow, indicate the bacteria originate from human sources.

Studies of municipal and industrial waste discharges into the Rouge and Detroit Rivers contain large quantities of pollutants which degrade the Detroit River. The major source of phenols, oil, inorganic nitrogen, phosphates, and BOD was found to be the main Detroit Sewage Treatment Plant

effluent. This is not considered unusual for BOD since this plant serves most of the people in the study area. The heavy contribution of waste constituents normally associated (in the concentrations found) with industrial waste indicates a heavy influence of industrial waste through discharges to the Detroit sewers, and then to the plant. This is varified by high phenol concentrations in combined overflow. The Detroit Plant was also a significant contributor of iron, suspended and settleable solids.

The largest source of iron was found to be the Great Lakes Steel Company, and the largest contributor of suspended solids and settleable solids was the Wyandotte Chemical Company.

Some municipal and industrial waste treatment plants were operating satisfactorily while others were not. Some facilities were considered adequate, while others were not. Recommendations and appraisal of each facility takes both operation and adequacy of facility into consideration.

Special dye tracer studies from waste influent indicated downstream travel of effluent from the Detroit Sewage Treatment Plant directly to the water intake of the City of Wyandotte. The dye from the Detroit, Wyandotte, and Trenton Sewage Treatment plants have a strong tendency to hug the United States shore.

Two major areas of pollution were found in the Michigan waters of Lake Erie. One extends several miles out from the mouth of the Detroit River, and the other out from the mouth of the Raisin River to a lesser extent. Pollution of these waters was primarily indicated by (a) excessive coliform concentrations; (b) extensive sludge deposits and generally unfavorable bottom conditions; (c) composition of bottom biologic organisms consisting almost entirely of pollution-tolerant forms; (d) high levels of inorganic

nitrogen and phosphates; and (e) massive plankton blooms. Dissolved oxygen was found in all cases to be greater than 4.8 mg/l, although great variation in this essential characteristic was observed in different parts of the Michigan waters.

Although the effects of pollution were most noticeable in the two zones extending out from the mouth of the Detroit and Raisin Rivers, over 80 percent of the Michigan waters of the Lake were found to be polluted from the standpoint of excessive nutrient concentration and bottom condition (as indicated by physical, chemical and biological description).

Over 95 percent of the pollutional load being discharged from Michigan sources to Lake Erie originates from the Detroit River. Much of the time the main part of the Detroit River is dispersed by wind action into Canadian, and to a lesser extent, Ohio waters, thus the full effect of the Detroit River is not felt in the Michigan waters of Lake Erie much of the time.

A great deal has been said referring to water quality in Lake Erie concerning levels of dissolved oxygen, biologic indicator organisms and levels of essential plant nutrients. It should be pointed out that the area of coverage of this Report is only the Michigan waters of Lake Erie, constituting only 1 percent of its area. Conditions found in the limited area making up the Michigan waters are not necessarily indicative of conditions throughout the main body of the Lake or vice versa.

The Raisin River was found to be in a grossly polluted condition near its mouth mainly due to discharges from inadequately treated wastes from several paper mills on the River, and to a much lesser degree to the effluent from the Monroe Sewage Treatment Plant. Pollution from the Raisin River was

found to adversely effect water quality in Lake Erie near its mouth, including the bathing beaches at Sterling State Park.

The high bacterial counts found under certain conditions at the Sterling State Park bathing beaches were attributable to pollution sources in the Raisin River and wastes from unsewered homes discharging raw sewage or septic tank effluent into surface drainage systems. Conditions of wind and rain play a large role in determining levels of coliform concentrations at the beaches.

Study of levels of water quality and hydrologic characteristics of the Lake revealed the two major zones of pollution were independent in their origin and effect. There appears to be no association between the polluted waters of Lake Erie and the degraded conditions at Sterling State Park and the polluted area near the mouth of the Raisin River.

The areas of major concern in Michigan Lake Erie are coliform concentrations, sludge from deposition of suspended solids originating from waste discharges, and concentration of inorganic nitrogen and soluble phosphorus, and severe changes in bottom organism composition.

High total coliform concentrations, especially when accompanied by hig fecal coliform concentrations, indicate the presence of human wastes which may contain pathogenic organisms capable of causing enteric diseases in humans. The presence of these organisms in concentrations above acceptable levels is considered a threat to the health and welfare of those who use certain parts of these waters for recreational purposes.

Suspended solids that have settled over the natural bottom will discourage or eliminate the activities of fishes and other aquatic life. In the shallow water, they are offensive to swimmers and boaters, and when

fluctuating water levels expose beds of these materials, the resulting appearance and odors destroy the esthetic value of the waterways. Since most of the bottom material in the poor condition areas is light and easily disturbed, there is a potential problem from this material being resuspended in the water in stormy weather, or from passage of large boats.

The resuspended bottom materials in the poor condition areas could cause increase in turbidity, increased oxygen demand, algae growth, and taste and odor problems, which would decrease the quality of the water for riverside or lakeside recreation, fishing, swimming, water skiing, and industrial and municipal water supplies. The increase in turbidity has been observed to occur during stormy weather on Lake Erie.

Plankton in large numbers can create nuisances. Some species may become toxic. Many cause water treatment problems by clogging filter beds and producing tastes and odors. Through the uptake of nutrients released to the waters by domestic wastes, some industrial wastes, and land drainage, algae can occur in such abundance as to contribute to the increased aging of lakes.

The colonies of Sphaerotilus found in the waters under study form ragged white, yellow, pink, or brown masses on all solid objects in rivers and lakes and may even form a carpet over mud surfaces. At times, drifting masses of sewage fungus may continue to grow in open waters of large rivers and cause trouble to fishermen by fouling lines and nets. Sewage fungus is one of the most unsightly products of pollution, and is indicative of organically enriched and highly polluted waters. Another growth, the filamentous green alga, Cladophora, also associated with polluted and nutrient-enriched waters, was found in the waters under study. When dead and windrowed upon beaches,

it decays and produces obnoxious odors and may become a fly-breeding habitat. Abundant growths of this alga may then become a nuisance on beaches, prohibit swimming, and interfere with recreation.

The abundance of phytoplankton observed in the Michigan waters of Lake Erie indicates that its capacity to produce plankton is among the highest in the Great Lakes. The heavy crops of algae observed at the inshore stations near Stony Point and Brest Bay could not be maintained throughout the summer season without an adequate supply of inorganic nitrogen and soluble phosphates. The nutrient levels at the beginning of the spring growing season that would be expected to produce nuisance blooms are 0.30 mg/l for inorganic nitrogen and 0.015 mg/l for soluble phosphates reported as phosphorus. These levels were equalled or exceeded in over 85 percent of the waters of Michigan Lake Erie.

Atmospheric and photosynthetic oxygen is thoroughly mixed throughout the water mass resulting in the absence of anaerobic organic decomposition near the bottom. High mid-summer temperatures of 24°C serve to increase the rate of decomposition of protein materials and to convert nitrogen into the form needed for growth of algae. Phosphorous, bound in cell material of dead and decaying algae and other organic material, is released in the form of soluble phosphates and a portion recycled as a plant nutrient.

In the Brest Bay area, where the nutrient supply is rich and the algal counts highest, the phosphates and nitrates are recirculated in the water mass by the clockwise currents. The addition of more nutrients gradually increases the concentration.

A considerable portion of the nutrient supply for maintaining the observed phytoplankton abundance in Brest Bay originates from the discharge of paper mill wastes of the Raisin River area at Monroe. Nutrient measurements substantiate this assumption as the phosphate and nitrate levels observed in the Raisin River were 0.4 mg/l and 0.6 mg/l, respectively.

