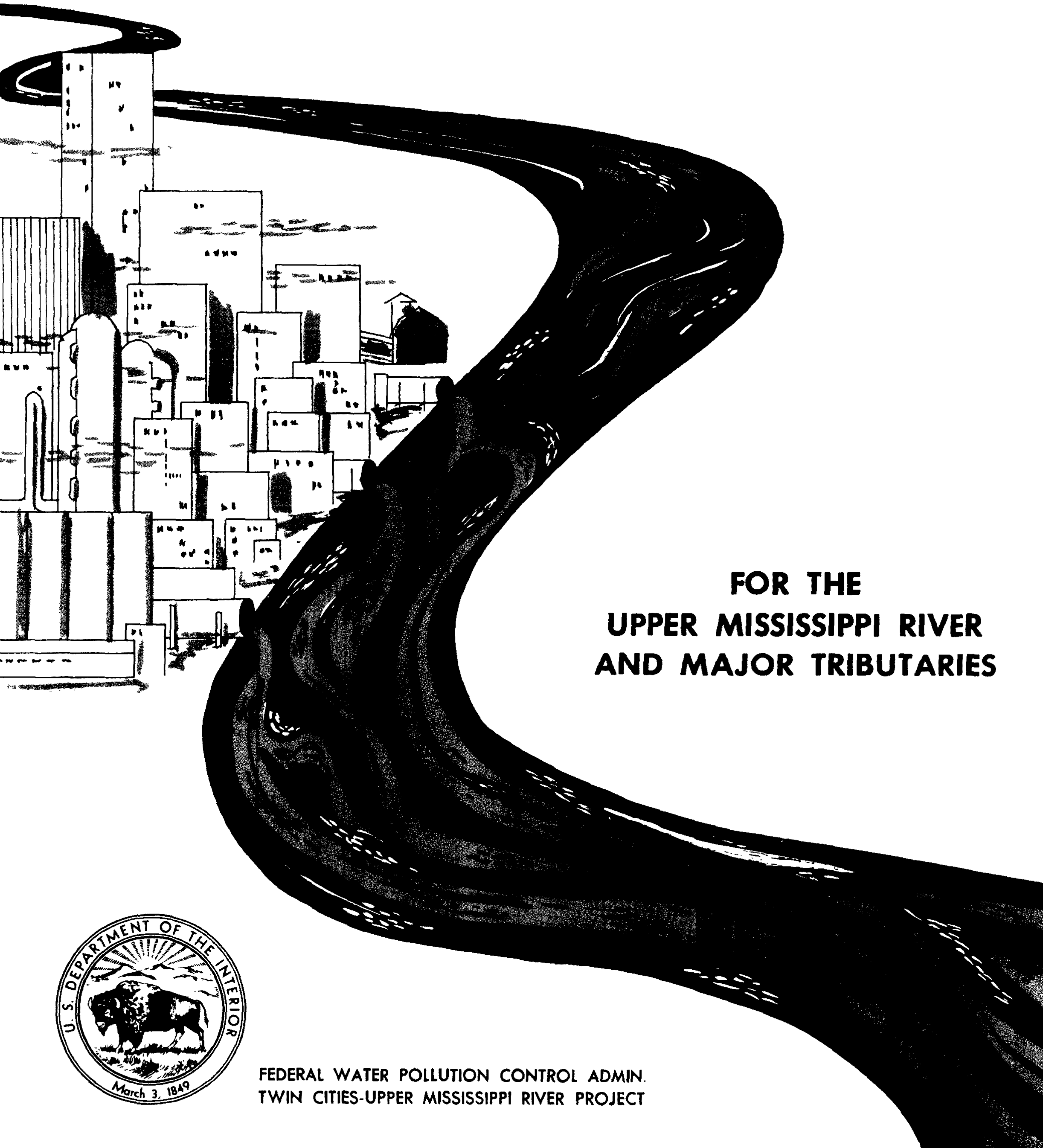
SUMMARY AND POLLUTION ABATEMENT RECOMMENDATIONS



FOR THE UPPER MISSISSIPPI RIVER AND MAJOR TRIBUTARIES

U.S. DEPARTMENT OF THE INTERIOR
March 3, 1849
FEDERAL WATER POLLUTION CONTROL ADMIN.
TWIN CITIES-UPPER MISSISSIPPI RIVER PROJECT

From
Public Awareness

To
Federal
Recommendations

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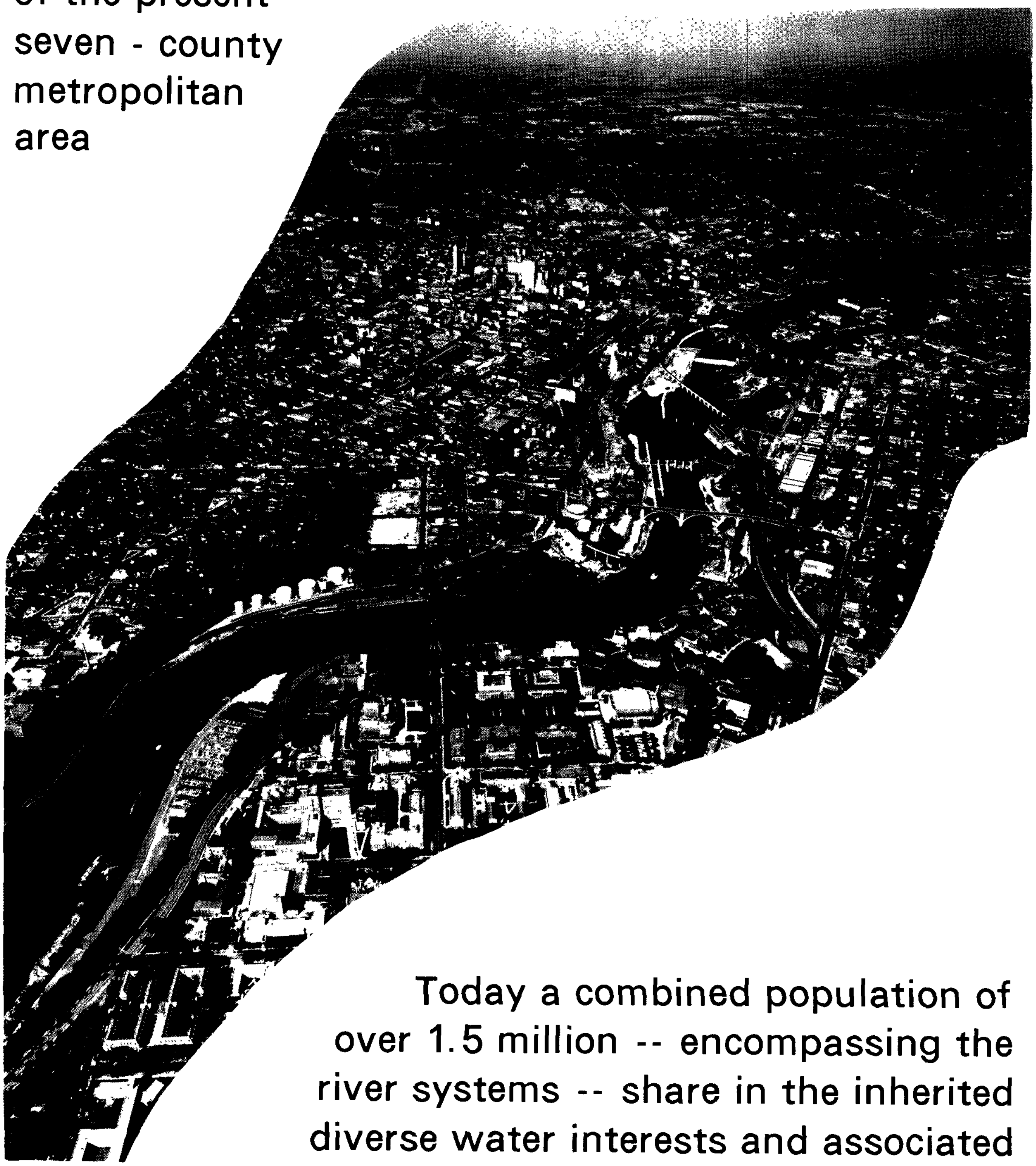
Before the turn of the century the rivers served as an important element in the initial development of the present seven - county metropolitan area



Today a combined population of over 1.5 million -- encompassing the river systems -- share in the inherited diverse water interests and associated problems