Another symptom of heavy organic enrichment at the inshore stations was the occurrence of sewage tolerant species of green and blue-green algae, and the occurrence of diatoms characteristic of highly eutrophic bodies of standing water. These blooms were concentrated in the Brest Bay area and also observed at the station above Stony Point close to the crib of the City of Monroe's water intake.

Taste and odor producing algae have caused trouble at the City of Monroe's water treatment plant. The intake was moved to its present locatio in 1950 to obtain waters less prone to tastes and odors. The excessive densities of organisms in Brest Bay are primarily caused by the nutritional wastes discharged in the Monroe area and retained there by the rotating currents. The fertilization of the lake area by man-contributed organic matter fosters the abundant crop of algae. This fertilization load simply represents a superimposed burden upon waters which are already in an advance state of enrichment.

As the environment in which bottom organisms live becomes modified by pollution, undesirable changes occur in the kinds and numbers of organisms present. This is especially true for those organisms that live on the bottom of lakes and streams. Bottom-dwelling organisms do not move great distances and therefore are subjected to all local environmental changes. As a community of organisms becomes upset by pollution, some species abound in

disproportionate numbers. Huge aggregations of only one kind of organism may be present. Deposition of fine silt or flocculent ooze from decaying organic matter of industrial and domestic origin constitutes one of the greatest hazards to most species of clean-water associated bottom-dwelling organisms. Oils and greases which are adsorbed into the bottom muds are another source of community disruption.

Based on their response to pollution, bottom dwellers can be separated into three categories: pollution-sensitive, intermediate, and pollution-tolerant organisms. Pollution-sensitive forms such as mayflies, caddisflies, and mussels are associated with clean-water habitats and are important because they provide essential food for many game fishes. Intermediate forms such as snails, fingernail clams, and scuds are capable of surviving in a moderately polluted environment. Pollution-tolerant forms such as sludge-worms, bloodworms, and leeches may survive in areas severely polluted with organic wastes. The elimination of the competition from sensitive organisms and the seemingly unlimited food supply from organic solids permits the surviving tolerant forms to increase inordinately in numbers.

Under conditions of drastic pollution even the tolerant forms may be wiped out and no signs of life will be apparent in the bottom muds.

The clustering of polluted zones close to the mouth of the Detroit River and the Raisin River points to the sources of pollutional discharges which render the bottom unfit for the survival of clean-water associations of organisms. In between the two polluted areas,

an association of bottom forms containing sensitive, intermediate, and tolerant specimens indicates that these two polluted areas are independent and separate of each other.

Samples collected from the Detroit River below sources of pollution and from the Michigan waters of Lake Erie did not contain a single burrowing mayfly. Among the causative factors involved in the disappearance of this important fish-food organism are the changes in the lake floor sediments themselves. The occurrence of ooze or flocculent sludge and oil laid down by pollution from Detroit and the Monroe area have replaced previously desirable habitats that supported mayflies and other fish-food organisms.

Suspended solids, and nitrogen and phosphate compounds, do not exclusively originate in manmade wastes since land run-off can contribute sizeable quantities of both waste constituents. It should be remembered, however, that a survey of known industrial and municipal waste sources in the study area reveals a daily contribution of over 1,500,000 pounds of suspended solids, 60,000 pounds of nitrogen compounds, and 160,000 pounds of phosphates. Comparison with total stream loadings reveals this is a significant part of the waste content in the stream in the case of solids and nitrogen compounds, and almost the entire amount in the case of phosphates. Manmade or associated wastes significantly contribute to the pollution and degradation of the Michigan waters of Lake Erie.

Partially treated municipal wastes and overflows from combined sewers jeopardize the users of the domestic water supplies from the Wyandotte intake, and at times, from the Southwest intake of the City of Detroit. Pollution from these sources also interferes with recreational uses in the lower Detroit River. If improvement in water quality and increased scope or use

of the Detroit River is desired, pollution originating from the Detroit and Wyandotte Sewage Treatment Plants and combined sewers along the entire shoreline of the River, must be abated.

Deposition of settleable material originating from industrial and municipal waste discharges is interferring with navigation, recreational boating, and fish and wildlife propagation, especially near the United States shore and at the mouth of the Detroit River, and in large areas of Lake Erie. Pollution control through reduction of suspended and settleable solids originating from industrial and municipal discharges must be effected to protect these uses. Reduction of oil, iron, and phenols that settle out with the aforementioned settleable solids is also required to assure better overall water quality.

All municipal sewage treatment plants in the area practice primary treatment followed by chlorination. Approximately 50 percent removal of suspended solids, as well as almost all settleable and floating matter, can be expected to be removed in properly designed and loaded installations. Primary treatment followed by heavy chlorination has been demonstrated to be effective in reduction of coliform concentrations in the Detroit area, however, removal has tended to be erratic as chlorine demand in primary effluent can be variable. Other investigators have found enteric virus removal poor by primary treatment, even with chlorination. On the other hand, secondary treatment by the activated sludge method is effective in the reduction of enteric viruses and, followed by effective chlorination, can accomplish almost complete removal of these organisms, as well as pathogenic and pollution indicator bacteria. While there is no direct epidemiologic evidence in linking enteric virus levels in sewage effluents with incidence of water-

borne virus diseases such as infectious hepatitis, the strong possibility of such an occurrence does exist, and good public health practice should make every effort to locate any of the links in the chain of transmission.

Although concentrations of ABS were currently found to be below levels associated with pollution and interference with water use, this problem may someday be of concern. Detergent manufacturers have agreed to put on the market a biologically degradable, or "soft detergent", which can be broken down by conventional sewage secondary treatment processes. No reduction of either "soft" or "hard" detergents can be expected from primary treatment alone.

Whenever maintenance or emergency requires alteration of the chlorine contact time, such as experienced in the experimental bypass of treated effluent by the City of Detroit, secondary treatment offers an additional safety factor by providing an effluent of lower and more consistent chlorine demand which would result in more effective chlorination and reduction of coliform organisms under such special circumstances.

BOD removal of 35 percent can be expected from primary treatment but was not demonstrated by all area plants during the Public Health Service Survey. BOD removal of as high as 90 percent plus greatly increased efficiency of removal of both suspended and settleable solids can be expected with secondary treatment as can the consistency of operation. Removal of waste constituents such as phenols and oils can also be efficiently accomplished with secondary treatment.

The problem of reduction of nitrogen compounds and phosphates is more difficult from the treatment approach. Very little reduction in the basic elements can be expected with primary treatment. Studies of existing plants

indicate 30 - 60 percent removal of nitrogen in conventionally designed and operated secondary treatment plants. Changes in the design and operation of the plant can increase this to over 75 percent removal if stress is placed on production of sludge. Several investigators report success with almost complete removal of phosphates in municipal and industrial plant effluents using chemical coagulation approach with either lime or alum as the coagulant.

Secondary treatment is synonomous with complete sewage treatment and is practiced by many communities in the Great Lakes area, including Milwaukee, Wisconsin; Chicago, Illinois; Toledo and Cleveland, Ohio.

Adequate primary and secondary treatment may be considered as the minimum acceptable level for all municipal waste sources in the area, even though the magnitude of the load discharged varies greatly (mainly because of population served), and a detrimental effect cannot be demonstrated from each facility. This philosophy recognizes the contribution from each source contributing to the problem as a whole and espouses equity in solution. The following could be expected to be accomplished by secondary treatment using the activated sludge process followed by effective chlorination.

1. Greater than 90 percent reduction in enteric virus density.
2. Consistently low coliform concentrations in the plant effluent.
3. Approximately 85 - 90 percent reduction in BOD.
4. Approximately 80 - 90 percent reduction in suspended solids, and for all practical purposes, complete removal of settleable solids.
5. Significant reduction of such troublesome constituents as phenols iron, and oil.
6. Approximately 50 percent reduction in nitrogen compounds and

phosphates (with chemical treatment).

7. Effective removal of ABS when biologically degradable detergents are introduced.

8. When chlorine contact time is reduced due to emergency or maintenance conditions, more effective chlorination with subsequent coliform reduction will result with secondary effluent compared with primary effluent under the same conditions.

9. Significant reduction of ammonia concentrations with subsequent lessening of chlorine demand and more effective chlorination by downstream domestic water treatment facilities.

A plan for improvement of water quality in the Detroit River and Lake Erie has been developed in the form of recommendations to the conferees. These recommendations are both general and specific and represent a plan of action to accomplish the desired objectives. International Joint Commission objectives and effluent recommendations were used where appropriate and when lacking criteria which represent a consensus of thought in this area were used. If followed, the following should be accomplished:

1. Hazard to public water supplies would be lessened.

2. Certain areas now restricted for recreational use could be used with a reasonable degree of security (including Sterling State Park bathing beaches). It should be pointed out that even with the best treatment now available, other areas must remain restricted for swimming.

3. Deposition of settleable material from industrial and municipal wastes as objectionable sludge banks would be materially decreased. This would result in improved navigation, recreational boating, and general esthetic enjoyment of water.

4. The extremely high loadings of nitrogen and phosphorus compounds discharging daily into Lake Erie would be reduced by over half and facilities installed to increase this reduction even more when technology and knowledge of treatment provide the necessary answers. This would be a significant forward step in slowing down the accelerated pace of the aging or fertilization process of Lake Erie caused by man's wastes.

5. International Joint Commission water quality objectives for international waters would be met in all parts of the Detroit River and Lake Erie.

RECOMMENDATIONS

Recommendations to achieve improved water quality in the Detroit River and Michigan waters of Lake Erie are made to the conferees in two basic forms. General recommendations of a broad nature are followed by specific recommendations designed to cope with a particular problem. In both cases the recommendations are made not only from the standpoint of maximum water quality improvement through pollution abatement but also with the realization of the limitation of today's scientific technology to remove undesirable constituents from wastes. Clean water and protection of water through abatement of pollution are therefore the goals of the recommendations. All general recommendations concerning sources of municipal and industrial wastes refer only to those Michigan facilities discharging into the Detroit River or Lake Erie, either directly or via a tributary. It is realized that the fulfillment of these recommendations will require considerable capital investment by the municipalities and industries in the area. Detroit and its suburban area are typified by a spirit of agressive and dynamic action in handling their problems. It is hoped that, after the problem is presented in this report and recommendations are made to alleviate it, such action will result. This assumption is made on the premise that cleaner water is desired.

General recommendations relating to upgrading the level of waste treatment in the study area are made independently of the individual contribution to the degradation of the receiving waters by each treatment facility. In those cases where improved treatment is recommended to reduce a highly significant contribution, additional information

will follow the discussion of individual facilities.

General

1. Complete sewage treatment including primary treatment, secondary treatment, and effective full-time chlorination should be adopted as the minimum level of treatment acceptable for all municipal installations discharging wastes into the Detroit River, Lake Erie, or their tributaries. This recommendation is made not only to alleviate specific problems described elsewhere but also to upgrade the level of sewage treatment for the area under study.

Chlorination should be expanded to a full-time basis (as the City of Detroit now practices) to provide greater protection and improve the quality of the waters all year-round. Chlorination should be capable of producing an effluent with a monthly geometric mean coliform concentration not exceeding 5,000 organisms per 100 ml.

2. Sewerage systems with collection sewers terminating in seconda: sewage treatment facilities should be provided in those areas alon the Michigan shore of Lake Erie and the Detroit River where sewers do not now exist and homes either discharge raw wastes or effluent from septic tank systems to the watercourse.

3. Regular monitoring of the Detroit River, Lake Erie, and their tributaries should be carried on as a permanent operation with a suitable staff and equipment. Such an operation should include regular sampling of waste effluents and overflows from combined sewers. Use of aerial techniques for reconnaissance and pollution

surveillance as practiced now by personnel of the Michigan Water Resources Commission is encouraged and expansion of this activity recommended. This monitoring should include surveillance of oil discharge from outfalls on vessels.

4. Establishment of PHS Water Pollution Control Surveillance Station (formerly National Water Quality Network Station) in the lower section of the Detroit River is recommended. This would be in addition to the network station now in operation at the head of the Detroit River. The two stations would collectively give a better indication of water quality in the Detroit River than either one alone.

5. Industries discharging wastes to the public streams should furnish operating records containing discharge information and concentrations of those waste constituents desired by the Michigan Water Resources Commission.

6. Municipal waste treatment plants should enlarge their program to include analyses of waste constituents found to be present in significant quantities in their wastes (such as phenols, iron, nitrogen compounds, and phosphates) as desired by the Michigan Department of Health. The results of these analyses should be submitted regularly to the Department.

7. A concentrated effort should be made by all agencies operating municipal and industrial waste treatment facilities to eliminate accidental spills of pollutional material to the river. This should be accomplished by looking ahead and planning waste treatment and production operations to minimize the possibility of

such accidents. An in-plant survey with this end in mind is recommended.

8. All waste treatment facilities should be designed, or in many cases existing facilities modified, to prevent the necessity of by-passing untreated wastes during maintenance and renovation operations.

9. All industries in the area discharging their waste material to the public waters should accept waste treatment as a vital part of plant operation. This acceptance can be shown by providing adequate funds for proper operation. An inventory of all waste treatment equipment and supplies should be maintained on the plant premises in order that a minimum delay in effective waste treatment will result when replacement is necessary.

10. Effort should be made through the auspices of the International Joint Commission to bring to the attention of Canadian water pollution control authorities significant waste contribution from Canadian sources in the Upper St. Clair River affecting water quality in the United States section of the Detroit River. They should be encouraged to bring about more effective pollution abatement to protect downstream water use.

Overflows from Combined Sewers

Although the severe effect of overflows from combined sewers upon water quality in the Detroit River and limited areas of Michigan Lake Erie was demonstrated, a specific method of approach to the solution of this problem is not now evident. The two methods considered feasible are:

1. Separation of the combined system into two systems, one handling sanitary waste and one storm runoff.
2. Treatment of combined overflows, including holding compartments and chlorination of overflow discharged to the watercourse.

It is recommended that a detailed engineering study be made by the municipal and county governments concerned to determine costs and select which of the two methods best suits their needs. It is further recommended that a report of these investigations be submitted within two years to the Secretary of Health, Education, and Welfare containing the method to be used to solve this problem and a time schedule for accomplishment.

An additional recommendation is made concerning the current operation of the combined sewer system in the Detroit area. Agencies responsible for the operation of combined sewer systems should immediately take steps to lessen the pollution effects of malfunctioning overflow regulators by finding and correcting the cause of failure of these diversion devices and checking the operation of all overflows every day to determine if unnecessary overflows are occurring due to this cause.

Federal Installations

U. S. Naval Air Station, Grosse Ile, Michigan

1. A separator capable of producing an effluent containing less than 15 mg/l oil should be installed on the line receiving aircraft washing wastes.

2. Operation of existing sewage treatment facilities should be improved by performing such procedures as breaking up scum in gas vents, reversal of flow at periodic intervals, more frequent withdrawal of sludge, and daily scraping of the sides of the sedimentation chamber.

3. Better operation records for submission to U. S. Navy and Michigan Department of Health should be maintained.

4. Continuous and effective chlorination of plant effluent should be practiced to assure that the geometric mean coliform density does not exceed 2,400 organisms per 100 ml.

5. The outmoded septic tank installation at the boat dock should be replaced with a treatment unit of the "Aerobic Digestion" type providing primary and secondary treatment followed by chlorination of the effluent.