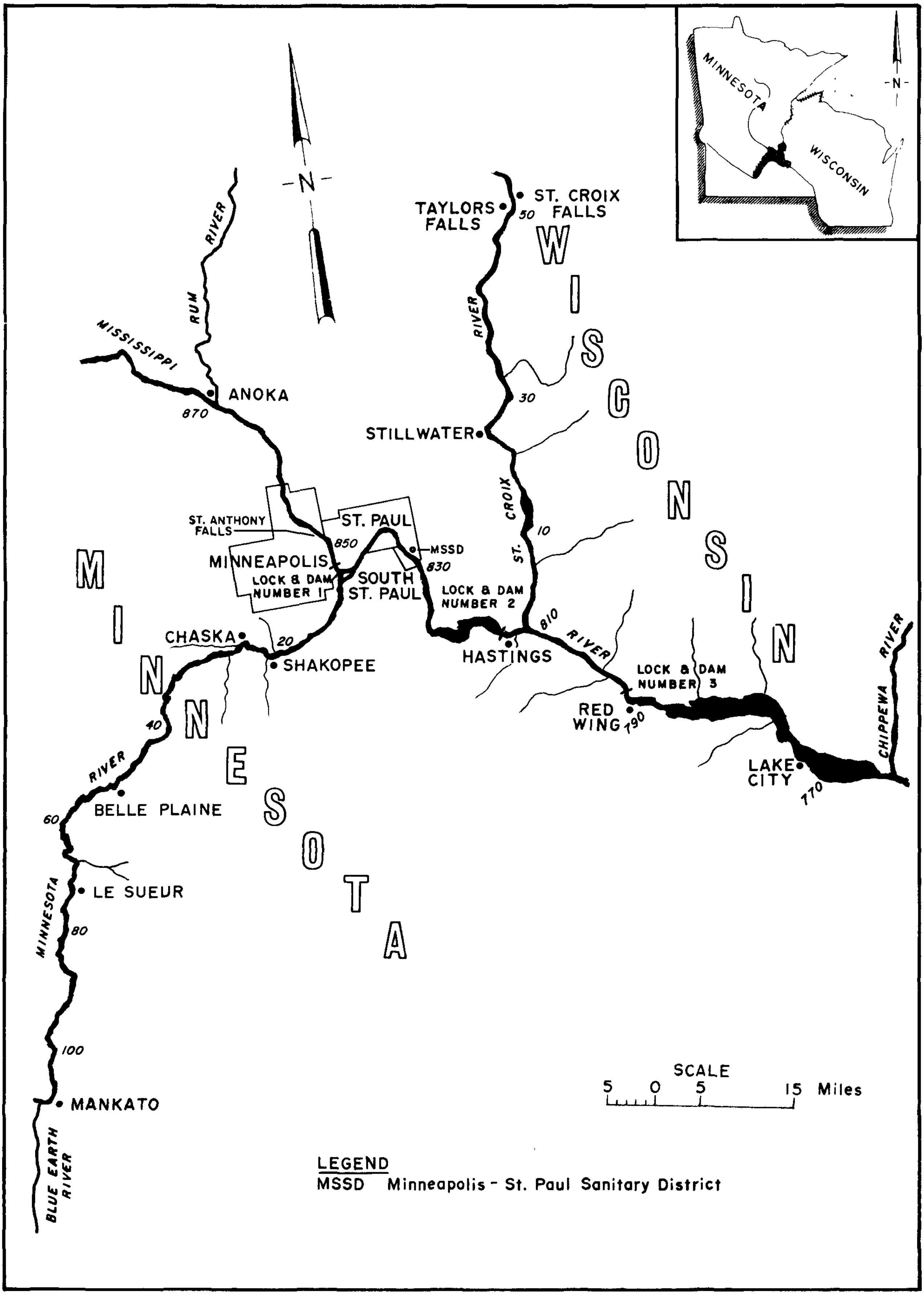


FIGURE 1 - For the development of pollution abatement recommendations investigations were conducted on water quality, sources and quantities of wastes, and the extent of pollution in 270 miles of river.

INTRODUCTION

The investigation of water pollution along the Upper Mississippi River and its major tributaries, a summary of which is presented herein, was conducted by the Twin Cities-Upper Mississippi River Project of the Federal Water Pollution Control Administration. The investigation was made under the authority of Section 10 (d) (1) of the Federal Water Pollution Control Act as amended (33 U.S.C. 466 et seq.) and at the request of the conferees of the Federal-State conference on water pollution held in St. Paul, Minnesota on February 7 and 8, 1964. The Conference, in turn, was held in response to a joint request from the Governors of Minnesota and Wisconsin to abate pollution in the area and was called by the Secretary of the Department of Health, Education, and Welfare.

The investigation was conducted to gather information on water quality, sources and quantities of wastes, the extent of pollution, and necessary abatement measures in the following river reaches: Upper Mississippi River from the Rum River at Anoka, 107 miles downstream to the outlet of Lake Pepin; lower 110 miles of the Minnesota River; and the lower 52 miles of the St. Croix River (see Figure 1).

Surveys of municipal and industrial waste sources were joint efforts of the Project, the appropriate State regulatory agencies, and in many instances the municipality or industry involved.

The summary of the 1st session of the Conference indicated that the investigations would be carried out in conjunction with both states and agencies. To this end, we are most appreciative of the cooperative attitude exhibited by all with whom the Project dealt. Participating agencies included the staffs of Minnesota's Department of Health and Department of Conservation; Wisconsin's Department of Resource Development and Department of Conservation, as well as many other federal, municipal, and private organizations.

All desired information on waste sources and stream quality, collected over the years by the Minnesota Department of Health, Wisconsin Department of Health, and the Minneapolis-St. Paul Sanitary District Sewage Treatment Plant (MSSD) was made available to the project by these agencies.

Laboratory procedures were performed in accordance with "Standard Methods for the Examination of Water and Wastewater, Eleventh Edition". Any deviations were based on proven research described in the literature. All calculations (except those on flow frequencies) were based on data collected during the survey period (June 1964 – October 1965) and reflect conditions resulting from waste loadings being discharged during that period.

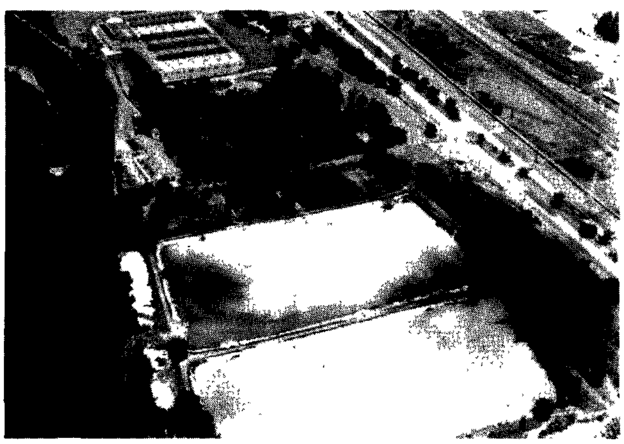
The main body of this report contains a more detailed description and discussion of all Project findings along with appropriate maps, figures and tables. The information provided in the Summary and Conclusions which follow, is a condensation of all the information contained in the main body of this report.

SUMMARY OF WATER USES

Water uses in practice along the Mississippi, and St. Croix Rivers are summarized below and illustrated in Figures 2 through 7.

POTABLE WATER SUPPLY

Minneapolis and St. Paul use the Mississippi System as a source of potable water supply for themselves and many of the suburbs. Other communities depend on ground water sources. The water intakes for Minneapolis and St. Paul, located just upstream from Minneapolis, withdraw an average of 103 million gallons per day (mgd) and serve approximately 873,000 people.



A component of Minneapolis' water treatment plants, located on the Mississippi upstream from the city.

NONPOTABLE INDUSTRIAL PROCESS WATER

Significant amounts of untreated water from the Mississippi and Minnesota Rivers are used by four industries in their processes at seven locations within the study area. No use is made of the St. Croix River for this purpose.

On the Mississippi River, barge and gravel washing is carried out at two locations, each. Both activities are of a seasonal nature, operating from April through October. Barge washing, conducted near downtown St. Paul (river miles 840.4 and 837.3), requires about 2 million gallons per operating season. Gravel washing is performed about 6 miles farther downstream (river miles 826.5 and 825.0) and requires 650 million gallons of water per operating season.

On the Minnesota River, sugar beet washing and fluming is conducted during the winter (4-month period) near Chaska. Barge washing is conducted at two locations (river miles 13.2 and 8.0) between April and November of each year. The former operation requires about 700 million gallons per season and the latter ones require about 800 thousand gallons per season.

COOLING WATER

One processing industry and five steam-generating plants utilize Mississippi and Minnesota River waters for cooling purposes. No use is presently being made of the St. Croix River for this purpose.

The Mississippi River serves the one processing industry located at South St. Paul and three of the steam-electric generating plants, located in Minneapolis, St. Paul, and Red Wing. Together, they use cooling water at a maximum rate of 1,100 mgd.

The Minnesota River serves two of the steam-electric generating plants, located near Mankato and Bloomington. They use cooling water at a maximum rate of 405 mgd.

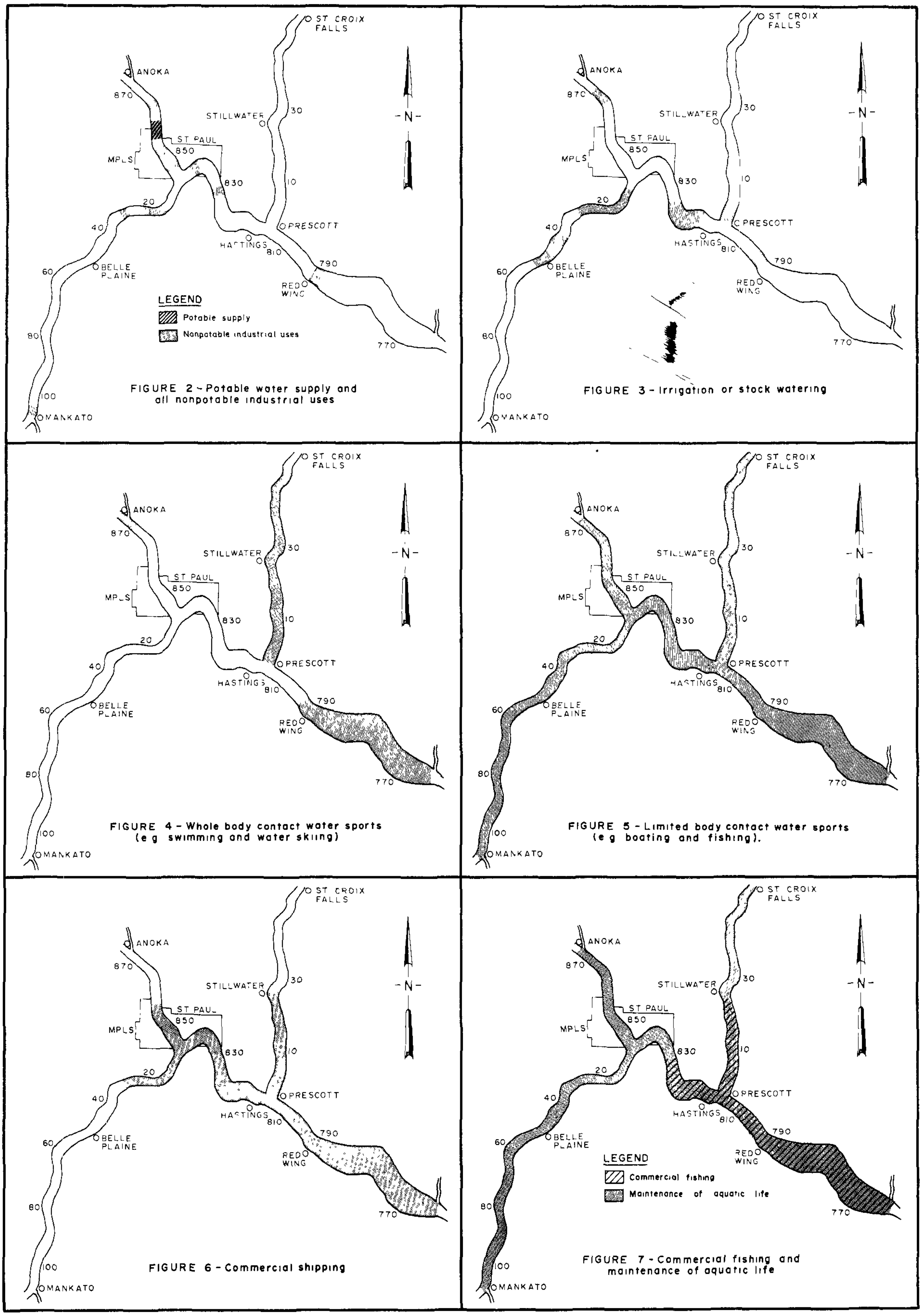


FIGURE 2 - Potable water supply and all nonpotable industrial uses

FIGURE 3 - Irrigation or stock watering

FIGURE 4 - Whole body contact water sports (e g swimming and water skiing)