6. If the U. S. Naval Air Station does not close on or before September 1, 1967, as scheduled, one of two alternatives should be followed:

   a. Connection to the municipal sewage collection and treatment system proposed for construction at Grosse Ile.

   b. Enlargement of the present naval facilities to include secondary treatment as proposed in the original plans.

At this writing the Navy has agreed to all of the foregoing recommendations and has already taken steps to accomplish all but the last recommendation.

U. S. Coast Guard Station - Detroit River Light

A macerator-chlorination type treatment similar to those placed aboard motor launches should be installed to the sanitary waste line now discharging raw sewage into Lake Erie.

U. S. Corps of Engineers Dredging Operations

1. The hopper dredges should discontinue disposing of the ship's trash and garbage at the Raisin River dumping grounds.
2. Suitable treatment units should be installed aboard ship to adequately dispose of all sanitary wastes including trash, garbage, and human excreta.
3. Closer control should be exercised to minimize the loss of dredge material from the hoppers while proceeding to the dumping grounds.
4. A vigorous attempt should be made by the Corps of Engineers to reduce the amount of dredging with action leading to reduction of discharge of settleable material by increasing the charges to polluters for removing the material commensurate with the damages to water uses incurred. It is believed that it was not the intent of Congress that such dredging operations should provide a method of disposal of solid material deposited by individuals or corporations in navigable streams. It is desirable not only

that dredged channels be maintained but that every means possible be taken to keep the cost of such maintenance to a minimum.

The District Engineer agreed to take steps to see that the recommendations be put into effect. He reiterated that the Corps of Engineers does charge the polluters for removing the material commensurate with the damages to water uses incurred and that the Corps of Engineers does not have any statutory authority to prevent the original discharge of the material to the navigable waterway. He also stressed the responsibility of the Corps of Engineers in enforcing Federal legislation relative to discharge of waste materials from vessels into navigable waters.

Sterling State Park

These recommendations will be repeated on a more specific basis for each industry and municipality involved. The recommendations listed here emphasize what is necessary to improve conditions at Sterling State Park and assure satisfactory water quality there.

1. The Consolidated Paper Company, Union Bag-Camp Paper Company, and Monroe Paper Products Company should:
   a. Immediately begin effective chlorination of plant effluent to reduce bacterial concentrations discharged to the Raisin River.
   b. Immediately improve operation of existing facilities to remove more effectively suspended and especially settleable solids in their effluent.
   c. Provide holding basins for wastes discharged during emergency bypass to prevent diversion of this discharge to the Raisin River.
   d. Construct additional secondary waste treatment facilities capable of effectively reducing suspended and dissolved organic solids and thus reducing the BOD load discharges to the Raisin River.
2. The Ford Motor Company should:
   a. As soon as possible eliminate detectable concentrations of cyanide from the plant effluent.
   b. Immediately begin effective chlorination of the effluent from their sewage treatment plant.
   c. Construct secondary treatment facilities for their sewage.

3. The City of Monroe should:

   a. Continue at a rapid pace their plan of separating roof runoff from sanitary wastes to prevent overloading municipal waste treatment facilities following heavy rainfall.

   b. Immediately expand chlorination of plant effluent to the entire year.

   c. Expand existing sewage treatment facilities to provide for secondary treatment capable of further reducing suspended and dissolved organic solids. Present operation of existing facilities is outstanding from the standpoint of reduction of BOD and suspended solids, and additional facilities will be required to achieve increased efficiency.

4. In the area north of Sterling State Park between Sandy Creek and Stony Creek, measures should be taken to eliminate direct and indirect discharge of sanitary sewage to Lake Erie. All discharge of sanitary wastes to the storm pumping stations should be eliminated. Areas having improperly functioning septic tanks and direct discharge installations should be sewered and the wastes transported to a sewage treatment plant providing complete treatment and chlorination.

5. The practice of allowing discharge of raw and septic tank effluent to surface drains originating in the suburban area outside the City of Monroe should be discontinued. This material is discharged into the Raisin River during heavy rainfall. The area should be sewered with sanitary wastes transported to a sewage treatment plant providing complete treatment and chlorination.

The foregoing recommendations are listed in the order of greatest importance in improving water quality at the Sterling State Park so that this recreational area could be more fully utilized in future years.

Municipal Waste Treatment

Detroit (Belle Isle Sewage Treatment Plant)

Results from the survey revealed a plant effluent of low concentration and treatment removal efficiencies within accepted limits for this type facility. While the per cent BOD removed was low (25%) the low concentration in the influent (60 mg/l) makes it difficult to achieve a higher degree of removal. Total coliform and fecal streptococci concentrations in the effluent were high (7,890,000 and 297,000) but should be expected in this type plant without chlorination.

Consultation with Michigan Health Department personnel revealed plans by the City of Detroit to abandon this plant and pump sewage from Belle Isle across to the mainland and into the Detroit system. This action is recommended as the most practical under the circumstances. If this is not accomplished, the following is recommended in addition to the general recommendations previously stated:

1. Immediate full-time chlorination of plant effluent should be accomplished capable of producing an effluent with a monthly geometric mean coliform concentration not exceeding 5,000 organisms per 100 ml.

Detroit (Main Treatment Plant)

Sewage received at the Detroit plant is considered of average strength from the standpoint of BOD and suspended solids concentrations.

Study of the plant effluent results collected during these surveys revealed waste constituents at levels normally not associated with municipal wastes. Among these are oil and grease, phenols, copper,

iron, chromium, nickel, zinc, and lead. Average phenol and oil effluent concentrations exceeded International Joint Commission recommendations.

Ammonia-nitrogen concentration and loadings in the effluent were high. Phosphate effluent concentration averaged 36 mg/l, representing a discharge to the Detroit River of 145,000 lbs/day of this substance.

Suspended solids, settleable solids, and BOD values in the plant effluent are considered high, and treatment efficiency for these substances is considered low although study of long-term records revealed higher efficiency at other times. Settleable solids removal during the survey was considered poor at 54%. The average suspended solids loading of 607,000 lbs/day is considered high. BOD loadings to the Detroit River of 500,000 lbs/day represent a population equivalent of approximately 3 million. These ranges of removal efficiency usually indicate an overloaded primary facility.

Bacteria removal during the survey was excellent and concentration in the effluent very low. This presumably was accomplished by raising the level of chlorination; and while averages during the survey do not correspond with mean monthly averages during the study period, they show that effective bacterial control can be accomplished on an average, if not consistent, basis.

Waste loadings from the main plant of the City of Detroit are responsible not only for a large part of the degradation of the waters of the lower Detroit River but also constitute a major source of nitrogen compounds and the major source of phosphates going into and contributing to the fertilization of Lake Erie. The major contribution of waste constituents from municipal sources being discharged into the

Detroit River and subsequently into Lake Erie originates from this effluent.

The following recommendations are made:

1. Existing primary treatment facilities should be enlarged to provide additional retention time in settling basins.

2. Facilities should be enlarged to provide secondary treatmen capable of producing an effluent containing not more than:

   a. Suspended solids concentration of 35 mg/l

   b. Settleable solids concentration of 5 mg/l

   c. BOD concentration of 20 mg/l

   d. Phenol concentration of 20 µg/l

   e. Oil concentration of 15 mg/l

   It is expected that good operation can reduce the effluent concentrations below these figures.

3. Additional treatment for phosphate removal should be installed as soon as possible. Chemical coagulation followed by adequate sedimentation is recommended. The facilities should be designed and operated to remove at least 80% of the total phosphate in the plant effluent.

4. Existing chlorination facilities should be operated to provide an effluent with a monthly geometric mean coliform concentration of less than 5,000 organisms per 100 ml.