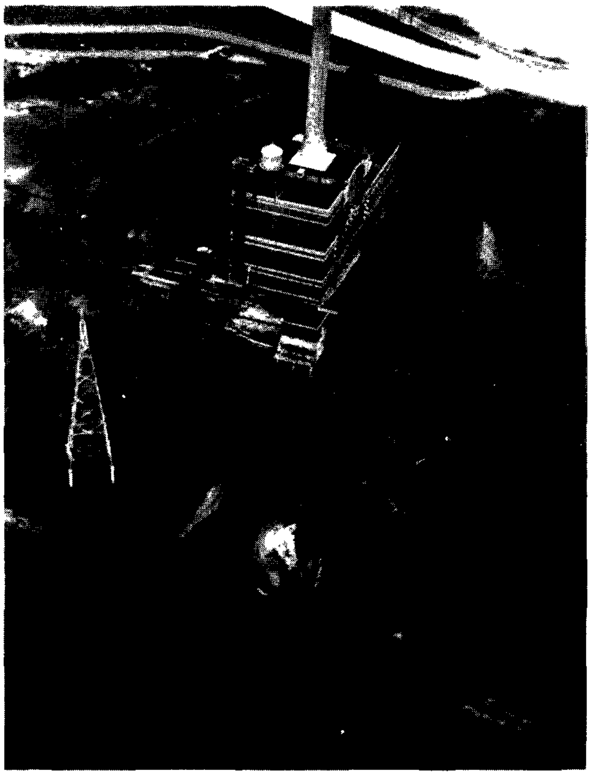
FIGURE 5 - Limited body contact water sports (e g boating and fishing).

FIGURE 6 - Commercial shipping

FIGURE 7 - Commercial fishing and maintenance of aquatic life

LEGEND ▒ Designates where each use is practiced extensively.

FIGURES 2-7. SUMMARY OF WATER USES.

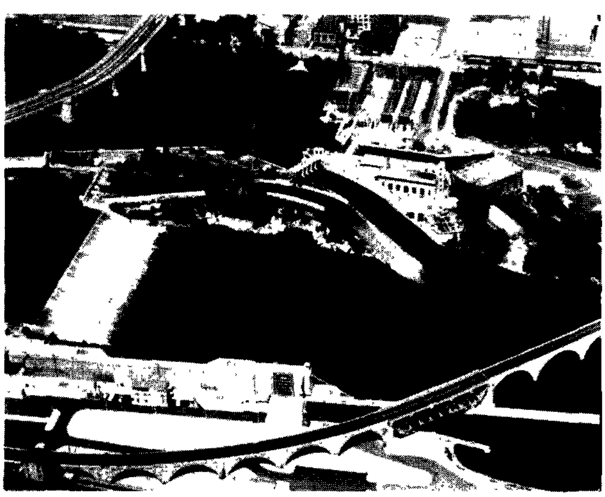


Northern States Power Co. Riverside steam-electric generating plant, located on Mississippi River in Minneapolis.

HYDROELECTRIC POWER

There are five hydroelectric plants within the study area and all utilize the Mississippi River. One is located 10 miles above Minneapolis and the other four are located in Minneapolis at St. Anthony Falls and Lock & Dam No. 1.

The total capacity of these plants is 42,260 KW, 3.2 percent of the total steam-electric power plant capacity in the study area.



St. Anthony Falls at Minneapolis, the site of three hydroelectric plants.

IRRIGATION AND STOCKWATERING

Very little use is made of the Mississippi River system for irrigation and stockwatering.

Permits for withdrawal of irrigation water have been issued to persons along the Mississippi River above Minneapolis and near North Lake in Pool No. 3; along the Minnesota River at Jordan; and along the St. Croix River just above Prescott. There may also be some use for irrigation by truck farmers along the north bank of the Mississippi River just above Lock & Dam No. 2 and along the lower 35 miles of the Minnesota River.

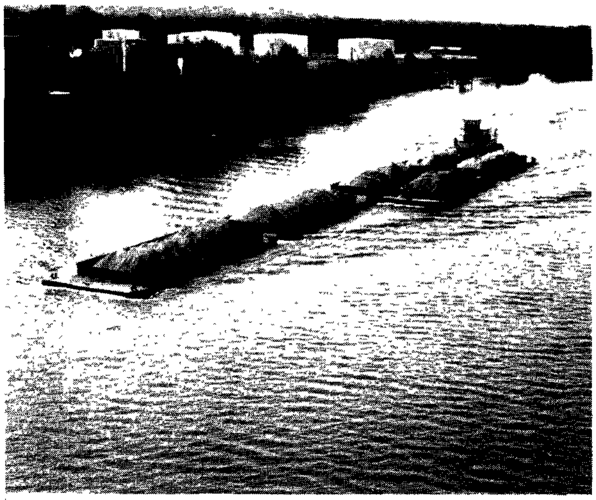
Very limited use is made of the rivers for stockwatering. Small numbers of cattle have been seen drinking from the Mississippi River just above Lock & Dam No. 2 and from the Minnesota River above Chaska.

COMMERCIAL SHIPPING

Although river traffic in the Twin Cities area is significant, it is less than on the remainder of the Mississippi River. During 1964 over five and one-half million tons of materials were received and shipped at the ports of Minneapolis and St. Paul. In this same year there were 1,556 commercial lockages made through Lock & Dam No. 2. Docking facilities extend upstream as far as the northern city limit of Minneapolis where the nine-foot channel ends.

The shipping channel extends upstream on the Minnesota River as far as Shakopee (river mile 25.1). During 1963 over two and one-quarter million tons of materials were received and shipped along this reach.

Commercial shipping extends upstream on the St. Croix River as far as Stillwater (river mile 23.3). In comparison to the Mississippi and Minnesota Rivers, barge traffic on the St. Croix River is very light.



Barge traffic on Mississippi River.

Receipts consist generally of only two products, coal and superphosphate. Of the 30,567 tons of materials received in 1964, 17,939 tons were coal. Coal receipts are expected to increase significantly after the Allen S. King Power Plant becomes operational.

COMMERCIAL FISHING

Commercial fishing is practiced on the Mississippi River in and below Pool No. 2 and on the lower 23 miles of the St. Croix River, known as Lake St. Croix. The major source of fish in this area, however, has always been Lake Pepin in Pool No. 4. Fish caught commercially in Pools 3 and 4 during 1964 were valued at $91,320. No figures were available for catches in Pool No. 2 that year. The 1964 catch in Lake St. Croix totaled 511,586 pounds and was valued at $15,750. The predominant species of fish caught commercially are carp, buffalo, catfish and drum.

Commercial fishing in the north end of Lake Pepin.

SWIMMING AND WATER SKIING

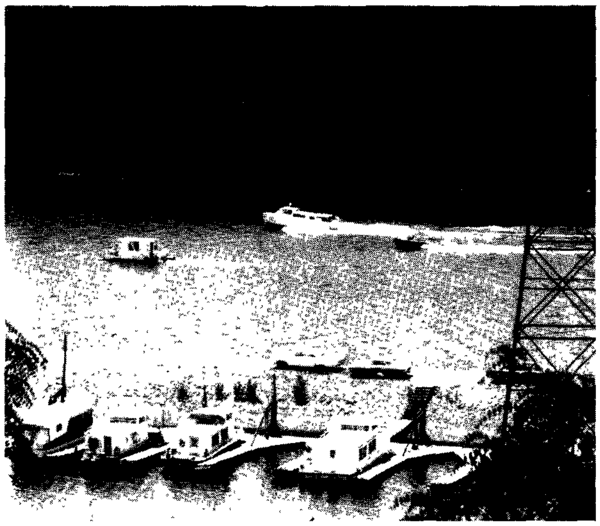
Swimming is practiced throughout the reach below Red Wing (Lake Pepin) and the lower St. Croix River from beaches as well as boats. There are eight beaches along Lake Pepin and seven beaches on the St. Croix River, however, which receive heaviest use. Approximately 650 people can normally be found along each of the two rivers using these beaches on a typical warm, sunny weekend day.

Bathing beach on St. Croix River near its mouth at Prescott, Wisc.

Water skiing is generally practiced in four areas, two on the Mississippi River and two on the St. Croix River. On the Mississippi River it is practiced near Anoka at the upper end of the study area and near Red Wing at the lower end. As many as 75 people make use of these areas on good days. Limited skiing is also practiced near St. Paul Park, seven miles below MSSD. The two areas on the St. Croix River receiving heaviest use by water skiers are near Hudson (river mile 17.0) and Afton (river mile 11.0). Approximately 150 people make use of these areas on good days.

PLEASURE BOATING

Pleasure boating is practiced from April to September throughout all three of the major streams under consideration. Greatest use, however, is made of the St. Croix River below Stillwater, and the Mississippi River below Lock & Dam No. 2.



Pleasure boating on Mississippi River below its confluence with the St. Croix River.

SPORT FISHING

Fishing is an important summer, as well as winter, recreational activity in the area under consideration. The St. Croix River and the Mississippi River below its confluence with the St. Croix receive the greatest use although fishing is practiced to some extent over the entire area.

ESTHETIC ENJOYMENT

The scenic beauty afforded by the streams in this area has resulted in the location of about 30 parks along their banks. The two parks receiving greatest use are the Interstate and O'Brien State Parks, both located on the St. Croix River. The former is located on both sides of the river near Taylors Falls and St. Croix Falls. The latter is situated on the Minnesota shore midway between Taylors Falls and Stillwater. A large river oriented park is proposed for the area adjacent to the mouth of the Minnesota River.

In addition, there are many scenic highways that border on the streams under consideration. Plans are being developed to construct a national parkway following the course of the Mississippi River on both sides from Canada to the Gulf of Mexico.

MAINTENANCE OF HABITAT FOR AQUATIC LIFE AND WATERFOWL

Fish can be found throughout the streams in the study area in varying numbers and species. Ducks, white egrets, and herons can also be found along many reaches of the three rivers. The Mississippi River serves as a major artery in the continental system of flyways serving wildfowl migrations. Pools 2, 3, and 4 are spring and fall concentration areas for several species of duck. As many as 10,000 ducks at a time have been seen in the Spring Lake area (immediately above Lock & Dam No. 2).

Heron in flight along Mississippi River above Lake Pepin.