It is difficult to assess fairly the waste contribution and effect of this plant upon water quality in the Detroit River because extensive enlargements and modifications have been underway through almost the entire Public Health Service survey.. Greatly overloaded when the project began, it was necessary to bypass untreated wastes for a portion of most days to the Detroit River. Enlargement of primary facilities was designed to alleviate this condition. The first Public Health Service survey of the Wyandotte survey was cancelled at the request of plant officials because of construction difficulties associated with the enlargement.

Two surveys at this plant indicate an influent sewage of average strength in terms of BOD and suspended solids.

Results of these surveys also indicate waste constituents at levels normally not associated with domestic sewage. These include phenols, oil and grease, iron, chromium, copper, cadmium, nickel, zinc, and lead.

Average concentrations of suspended solids and settleable solids were high during the two surveys and loadings to the river significant. Average BOD in the effluent during the first survey was high at 120 mg/ and the loadings significant (population equivalent of 132,000). Treatment efficiency in this plant for BOD and suspended solids removal was in the expected range for this type of plant.

Average phenol and oil concentrations in the effluent were above the International Joint Commission recommended effluent levels. Contribution of nitrogen compounds was significant, and phosphate

concentrations of 40 mg/l were considered unusually high and the loading of 7,200 lbs/day considerable.

Bacteriological control was excellent during the first survey when chlorination of the effluent was practiced. Geometric mean concentrations for total coliforms, fecal coliforms, and fecal streptococci during the first survey were less than 100 organisms per 100 ml. Study of plant operation records reveals these results are not typical; but once again, it is encouraging to note that results in this magnitude can be obtained. During the second survey, effluent chlorination was not practiced, and geometric means for total coliform, fecal coliform, and fecal streptococci exceeded one million.

Suspended solids, nitrogen compounds, phosphates, and organic matter contribute significantly to the degradation of the Detroit River and fertilization of Lake Erie.

In addition to the general recommendations previously stated it is recommended that:

1. Treatment facilities should be enlarged to provide secondary treatment capable of producing an effluent containing not more than:

    a. Suspended solids concentration of 35 mg/l

    b. Settleable solids concentration of 5 mg/l

    c. BOD concentration of 20 mg/l

    d. Phenol concentration of 20 µg/l

    e. Oil concentration of 15 mg/l

    It is expected that good operation can reduce the effluent concentrations below these figures.

2. Additional treatment for phosphate removal should be installed. Chemical coagulation followed by adequate sedimentation is recommended. The facilities should be designed and operated to remove at least 80% of the total phosphate in the plant effluent.

Wayne County Sewage Treatment Plant (Trenton)

Results of the Trenton survey revealed high concentrations of oil and grease and phenols in the plant effluent. Values of both constituents exceed International Joint Commission recommended effluent levels.

Average suspended and settleable solids were high in the effluent, but treatment efficiency was within the range expected for this type of installation.

Bacteriological control during the survey was excellent, with all samples examined averaging less than 15 organisms per 100 ml. Examination of plant records reveals that though these values are not typical, they are certainly outstanding.

With the construction of the new primary plant by the City of Trenton just before this project ended, waste loadings to the county plant were no doubt significantly reduced. Wastes from this plant do not materially contribute to the degradation of the Detroit River except from the standpoint of bacterial pollution during eight months of the year.

No recommendations other than those listed under the general category are made for this installation.

Wayne County Sewage Treatment Plant (Grosse Ile)

The results of this survey revealed phenols and oil and grease effluent concentrations in excess of International Joint Commission recommended effluent limits.

Removal efficiencies for suspended and settleable solids were within expected limits for this type of installation.

Bacterial control during the survey was excellent, with effluent geometric means for all organisms examined under 25 per 100 ml.

Wastes from this plant do not materially contribute to the degradation of the Detroit River except from the standpoint of bacterial pollution during eight months of the year.

A new primary sewage treatment plant is scheduled for construction in the near future. This plant will serve the entire island, and it is difficult to predict treatment efficiencies or waste loadir

No recommendations other than those listed under the general category are made for this installation.

Monroe Sewage Treatment Plant

Results from the two surveys indicated an influent fairly typical of a weak domestic waste. Exceptions to this general observation include soluble and total phosphates and high concentrations of certain toxic metals including copper, zinc, and lead. These constituents were present in approximately the same concentrations in the plant effluent.

Plant efficiency as measured by per cent removal of suspended solids and BOD was very good for a primary sewage treatment plant. Bacterial control was effective during the first survey when effluent

chlorination was practiced but poor during the second survey when no chlorine was added for effluent disinfection.

Study of operating records revealed that similar degrees of plant efficiency were maintained on a long-term basis.

Oil and phenol concentrations in the plant effluent exceeded International Joint Committee recommendations.

In summary, the operation of this plant is considered outstanding and far above average for an installation of this type, and the operating personnel are so commended.

This plant contributes to the degradation of the Raisin River and subsequently Lake Erie. Its contribution, however, is minor compared to the paper mills on the Raisin.

The following is recommended in addition to the general recommendation already stated:

1. The City of Monroe should continue at a rapid pace to implement its plan of separating roof runoff from sanitary wastes to prevent overloading plant facilities following heavy rainfall.

Other Municipal Installations

Four municipal sewage treatment plants in the study area were not evaluated by survey either because they were new and not in operation at the time (City of Trenton sewage treatment plant and City of Riverview sewage treatment plant) or they were located on the Huron River whose contribution to the degradation of Lake Erie could not be demonstrated. The Huron River sewage treatment plants near the mouth serve the municipalities of FlatRock and Rockwood.

No recommendations other than the general recommendations previously stated are made for these facilities.

Industrial Waste Treatment

Each industry survey by personnel of the Michigan Water Resources Commission and the Public Health Service is listed in alphabetical order followed by a brief evaluation of the waste treatment facility and recommendations designed to improve water quality in the waters under study. The Detroit River industries constitute the first three sections and are followed by those located on the Raisin River and Lake Erie.

The recommendations which follow are in addition to the general recommendations previously stated which are applicable to industrial waste treatment.

The recommendations which limit the effluent concentration of particular waste constituents are made with the idea of reduction of overall loadings. If significant increase in the volume of plant discharge is effected, a corresponding decrease in recommended waste concentrations will be required.

Section I - Upper Detroit River Industries

Allied Chemical Corporation (Solvay Process)

Wastes from this plant have excessively high concentrations of suspended and settleable solids, phenols, and chlorides and at times exceed the International Joint Commission range for pH. Chloride loadings from this source represent approximately 20 per cent of the entire industrial loading to the Detroit River. Suspended and settleable solids loadings and effluent concentrations indicate a lack of waste control and disregard for the receiving stream. The following recommendations are made:

1. Adequate sedimentation units should be installed for maximum removal of suspended and settleable solids, and operation and maintenance at existing facilities should be improved.
2. Treatment for phenol reduction should be installed capable of limiting the concentration in the plant effluent to 20 µg/l.
3. Wastes should be consistently neutralized to levels between pH 5.5 and 10.6 to conform to International Joint Commission recommendations.
4. The industry should begin investigation of methods to dispose satisfactorily of chlorides other than discharge into the Detroit River. While no practical method of removal from plant effluent now exists, alternate methods of disposal of concentrated brines, such as subsurface disposal, should be investigated.

Anaconda-American Brass Company

Although the waste discharges (principally toxic metals) have only limited effect on water quality of the Detroit River, continued control and treatment, presently employed, are needed to maintain this level. No recommendations for improvement of the plant effluent are made at this time.

Great Lakes Steel Corporation - Blast Furnace Division

Waste treatment facilities provided for the removal of iron, phenols, and suspended solids are ineffective. Nearly 100 per cent of the suspended solids in the plant effluent were found to be readily settleable. Outfalls from this industry located on the old channel of the Rouge River did not contain significant waste pollutants. The following recommendations are made:

1. Operation should be improved to consistently limit the concentration of phenols and iron in the effluent to 20 µg/l and 17 mg/l, respectively.
2. Additional sedimentation facilities should be installed to remove a greater percentage of the suspended and settleable solids.

Parke Davis Company

Waste Treatment at this installation is considered satisfactory at this time, and no specific recommendations for improvement are made.

Revere Copper and Brass, Inc.

The concentration of oil and settleable solids in the effluent from this installation is considered excessive. All of the suspended solids released by this industry are readily settleable. The following recommendations are made:

1. The concentration of oil and grease in the effluent should not exceed 15 mg/l, and this should be achieved by improved operation or new facilities.
2. Adequate sedimentation facilities should be installed to remove the settleable material in the plant effluent.

United States Rubber Company

Waste treatment at this installation is considered satisfactory at this time, and no specific recommendations are made.

Section II - Rouge River Industries

Allied Chemical Corporation (General Division)

Stringent control should be exercised over acid leaks and discharges to prevent spills to the Rouge River. It is recommended that the hydrogen ion concentration in the plant effluent be maintained at a level comparable to that obtained during the Michigan Water Resources and Public Health Service survey (pH 7.1-7.5).

Other than neutralization as mentioned above, waste treatment at this installation is considered satisfactory at this time, and no other specific recommendations for improvement are made.

Allied Chemical Corporation (Plastics Division)

Phenol and ammonia concentrations in the plant effluent were considered excessive at 10,600 µg/l and 166 mg/l, respectively. Waste loadings of these waste constituents are relatively small because of a low volume of discharge. The following recommendations are made:

1. Treatment for phenol reduction should be installed (or present facilities operated) capable of limiting the concentration in the plant effluent to 20 µg/l.
2. Treatment facilities should be installed capable of materially reducing the concentration of ammonia in the plant effluent.

Allied Chemical Corporation (Semet-Solvay)

Phenol concentrations in the plant effluent were found to be quite satisfactory during the survey conducted by the Michigan Water Resources Commission and the Public Health Service. Spot samples collected at other times revealed excessive concentrations of this substance. It is therefore recommended that this industry maintain phenol levels below 20 µg/l as demonstrated during the survey.

Other than phenolic control as mentioned above, waste treatment at this installation is considered satisfactory at this time, and no other specific recommendations for improvement are made.

Allied Chemical Corporation (Solvay Process)

Wastes from this plant have excessively high concentrations of phenols and chlorides and at times exceed the International Joint Commission recommended range for pH. Chloride loadings represent approximately 10 per cent of the entire industrial load to the Detroit River. The following recommendations are made:

1. Treatment for phenol reduction should be installed, or present facilities operated, to limit the concentration in the plant effluent to 20 µg/l.
2. Wastes should be consistently neutralized to levels between pH 5.5 and 10.6 to conform to International Joint Commission recommendations.
3. The industry should begin investigations of methods to dispose satisfactorily of chlorides other than discharge to the Detroit River. While no practical method of removal

from plant effluent now exists, alternate methods of disposal of concentrated brine, such as subsurface disposal, should be investigated.

American Agricultural Chemical Company

Waste treatment at this installation is considered satisfactory at this time, and no specific recommendations are made.

Darling and Company

Survey reports indicate inadequate facilities for control of BOD and coliform organisms. Treatment for effective control is needed immediately to eliminate excessive discharges of BOD, coliform organisms, oil and grease, and suspended solids. This plant discharges to the Rouge, and subsequently to the Detroit River, wastes equivalent in oxygen-consuming capacity to the untreated wastes of over 40,000 persons. The following recommendations are made:

1. Facilities should be installed which are capable of limiting the concentration of coliform organisms in the plant effluent to a monthly geometric mean not exceeding 5,000 organisms per 100 ml.

2. Treatment facilities should be installed which are capable of limiting concentrations of the following waste constituents as indicated:

    a. BOD not to exceed 100 mg/l

    b. Suspended solids not to exceed 85 mg/l

    c. Settleable solids not to exceed 5 mg/l

    d. Phenols not to exceed 20 µg/l

    e. Oil and grease not to exceed 15 mg/l

Ford Motor Company

Wastes from this plant represent in volume approximately 83 per cent of the industrial wastes being discharged into the Rouge and subsequently into the Detroit River. Phenolic wastes exceed the limit of 600 pounds per day set by the Michigan Water Resources Commission in their order of determination. Concentrations of iron, phenols, and oil exceed the International Joint Commission recommendations. Suspended and especially settleable solids are considered excessive at times, while excellent control was achieved on other occasions. Acid in the form of spent pickling liquor is excessive and imparts an unnatural color to the Rouge and Detroit Rivers. Excessive concentrations of copper and cyanides were detected in one effluent channel (Tailrace outlet). Low values of pH were observed outside of the International Joint Commission recommended range.

The loadings of phenols, iron, and oil and grease from this industry constitute over 90 per cent of the loading from industrial sources to the Rouge River. Improvement must be accomplished at this source if significant reduction in waste loadings to the Rouge River and subsequently to the Detroit River is to be effected.

The following recommendations are made:

1. Cyanide concentration in all outlets should be reduced to 0.01 mg/l or less.

2. Sedimentation facilities should be provided at Roulo Creek and Gate 11 to reduce the concentration and loading of suspended and settleable solids in the effluent. These facilities should

be capable of producing an effluent whose concentration of suspended solids does not exceed 85 mg/l and settleable solids does not exceed 5 mg/l.

3. Waste treatment practices should be reviewed at this installation to assure that phenol concentrations in the plant effluent do not exceed 20 µg/l and the iron concentration does not exceed 17 mg/l.

American Cement Corporation (Peerless Division)

Suspended solids, almost all of which are readily settleable, are present in excessive concentrations in the plant effluent. It is recommended to limit the effluent concentration of suspended solids to 85 mg/l and settleable solids to 5 mg/l.

Other than the problem concerning suspended and settleable solids mentioned above, waste treatment is considered satisfactory, and no other specific recommendations are made.

Scott Paper Company

Discharges of excessive quantities of phenols, suspended solids, and BOD impose a severe burden on the Rouge and subsequently the Detroit River. This industry discharges to the receiving stream wastes equivalent in oxygen-consuming capacity to the untreated sewage from a population of over 800,000 persons. The following recommendation is made:

1. Secondary treatment facilities should be installed which are capable of producing an effluent containing not more than:

   a. Phenol concentration of 20 μg/l

   b. Settleable solids concentration of 5 mg/l

In addition these treatment facilities should be capable of producing at least a 50 per cent reduction in the BOD loading to the receiving stream.

Section III - Lower Detroit River Industries

Chrysler Corporation (Amplex Division)

Pollution control is considered satisfactory at this time, and no specific recommendations for improvement are made.

Chrysler Corporation (Cycleweld Division)

Pollution control is considered satisfactory at this time, and no specific recommendations for improvement are made.

Chrysler Corporation (Engine Division)

Phenol concentrations in the plant effluent were found to exceed International Joint Commission recommendations. Treatment should be provided to limit the phenol concentration in the effluent to 20 µg/l.

Other than control of phenol concentration, waste treatment is considered adequate at this time, and no additional specific recommendations for improvement are made.

Dana Corporation

Concentrations of oil, phenol, and iron exceeding International Joint Commission recommendations were found in the effluent of this plant. The following recommendation is made:

1. Treatment facilities should be installed capable of producing an effluent containing not more than:
    a. Oil concentration of 15 mg/l
    b. Phenol concentration of 20 µg/l
    c. Iron concentration of 17 mg/l

E. I. du Pont de Nemours and Company
(Industrial and Biochemical Division)

At times the pH of the plant effluent was outside the International Joint Commission recommended range of pH 5.5-10.6. Acid wastes should be neutralized to conform with this recommendation.