Mallard ducks along Mississippi River below Red Wing, Minnesota.

WASTE DISPOSAL

Fifty-nine significant waste water producers utilize the major streams within the study area for disposal purposes. Their discharges total 1,800 (mgd). The steam-electric generating plants contribute 85 percent of this amount. Municipalities and other industries contribute 12 and 3 percent, respectively. In addition to the above contributors there are more than 100 combined and storm sewer outfalls which discharge during and immediately after rains. Approximately 80 of these are located in Minneapolis and St. Paul.

SUMMARY OF WASTE SOURCES

GENERAL

Sewage and other wastes contain many constituents which affect water quality in different manners and restrict the water's use. Floating materials such as grease, oils and solids lower the esthetic quality of a body of water, making it less attractive for all uses. Oxygen consuming materials (measured by 5-day (20°C) BOD) can limit or destroy fish, fish food organisms, and other desirable aquatic life by reducing the dissolved oxygen concentration in the water. Complete depletion of dissolved oxygen results in the generation of offensive odors. Suspended solids, including silt from land erosion, create turbidity which not only makes the water less suitable as a source of supply and for recreational uses, but can also be damaging to fish. Larger suspended solids eventually settle out, forming a sludge blanket on the bottom. This sludge blanket smothers fish food organisms and may affect navigation. Nitrogen, phosphorus, and heat promote the growth of algae (simple plants, many microscopic in size) which, in turn, create nuisance conditions affecting water supplies, recreational uses, and esthetic quality. Excessive ammonia nitrogen concentrations affect fish life. Some chemicals, such as phenols, impart undesirable tastes and odors to the water and the flesh of fish. Some of the intestinal bacteria, present in sewage in astronomical numbers, may be pathogens which can reinfect man.

The location of all waste sources investigated are shown in Figure 8. The most significant sources and the amounts of materials discharged by them are depicted in Figures 9, 10, and 11.

FEDERAL INSTALLATIONS

Twelve Federal installations within the Project's study area watershed handle their own waste disposal. Others discharge to municipal sewerage systems. Table 1 (see Appendix) gives information on the type of treatment and place of final disposal of wastes from each of these 12 installations.

None have any measurable effect on water quality in the portions of rivers under study. One, however, the 934th Troop Group Officers' Club, has unsatisfactory waste treatment facilities which discharge effluent to a marsh area adjacent to the Minnesota River. These wastes present a potential health hazard to water users along the lower Minnesota River.

MUNICIPAL SOURCES

Mississippi River

There were five primary and seven secondary municipal sewage treatment plants discharging 208 mgd of wastes to the Mississippi River investigated. The primary plants are those operated by MSSD, Hastings, Prescott, Lake City, and Pepin. The secondary plants are those operated by Anoka, South St. Paul, Newport, Inver Grove, St. Paul Park, Cottage Grove, and Red Wing.

At the time of the survey these sources contributed the following loadings of constituents:

1. Oxygen-consuming wastes equivalent to raw sewage from a population of 1,800,000.
2. Coliform bacteria equivalent to raw sewage from a population of 1,200,000.
3. Suspended solids equivalent to raw sewage from a population of 920,000.
4. Approximately 42,000 pounds of organic and ammonia nitrogen compounds per day.

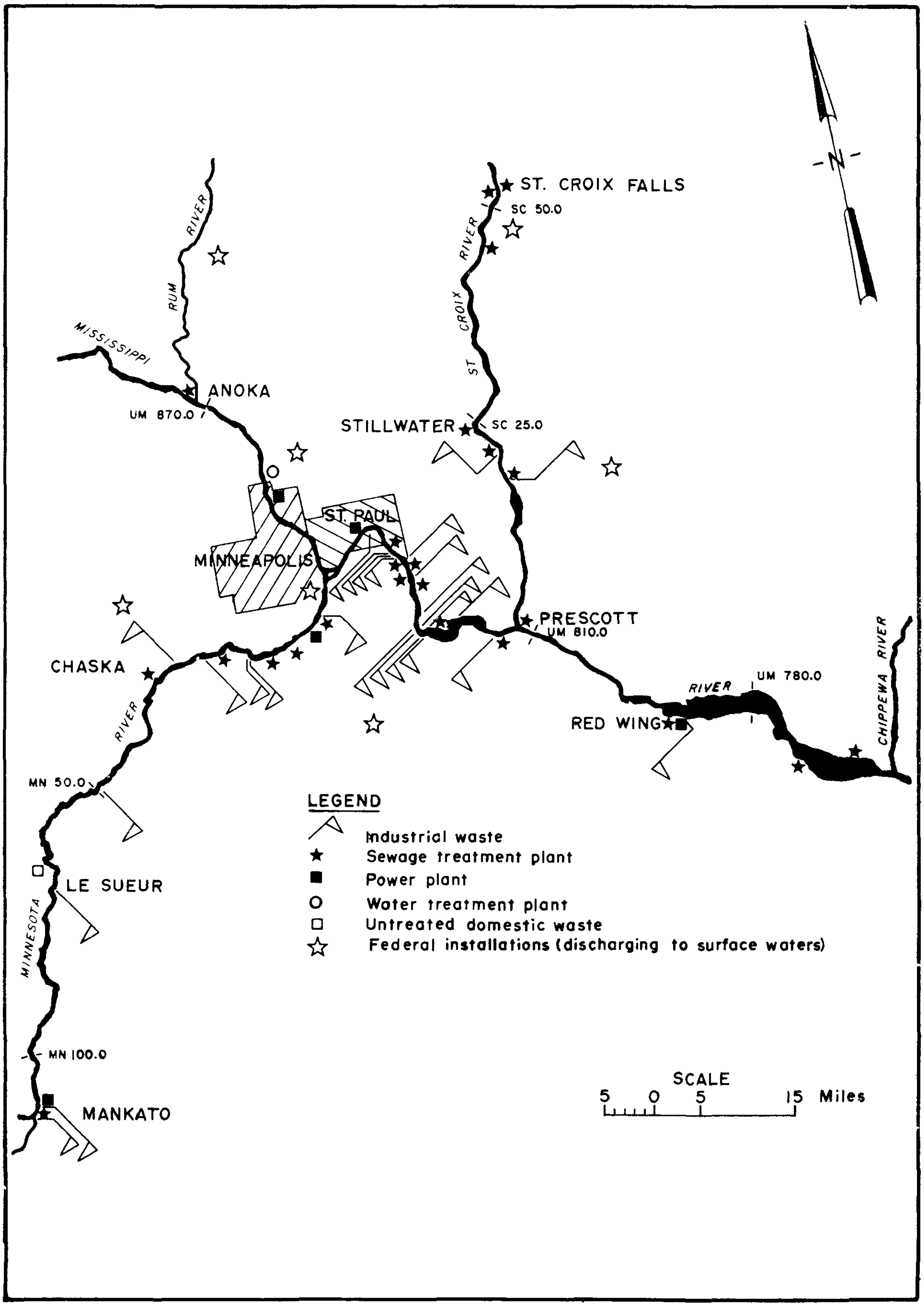


FIGURE 8 - Location of waste sources investigated

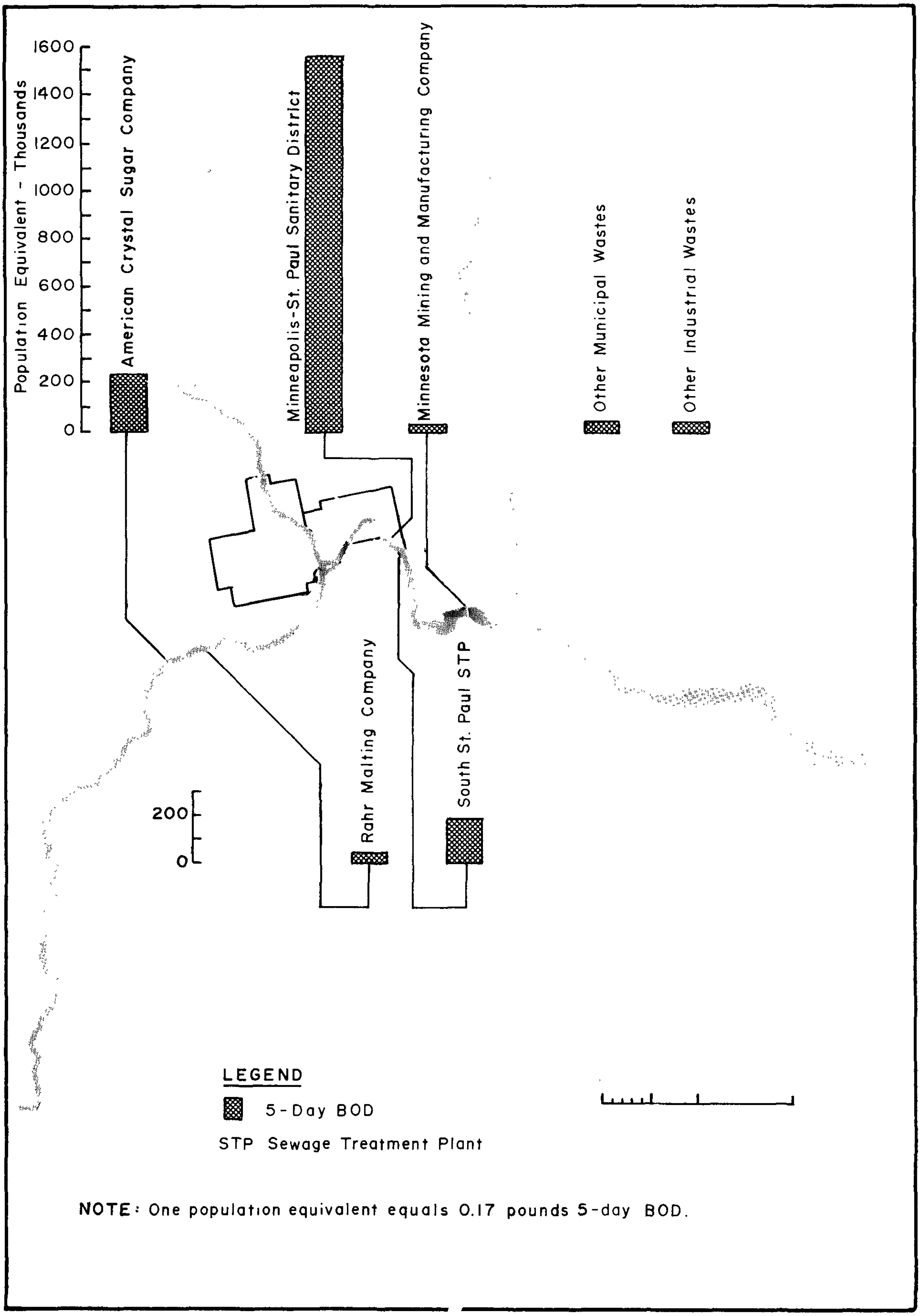


FIGURE 9 - Most significant con ributors of BOD during 1964-1965.

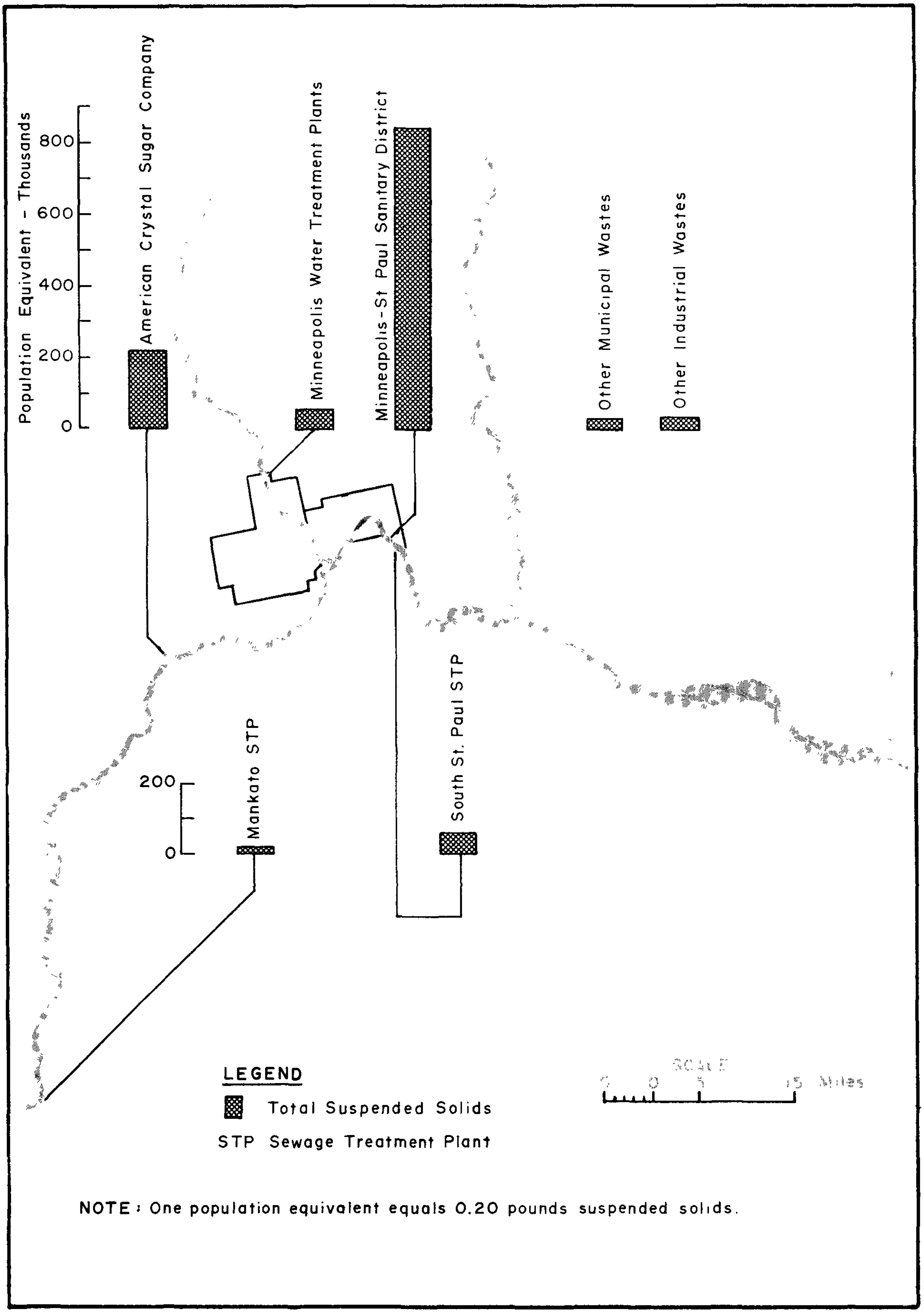


FIGURE 10 - Most significant contributors of Suspended Solids during 1964-1965.

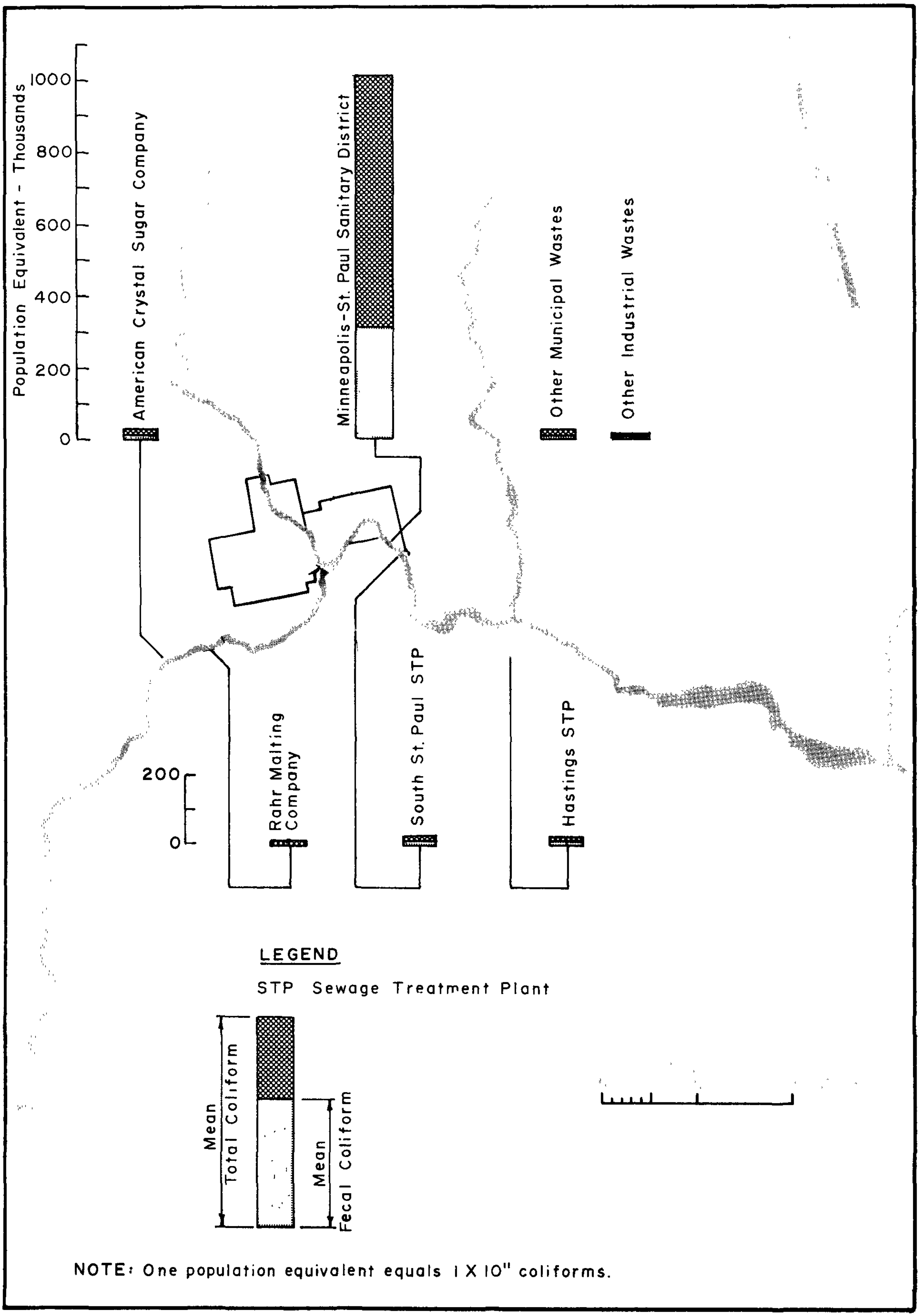
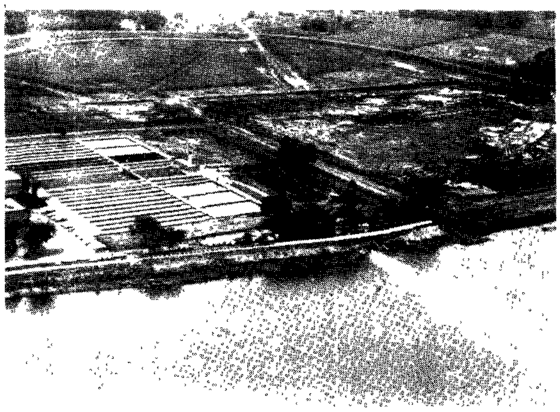


FIGURE 11 - Most significant contributors of Coliform Bacteria during 1964-1965

5. Approximately 24,000 po ds of phosphates per day.

6. Approximately 850 pounds of phenols per day.

The MSSD is the largest plant and contributes 91 percent of the municipal wastes volume. Of the total municipal contribution, MSSD's waste effluent contained 88 percent of the oxygen consuming materials; 95 percent of the coliforms; 92 percent of the suspended solids; 85 percent of the organic nitrogen, ammonia nitrogen, and phosphates; and essentially 100 percent of the phenols.



Minneapolis-St. Paul Sanitary District sewage treatment plant discharging to Mississippi River downstream from St. Paul, Minnesota (before addition of secondary unit).

The South St. Paul sewage treatment plant (SSP) is the second largest one and contributes 7 per cent of the municipal wastes volume. Of the total municipal contribution, this source discharged 11 percent of the oxygen consuming materials, 2 percent of the coliforms, 6 percent of the suspended solids, 12 percent of the organic and ammonia nitrogen, and 9 percent of the phosphates.

South St. Paul sewage treatment plant discharging to Mississippi River.

The other 10 plants contributed the remaining 2 percent of the municipal wastes volume and from 1 to 6 percent of the various constituents discussed above.

Table 2 (see Appendix) summarizes the information obtained on the characteristics of wastes from all municipal sewage treatment plants investigated. Loading rates of the various constituents discharged from each plant to the river are summarized in Table 3 (see Appendix).