Other than pH control, waste treatment is satisfactory at this time, and no additional specific recommendations for improvements are made.

Firestone Tire and Rubber Company

Excessive concentrations of iron, suspended solids, settleable solids, and acid were found in the plant effluent. At times phenol concentrations exceeded International Joint Commission recommendations, and the pH was below the International Joint Commission recommended range of pH 5.5-10.6. The following recommendations are made:

1. Acid wastes should be neutralized so that plant effluent is within the range of pH 5.5-10.6.
2. Iron and phenol concentrations in the effluent should be reduced by additional treatment to a level not exceeding 17 mg/l and 20 µg/l, respectively.
3. Additional sedimentation facilities should be provided capable of producing an effluent not exceeding 85 mg/l suspended solids and not exceeding 5 mg/l settleable solids.

Fuel Oil Corporation

Excessive concentrations of oil were found in the effluent from this installation (when ships were being washed). In fact, the

concentration observed during the survey was over 20 times as high as the International Joint Commission recommendation of 15 mg/l. The following recommendations are made:

1. The oil concentration in the effluent should be reduced immediately to 40 mg/l by improved operation of existing facilities.
2. Additional treatment should be provided to limit the oil concentration in the plant effluent to 15 mg/l.

Great Lakes Steel Corporation - Strip Mill

Excessive quantities of suspended solids and settleable solids were found in the plant effluent. Since the major portion of these suspended solids is readily settleable, the concentration of settleable solids should be limited to 5 mg/l and the concentration of suspended solids to 85 mg/l by either improved operation or additional treatment facilities.

Other than the problem of settleable solids, waste treatment is considered satisfactory at this time, and no additional recommendations for improvement are made.

Koppers Company

Large concentrations of phenol were found in outfall number 2 which exceeded International Joint Commission recommendations. It is recommended that treatment of the wastes be provided to reduce the phenol concentration to a level below 20 µg/l.

Other than the phenol problem, waste treatment was considered

satisfactory at this time, and no additional recommendations for improvement are made.

Great Lakes Steel Corporation - Ecorse

Excessive concentrations and significant quantities of oil, phenols, iron, suspended solids, settleable solids, and acid were found in the effluent from this installation. Over 50 per cent of the iron and acid loadings to the Detroit River originate from this source. Effluents containing acid wastes are far below the International Joint Commission recommended range of pH 5.5-10.6. The following recommendations are made:

1. Wastes should be neutralized before discharge to fall within the range pH 5.5-10.6.
2. Oil concentrations (especially in outfalls number 2 and number 11) should be reduced by additional treatment or improved operation to 15 mg/l.
3. Iron concentrations should not exceed 17 mg/l. This should be accomplished by the installation of treatment facilities or improved operation.
4. Treatment facilities should be installed capable of producing an effluent containing not more than:
    a. Phenol concentration of 20 µg/l
    b. Suspended solids concentration of 85 mg/l
    c. Settleable solids concentration of 5 mg/l

McLouth Steel Corporation - Gibralter

Excessive concentrations and quantities of phenols and acid were found in the effluent of this industry. In addition, control of oil and iron concentrations was considered marginal. The following recommendations are made:

1. All waste treatment practices should be reviewed and steps taken to improve the effluent to conform with the order of determination issued by the Michigan Water Resources Commission.
2. Treatment should be improved to assure a phenol concentration in the effluent not exceeding 20 µg/l.
3. Wastes should be neutralized to assure a pH within the range pH 5.5-10.6.

McLouth Steel Corporation - Trenton

Operation of the waste treatment facilities of this installation has been very erratic from the standpoint of control of suspended solids, settleable solids, iron, phenols, oil, and pH. At times excellent pollution control is achieved in all measures of water quality mentioned above. At other times complete lack of treatment effectiveness was observed, with concentrations of solids, oil, phenols, and iron exceeding the International Joint Commission recommendations and the order of determination of the Michigan Water Resources Commission.

Since it has been demonstrated that this industry can achieve

effective pollution control by operation of its existing facilities, it is recommended that a thorough review be given waste treatment operations to assure an effluent which meets the following criteria:

a. Phenol concentration not exceeding 20 µg/l

b. Oil concentration not exceeding 15 mg/l

c. Iron concentration not exceeding 17 mg/l

d. Suspended solids concentration not exceeding 85 mg/l

e. Settleable solids concentration not exceeding 5 mg/l .

In such a review, attention should be given to preventive maintenance and replacement of worn equipment before failures occur. Greater attention should be given to training of operators of waste treatment facilities. A complete stock of inventories of parts and equipment should be maintained to assure a minimum amount of down time when an equipment failure does occur.

Mobil Oil Company

During the survey the concentration of oil in the plant effluent was excessive, but additional grab samples before and after the survey indicated satisfactory control. Effective operation of the industry's oil separation facilities should also improve suspended solids removal. Phenol concentrations were consistently high, averaging 12,000 µg/l, which far exceeds the International Joint Commission recommendation of 20 µg/l.

The following recommendations are made:

1. Existing facilities should be operated effectively to assure an oil concentration in the effluent below 15 mg/l.

2. Suspended solids and settleable solids should be maintained in the effluent below 85 mg/l and 5 mg/l by improved operation of existing facilities or installation of new facilities.

3. Treatment should be provided to reduce the phenol concentration in the effluent to 20 µg/l or less.

Monsanto Chemical Corporation

Waste treatment at this installation is satisfactory with the exception of phosphate concentrations in the plant effluent. It is recommended that treatment be provided to reduce the phosphate concentration and loading to at least 80 per cent of the present values of 240 mg/l and 10,000 pounds per day.

Pennsalt Chemicals Corporation - East Plant

The concentration of chlorides, suspended solids, and settleable solids in the plant effluent was considered excessive. Approximately 1/2 million pounds of chlorides per day were discharged from this source to the Detroit River, representing about 20 per cent of the industrial loading to the river. The following recommendations are made:

1. Treatment facilities should be installed to reduce the suspended solids in the plant effluent to 85 mg/l and settleable solids to 5 mg/l.

2. The industry should begin investigation of methods to dispose satisfactorily of chlorides other than discharge into the Detroit River. While no practical method of removal from

plant effluent now exists, alternate methods of disposal of concentrated brines, such as subsurface disposal, should be investigated.

Pennsalt Chemical Corporation - West Point

Wastes from this industry exhibit excessive concentrations of phenols, suspended solids, and settleable solids. Phenol concentrations were found over 1,000 µg/l, which far exceeds the International Joint Commission recommendation of 20 µg/l. The following recommendations are made:

1. The entire waste disposal program of this plant should be carefully investigated by company personnel, since discharge of phenols, oxidizing agents, and settleable solids is far in excess of that expected by company officials.
2. A phenol concentration of not more than 20 µg/l should be maintained in all discharges leaving the plant.
3. Settleable solids in the effluent should be reduced by improved operation and maintenance of existing treatment facilities.

Shawinigan Resins Corporation and Monsanto Chemical Corporation (Saflex Division)

The wastes from these industries are discharged to the Detroit River from a common lagoon. During the survey the only waste constituents considered excessive were BOD and suspended solids (originating primarily from Shawinigan Resins). The installation of

a new lagoon after the survey should reduce these levels considerably.

Waste treatment at this installation is considered satisfactory at this time, and no specific recommendations are made.