Minnesota River

There were seven communities and a Masonic home discharging to the Minnesota River within the study area. Two of the communities (Mankato and Shakopee) and the Masonic home provide primary treatment. Only one, the City of Henderson, is without any treatment facilities. The remaining four communities (Chaska, Savage, Burnsville, and Cedar Grove) provide secondary treatment. At the time of the survey, these sources contributed the following loadings of constituents:

1. Oxygen consuming wastes equivalent to raw sewage from a population of 24,600.

2. Coliform bacteria equivalent to raw sewage from a population of 12,500.

3. Suspended solids equivalent to raw sewage from a population of 19,300.

4. Approximately 850 pounds of organic and ammonia nitrogen per day.

5. Approximately 550 pounds of phosphates per day.

The Mankato sewage treatment plant is the largest one on the Minnesota River and contributes 4.5 mgd, about 74 percent of the total municipal wastes volume. Of the total municipal contribution, Mankato's waste effluent contained 85 percent of the oxygen consuming materials; 54 percent of the coliforms; 69 percent of the suspended solids, 69 percent of the nitrogenous compounds; and 49 percent of the phosphates.

The second largest municipal contributor of oxygen consuming wastes and coliforms was Shakopee, which contributed 7 and 24 percent of the totals, respectively. The remaining plants discharge much smaller quantities of wastes. Additional information on municipal waste characteristics and stream loading rates from these plants is summarized in Tables 2 and 3.

St. Croix River

Six communities discharge wastes to the St. Croix River within the study area. Two (Osceola and Stillwater) provide primary treatment and the remainder (St. Croix Falls, Taylor Falls, Bayport, and Hudson) provide secondary treatment. At the time of the survey, these sources contributed the following loadings of constituents:

1. Oxygen consuming wastes equivalent to raw sewage from a population of 940.
2. Coliform bacteria equivalent to raw sewage from a population of 1,600.
3. Suspended solids equivalent to raw sewage from a population of 700.
4. Approximately 400 pounds of organic and ammonia nitrogen per day.
5. Approximately 500 pounds of phosphates per day.

The Stillwater, Minnesota primary sewage treatment plant is the largest single contributor on the St. Croix River. It discharges 1.8 mgd, about 58 percent of the total municipal wastes volume. Of the municipal contribution, Stillwater's waste effluent contained 78 percent of the oxygen consuming materials; 54 percent of the coliforms; 75 percent of the suspended solids; 57 percent of the nitrogenous compounds; and 54 percent of the phosphates.

The remaining five plants are much smaller in capacity, receiving less than 0.6 mgd each. Additional information on municipal waste characteristics and stream loading rates from these plants is summarized in Tables 2 and 3.

INDUSTRIAL SOURCES

Mississippi River. .

Fourteen manufacturing and processing plants, two water treatment plants, three steam-electric generating plants, and two barge washing facilities were investigated on the Mississippi River. The fourteen manufacturing and processing plants referred to are Swift & Co., Union Stockyards, Armour & Company, King Packing Co., Northwestern Refining Co., J. L. Shiely Co., General Dynamics Liquid Carbonics Division, St. Paul Ammonia Products Co., Great Northern Oil Co., Northwest Cooperative Mills, Minnesota Mining and Manufacturing Co., H. D. Hudson Manufacturing Co., Foot Tanning Co., and Pittsburgh Plate Glass Co. The two water treatment plants investigated are owned and operated by the City of Minneapolis. The three steam-electric generating plants (Riverside, Highbridge, and Red Wing) are owned and operated by the Northern States Power Co.

The barge washing facilities investigated were those of the Minnesota Harbor Service and Twin City Shipyard. These industrial sources, excluding the three electric plants, discharge wastes at the rate of about 35 mgd to the river. The steam-electric plants utilize as much as 1,095 mgd of river water for cooling purposes, returning it directly to river after use. These sources, together contributed the following loadings of constituents:

1. Oxygen consuming wastes equivalent to raw sewage from a population of 35,000.
2. Coliform bacteria equivalent to raw sewage from a population of 170.
3. Suspended solids equivalent to raw sewage from a population of 70,000.

Northwestern Refining Co. with treatment facilities in foreground discharging to the Mississippi River at St. Paul Park, Minnesota.

4. Approximately 4,500 pounds of organic and ammonia nitrogen compounds per day.
5. Approximately 2,500 pounds of phosphates per day.
6. Approximately 40 pounds of phenols per day.
7. Approximately 600 pounds of fluoride per day.

8. Approximately 160 billion British Thermal Units (BTU) of heat per day (when steam-electric plants are operating at full capacity).

Table 4 (see Appendix) summarizes the information obtained on the characteristics of wastes from all industries investigated. Loading rates of the various constituents discharged to the river are summarized in Table 5 (see Appendix).

Minnesota River. Eleven manufacturing and processing plants, two steam-electric generating plants, and two barge cleaning facilities were investigated on the Minnesota River. The eleven manufacturing and processing plants investigated were the North Star Concrete Co., Archer Daniels Midland Co., Blue Cross Rendering Co., Green Giant Co., Minnesota Valley Milk Processing Assoc., American Crystal Sugar Co., M. A. Gedney Co., Rahr Malting Co., Owens-Illinois Glass Co., American Wheaton Glass Co., and Cargill, Inc. The two steam-electric generating plants (Wilmarth and Blackdog) referred to are owned and operated by the Northern States Power Company. The two barge washing facilities are those of Twin City Shipyards. One industry, Honeymead Products Co., located on the Blue Earth River near its confluence with the Minnesota River, was also investigated. These industries, excluding the two electric plants, discharge wastes at the rate of 18 mgd to the river. The steam-electric plants utilize as much as 405 mgd of river water for cooling purposes, returning it to the river after use. The Blackdog electric plant passes the water through a cooling pond before returning it to the river. At the time of the survey, these sources, together, contributed the following loadings of constituents:

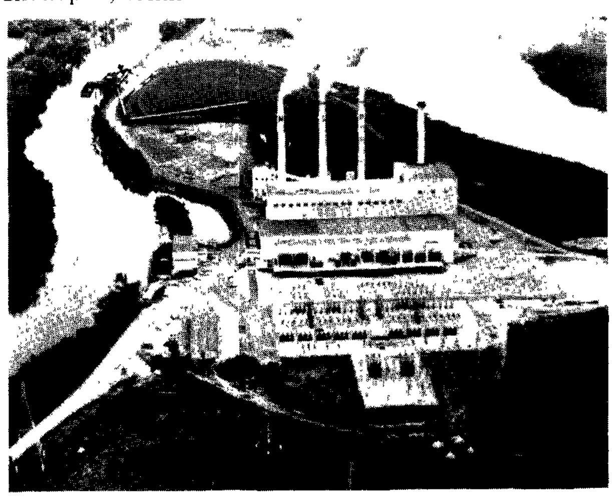
1. Oxygen consuming wastes equivalent to raw sewage from a population of 273,000.

American Crystal Sugar Co. plant which discharges to the Minnesota River at Chaska, Minnesota.

2. Coliform bacteria equivalent to raw sewage from a population of 40,300.
3. Suspended solids equivalent to raw sewage from a population of 238,000.
4. Approximately 1,200 pounds of organic and ammonia nitrogen per day.
5. Approximately 950 pounds of phosphates per day.
6. Approximately 740 pounds of oil and grease per day.
7. Approximately 60 billion BTU of heat per day (when steam-electric plants are operating at full capacity and discharging cooling water directly to river.)

Additional information on industrial waste characteristics and stream loading rates is summarized in Tables 4 and 5.

Rahr Malting Co. located on Minnesota River at Shakopee, Minnesota.



Northern States Power Co. Blackdog power plant and cooling pond, located eight miles above the mouth of the Minnesota River.

St. Croix River. There are two industries (Andersen Window Co. and United Refrigerator Co.) on the St. Croix River. Together they discharge wastes at the rate of 0.5 mgd. These sources contributed the following loadings of constituents:

1. Oxygen consuming wastes equivalent to raw sewage from a population of 330.
2. Suspended solids equivalent to raw sewage from a population of 300.
3. Approximately 3 pounds of organic and ammonia nitrogen per day.
4. Approximately 5 pounds of phosphates per day.
5. Less than one pound of chromium per day.

Additional information on industrial waste characteristics and stream loading rates is summarized in Tables 4 and 5.

COMBINED SEWER OVERFLOWS

The cities of Minneapolis, St. Paul, and South St. Paul each have combined sewers with regulators that divert excess flows directly to the Mississippi River.

The Minneapolis - St. Paul combined sewer system has more than 80 overflow points. It is estimated that over a period of one year, up to 3.5 percent of sewage reaching the MSSD treatment plant may be lost without treatment. The total of these figures represent about 7.5 million pounds of 5-Day (20°C) BOD and 9.5 million pounds of suspended solids on a yearly basis. This overflow occurs over about 10 percent of the time in a given year.

Combined sewer overflow discharging to Mississippi River in Twin Cities area.

The South St. Paul combined sewer system is very similar in design to that of the Twin Cities. South St. Paul has a more serious surcharging problem along a considerable portion of the interceptor, however, during periods of maximum dry-weather flow. In general, the interceptor has only about one-half the required capacity to handle the maximum dry-weather flow plus the runoff from a rainfall intensity of 0.04 inches per hour. It is estimated that South St. Paul's overflow system contributes about 6 million pounds of 5-Day (20°C) BOD and 5 million pounds of suspended solids on a yearly basis.

AGRICULTURAL AND NATURAL POLLUTION

Nutrients are the primary products of concern resulting from agricultural activities and the natural death and decay of plant and animal life. Among the nutrients, nitrogen and phosphorus are considered the most important. At times, suspended solids, resulting from erosion, are also of concern.

Mississippi River Approximately 40,000 and 20,000 pounds per day of total nitrogen and phosphate (as PO_4), respectively, would be expected to enter the Mississippi River above Lake Pepin from agricultural and natural sources at the mean August flow (9,480 cfs at St. Paul).

Minnesota River. Approximately 6,000 and 4,000 pounds per day of total nitrogen and phosphate (as PO_4), respectively, would be expected to enter the study area via the Minnesota and Blue Earth Rivers from agricultural and natural sources at the mean August flow (2,677 cfs at Carver).

Turbidity, occurring naturally, is considerably more than 25 units in waters entering the study area at Mankato except on occasions of low stream flows after long absences of surface runoff. The sand-silt-clay mantle, through which the river flows is largely responsible for this condition. Land erosion within the drainage basin also contributes to this problem.

Soil erosion along Minnesota River above Shakopee, Minnesota.

St. Croix River. Approximately 13,000 and 2,000 pounds per day of total nitrogen and phosphate (as PO_4), respectively, would be expected to enter the study area via the St. Croix River from agricultural and natural sources at the mean August flow (3,580 cfs at Stillwater).

SUMMARY OF WATER QUALITY AND INTERFERENCE WITH WATER USES

GENERAL

Ideally, a stream should be high in dissolved oxygen, low in temperature, turbidity, nitrogen, phosphate, phenol and bacteria.

A dissolved oxygen concentration of at least three mg/l is required in order to maintain a suitable habitat for rough fish. A minimum of five mg/l is required for game fish.

Water temperatures should not exceed 93°F in order to maintain a suitable habitat for rough fish and to be suitable for limited body contact activities (e.g. boating and commercial shipping.) The maximum temperature permitted for whole body contact activities (e.g. swimming and water skiing) and for irrigational or cooling water use is 90°F. To be suitable as a source of potable supply and as a habitat for game fish, the water temperature should not exceed 86°F.

Waters used as a source for potable supplies and for whole body contact activities, such as swimming and water skiing, should have a turbidity of not greater than 25 jackson units. Most other water uses require a turbidity of less than 250 jackson units.

Nitrogen in the ammonia form should not exceed 1.0 mg/l for game fish and 2.0 mg/l for rough fish. Inorganic nitrogen and phosphorus in concentrations greater than 0.3 mg/l (as nitrogen) and 0.03 (as phosphate) at the time of spring overturn are generally considered sufficient to produce algal blooms in lakes. (Pools behind locks and dams become lakes at low-stream flows.)

Phenolic compounds in concentrations greater than 0.001 mg/l produce undesirable tastes and odors in chlorinated drinking water supplies. In concentrations greater than 0.01 mg/l they taint fish flesh.

Sewage polluted waters frequently contain pathogenic bacteria which, if ingested, can cause gastrointestinal diseases such as typhoid fever, dysentery, and diarrhea. Body contact with sewage-polluted waters can cause eye, ear, nose, throat or skin infections. Viruses, which cause diseases, including polio, hepatitus, and meningitis may also be present.

Sewage also contains readily detectable coliform bacteria which typically occur in the feces of man and other warm-blooded animals. Not all coliform bacteria are of intestinal origin, however. Though generally harmless in themselves, coliform bacteria are always present in sewage-polluted waters and have, therefore, been considered indicators of the probable presence of pathogenic bacteria.

Many water pollution control agencies evaluate water quality on the basis of total coliform count, which includes those of intestinal as well as non-intestinal origin. In this report a total coliform density of greater than 5,000/100 ml is considered to be unsafe for any water use involving limited body contact (e.g. boating, commercial shipping, and fishing) or for irrigation and stock and wildlife watering. Waters used as a source of potable water supply should not have a total coliform density greater than 4,000/100 ml. The total coliform density in waters used for whole body contact activities (e.g. swimming and water skiing) should not exceed 1,000/100 ml.

In this study a more selective test was used to identify fecal coliform bacteria, in addition to the total coliform. This permitted a better evaluation of the significance of total coliform counts since the presence of fecal coliform bacteria is positive proof of fecal contamination.

More recently, refined methods for isolation and detection of *Salmonella* organisms (producers of many intestinal diseases, including typhoid fever) have made it more practical to test for these specific infectious disease bacteria.

General water quality conditions found in the study area during the Project's survey are shown in Figure 12. Figures 13 through 18 show the river reaches that were found to be unsuitable for various water uses because of the water quality. The streams' flow (daily average) during this period ranged from 1.3 to 10 times the 7-consecutive-day, once in 10-year low flow.

MISSISSIPPI RIVER

Anoka to St. Anthony Falls.

The water quality of the Mississippi River between Anoka and St. Anthony Falls was unsatisfactory from a bacteriological standpoint, only. The average total coliform density in this segment ranged from 5,000 MPN/100 ml at Anoka to 4,000 MPN/100 ml a short distance above St. Anthony Falls. Fecal coliform counts were approximately 10 percent of the total counts. Almost all of this bacterial pollution originates upstream from the study area on the Mississippi and Rum Rivers. The only sources of bacterial pollution of any consequence along this segment are the Anoka sewage treatment plant and some of the metropolitan combined sewer overflows, including Bassett Creek. The Minneapolis water treatment plant and the Riverside steam-electric generating plant also discharge to this segment but do not contribute to the bacterial pollution. Minneapolis Water Works officials reported that a few tributaries to this segment are sometimes a source of high algal populations in the vicinity of their water intake.

In its present condition this segment of river is suitable for all uses except whole body water contact activities (e.g. swimming and water skiing). Before these activities could be practiced safely, the average total coliform density would have to be reduced to less than 1,000 organisms per 100 ml. Since water quality in this segment does not change appreciably with variations in flow (in the low and intermediate ranges), the water is suitable for all uses except whole body contact activities even at very low flows.

St. Anthony Falls to MSSD Outfall.

This segment of river receives waste water from more than 80 combined sewer overflows serving the Twin Cities as well as from the Minnesota River, High Bridge steam-electric generating plant, Minnesota Harbor Service, and Twin City Shipyard.

In dry weather the water quality is nearly as good as it is upstream of St. Anthony Falls. During and immediately following rainfall, however, the combined sewer overflows discharge into this reach, affecting the bacteriorlogical quality. These discharges were sufficient in the summer and early fall of 1964 to increase the monthly average total coliform density along the segment from 4,000 MPN/100 ml at the upper end to approximately 30,000 MPN/100 ml at the lower end. Coliform data collected by the Minneapolis - St. Paul Sanitary District between 1942 and 1955 show similar average values at these locations for August and September. Fecal coliform counts were approximately 10 percent of the total counts.

The Minnesota River at its mouth is usually lower in quality than the Mississippi River immediately above their confluence. During the summer and early fall of 1964 the Minnesota River had an effect on dissolved oxygen and turbidity levels in the Mississippi River. The average dissolved oxygen level decreased from 8.0 to 7.7 mg/1 and the average turbidity increased from <25 to 60 units as a result of the Minnesota River's inflow.

The other waste sources in this reach do not have an appreciable effect on water quality.

Confluence of the Mississippi and Minnesota Rivers (Note the greater turbidity of the Minnesota River).

In its present condition this segment of the river is generally unsuitable for body contact activities such as swimming, boating, fishing, and navigation. Before the water would be suitable for the latter three activities, the average total coliform density would have to be reduced to less than 5,000 organisms/100 ml. To make this segment suitable for swimming or water skiing, the average total

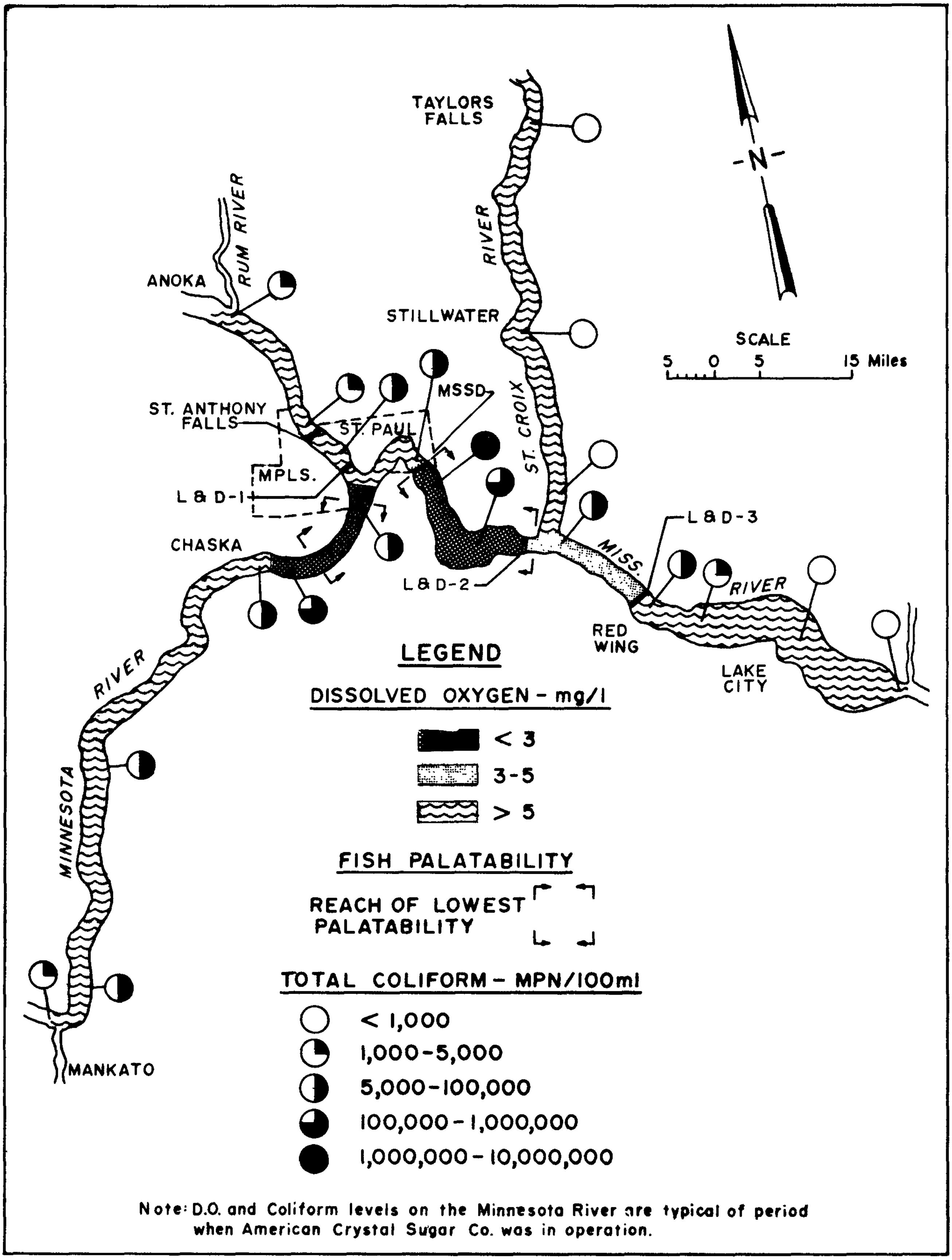


FIGURE 12 – Typical water quality conditions during low flow periods in 1964 and 1965