Wyandotte Chemicals Corporation - North Plant

Concentrations of phenols, chlorides, suspended solids, and settleable solids in the plant effluent were found to be excessive. The contribution of chlorides in the amount of 1,300,000 pounds per day represents almost half the entire industrial loading to the Detroit River. The suspended and settleable solids loadings from this industry represent 35 per cent of the total loadings to the Detroit River from industrial sources.

The composition of the suspended solids (most of which are readily settleable) is mainly calcium bicarbonate. This chemical is almost insoluble in water and will readily settle out in clarifiers. The sludge from this operation will cover the river and lake bottom and can interfere with aquatic life.

The following recommendations are made:

1. Phenol concentration in the plant effluent should be limited consistently to 20 µg/l or less by either improved operation of existing facilities or installation of new treatment facilities.

2. Treatment facilities should be provided capable of producing an effluent containing not more than:

    a. Suspended solids concentration of 85 mg/l

    b. Settleable solids concentration of 5 mg/l

3. The industry should continue investigation of methods to dispose satisfactorily of chlorides other than discharge into the Detroit River. While no practical method of removal from plant effluent by treatment now exists, alternate methods of disposal of concentrated brines should continue to be investigated.

Wyandotte Chemicals Corporation - South Plant

Heavily concentrated wastes are pumped from this plant to the waste beds of Fighting Island. The remainder of the plant effluent is discharged to the Detroit River and contains excessive concentrations of chlorides and suspended solids. Wide fluctuation in many waste constituents was also observed.

The following recommendation is made:

1. The concentrations of suspended solids and settleable solids in the plant effluent should be reduced to 85 mg/l and 5 mg/l by additional waste treatment facilities.

Wyandotte Chemicals Corporation - South Plant (Propylene Oxide)

The effluent from this plant contained excessive concentrations of chlorides and suspended solids. The pH of this effluent was higher than the International Joint Commission recommended range of pH 5.5-10.6.

The following recommendations are made:

1. The pH of the effluent should be adjusted to the range 5.5-10.6.

2. Treatment facilities should be provided capable of producing an effluent containing a suspended solids concentration not more than 85 mg/l and settleable solids concentration not more than 5 mg/l.

Section IV - Raisin River and Lake Erie Industries

Enrico Fermi Atomic Reactor

This was the only industrial facility survey that was located directly on Lake Erie. Waste treatment was found to be satisfactory, and no specific recommendations are made.

Consolidated Paper Company - North Plant

Significant quantities of phenols, oil, suspended solids, settleable solids, and BOD originate from this source and are discharged into the Raisin River and subsequently into Lake Erie. The wastes from this industry are equivalent in oxygen-consuming capacity to the untreated wastes from a population of over 100,000 persons. This represents approximately 45 per cent of the total load to the Raisin River. Phenol and oil concentrations were inconsistent and often exceeded International Joint Commission recommendations. Concentrations of coliform and fecal streptococci organisms were also excessive. The following recommendations are made:

1. Chlorination of the plant effluent should be practiced at a level capable of assuring that the monthly geometric mean coliform concentration does not exceed 5,000 organisms per 100 ml.
2. Secondary treatment facilities should be installed which are capable of producing an effluent containing not more than:
    a. Phenol concentration of 20 µg/l
    b. Oil concentration of 15 mg/l

c. Suspended solids concentration of 85 mg/l

d. Settleable solids concentration of 5 mg/l

In addition, the treatment facilities should reduce the BOD loading to the receiving waters at least 50 per cent.

3. The chemical coagulation facilities of the existing treatment units should be put into use to assure a higher degree of treatment.

4. Wastes which are discharged to the Raisin River through the outlet near the Winchester Street bridge should be pumped to the treatment facilities for clarification.

Consolidated Paper Company - South Plant

Significant quantities and excessive concentrations of phenols, oil, suspended solids, settleable solids, and BOD are discharged from this source into the Raisin River and subsequently into Lake Erie. The wastes from this industry are equivalent in oxygen-consuming capacity to the untreated wastes of over 40,000 persons. Phenol and oil concentrations are erratic and often exceed International Joint Commission recommendations. Concentrations of coliform and fecal streptococci organisms are unusually excessive, averaging over 1,000,000 total coliform organisms per 100 ml during the special survey. The following recommendations are made:

1. Chlorination of all plant effluent should be practiced at a level capable of assuring that the monthly geometric mean coliform concentration does not exceed 5,000 organisms per 100 ml.

2. Secondary treatment facilities should be installed which are capable of producing an effluent containing not more than:

a. Phenol concentration of 20 µg/l

b. Oil concentration of 15 mg/l

c. Suspended solids concentration of 85 mg/l

d. Settleable solids concentration of 5 mg/l

In addition, the treatment facilities should reduce the BOD loading to the receiving stream at least 50 per cent.

3. Waste treatment measures employed by this industry should be reviewed in order to achieve improved clarification.

Ford Motor Company

The discharge from this plant represents 80 per cent of the total volume from industrial sources discharged to the Raisin River and subsequently into Lake Erie. Cyanide concentrations and loadings in the plant effluent were found to be excessive. The effluent from the company-owned sewage treatment plant was not chlorinated. The quantity of oil released to the Raisin River through a dilution canal outlet is excessive even though the concentration remains below the International Joint Commission recommendation of 15 mg/l. The following recommendations are made:

1. Chlorination facilities should be installed capable of producing an effluent whose monthly geometric mean coliform concentration does not exceed 5,000 organisms per 100 ml.

2. The cyanide concentration in the plant effluent should not exceed 0.01 mg/l.

3. Oil removal facilities should be provided to limit the concentration of oil reaching the dilution canal from in-plant sources to 15 mg/l.

Monroe Auto Equipment Company

Waste treatment at this installation is considered satisfactory at this time, and no specific recommendations for improvement are made.

Monroe Paper Products Company

Significant quantities and excessive concentrations of phenols, suspended solids, settleable solids, and BOD are discharged from this source into the Raisin River and subsequently into Lake Erie. The major portion of the suspended solids is readily settleable. Concentrations of coliform organisms were found to be excessive during this survey at 32,400 organisms per 100 ml; however, during a separate Public Health Service survey several months later, the average coliform concentration exceeded 2,000,000 organisms per 100 ml. The following recommendations are made:

1. Chlorination facilities should be installed which are capable of producing an effluent whose monthly geometric mean coliform concentration does not exceed 5,000 organisms per 100 ml.
2. The present practice of chemical coagulation should be continued, and both clarifiers should be used simultaneously to assure greater removal of waste constituents.
3. Secondary treatment facilities should be installed which

are capable of producing an effluent containing not more than:

a. Phenol concentration of 20 µg/l

b. Suspended solids concentration of 85 mg/l

c. Settleable solids concentration of 5 mg/l

In addition, the treatment facilities should reduce the BOD loading to the receiving stream at least 50 per cent.

Union Bag-Camp Paper Company
River Raisin Paper Company Division

Significant quantities and excessive concentrations of phenols, oil, suspended solids, settleable solids, and BOD are discharged from this installation to the Raisin River and subsequently into Lake Erie. The wastes from this industry are equivalent in oxygen-consuming capacity to the untreated wastes of 70,000 persons. Phenol and oil concentrations exceeded International Joint Commission recommendations. A large part of the suspended solids was readily settleable. Effective bacterial control was achieved during the survey. The following recommendations are made:

1. The chemical coagulation facilities at the existing treatment units should be put into use to assure a higher degree of treatment.

2. Secondary treatment facilities should be installed capable of producing an effluent containing not more than:

a. Phenol concentration of 20 µg/l

b. Oil concentration of 15 mg/l

c. Suspended solids concentration of 85 mg/l

d. Settleable solids concentration of 5 mg/l

In addition, the treatment facilities should reduce the BOD loading to the receiving stream at least 50 per cent.