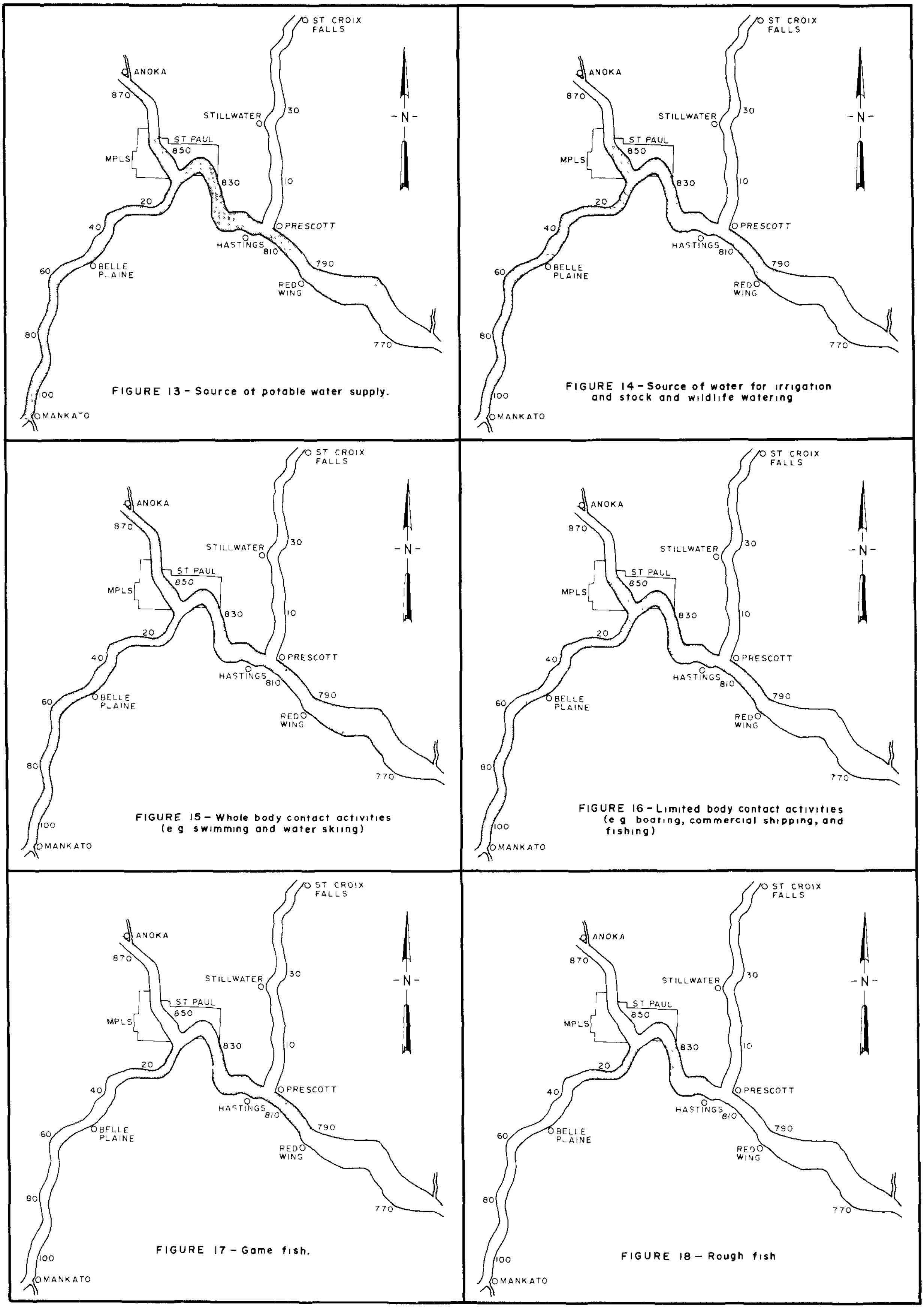


FIGURE 13 - Source of potable water supply.

FIGURE 14 - Source of water for irrigation and stock and wildlife watering

FIGURE 15 - Whole body contact activities (e g swimming and water skiing)

FIGURE 16 - Limited body contact activities (e g boating, commercial shipping, and fishing)

FIGURE 17 - Game fish.

FIGURE 18 - Rough fish

LEGEND ▭ Designates unsuitable reaches

FIGURES 13-18. RIVER REACHES UNSUITABLE FOR VARIOUS WATER USES.

coliform density would have to be reduced to less than 1,000 organisms/100 ml and the turbidity reduced to 25 units or less in the reach below the mouth of the Minnesota River.

MSSD Outfall to Lock & Dam No. 2

This segment of river receives wastes from the two largest contributors in the study area (MSSD and South St. Paul sewage treatment plants) as well as from 16 other smaller sources discussed previously and listed in Tables 2 and 4. As a result of these waste discharges this 21 1 mile reach of river had the lowest water quality of the entire study area.

Dissolved oxygen levels decreased from an average of 7.8 mg/1 just above the MSSD outfall to an average of 2.9 mg/1 in the vicinity of Spring Lake during the summer and early fall of 1964. The minimum dissolved oxygen level measured at this lower station during the same period was 0.5 mg/1. Winter levels were only slightly higher than summer levels in the lower 10 miles of this segment. The minimum daily river flow during this period has a recurrence interval of 4 years.

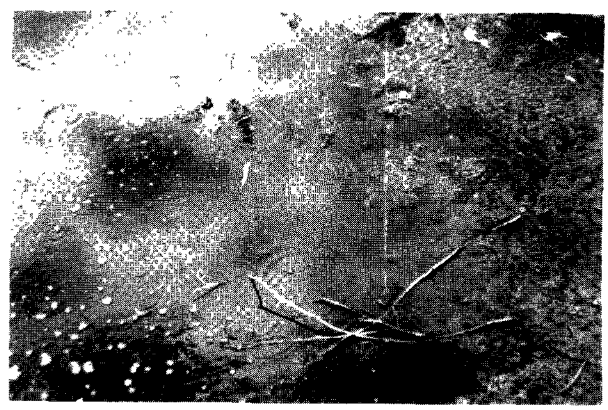
Ammonia nitrogen levels exceeded 1.0 mg/1 (the maximum permitted for game fish) one or more times during the summer survey at all stations in the entire segment. Values were highest at a point two miles below the South St. Paul plant outfall, ranging from 0.57 to 2.01 mg/1 (2.0 mg/1 is maximum permitted for rough fish) and averaging 0.96 mg/1 during the summer and early fall of 1964. Ammonia nitrogen values were slightly higher during the winter of 1964-1965.

The bacteriological quality of the river decreased markedly below the MSSD outfall. The total coliform density ranged from 460,000 to 17,000,000 MPN/100 ml, averaging 6,500,000 MPN/100 ml between June and October of 1964 at a point 8.8 miles below the plant outfall. Above the outfall, the total coliform density averaged about 30,000 MPN/100 ml over this same period. The fecal coliform density throughout this reach averaged about 20 percent of the total density.

Pathogenic bacteria and viruses were also isolated from stream and waste samples collected along this segment. Fourteen species of *Salmonella* bacteria and three types of viruses were isolated from the MSSD effluent. Five species of *Salmonella* were isolated from the South St. Paul plant effluent. Ten species of *Salmonella* were found in the river a distance of six miles below MSSD (two miles below South St. Paul). Ten miles downstream of MSSD, seven species of *Salmonella* were found.

Biologically, the river was relatively unpolluted above the MSSD outfall. Conditions changed abruptly, however, at this point. Here, a zone of degradation began and extended downstream to the vicinity of the South St. Paul sewage treatment plant outfall. The remainder of the segment, down to Lock & Dam No. 2, was a zone of active decomposition. The river bottom was composed of organic sludge along the entire length of this segment. No clean water associated bottom organisms were found.

Dead fish found below the Twin Cities.



Floating sludge and rising gas bubbles in Mississippi River below MSSD.

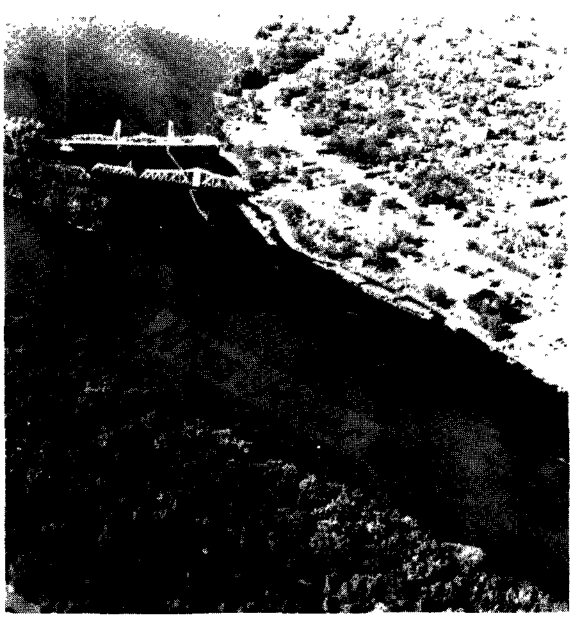
Carp was the predominant species of fish throughout Pool No. 2. In the reach between South St. Paul and Spring Lake, game fish made up only 6% of the total fish population. In the two-mile reach above Lock & Dam No. 2, they made up only

9% of the total population. Of all the fish evaluated in the study area by a taste panel, the flesh of those caught between South St. Paul and Lock & Dam No. 2 received palatability ratings which were among the lowest. Ratings ranged from 3.8 to 4.4. A rating of 4 or below indicated the fish flesh to be unacceptable.

The water quality found in this segment during the Project's surveys indicated that it was consistently suitable for only one use – cooling water. To make this segment suitable for uses such as pleasure boating, navigation, fishing, stock and wildlife watering, irrigation, and the maintenance of rough fish, the minimum dissolved oxygen concentration should be maintained above 3 mg/1 and the average coliform density maintained less than 5,000 organisms/100 ml.

Lock & Dam No. 2 to Lock & Dam No. 3.

This segment of river, which lies in the pollution recovery zone, has three small waste sources discharging to it. (Hudson Manufacturing Co., Hastings Sewage Treatment Plant, and Prescott Sewage Treatment Plant). The dissolved oxygen level was generally increased by 1 or 2 mg/1 during passage over Lock & Dam No. 2. Water quality in this reach is also enhanced by the St. Croix River which enters the Mississippi River about four miles below Lock & Dam No. 2.



Confluence of the Mississippi and St. Croix Rivers (Note the greater turbidity of the Mississippi River).

The minimum dissolved oxygen concentration recorded during the summer and early fall of 1964 between Lock & Dam No. 2 and the St. Croix River was 3.1 mg/1. Below the mouth of the St. Croix during this same period, the minimum concentration measured was 4.4 mg/1. Winter levels were also low. The minimum values recorded in the Mississippi River above and below the St. Croix's mouth during the winter of 1964-1965 were 2.1 and 5.7 mg/1, respectively.

Ammonia nitrogen levels were highest in the four-mile reach below Lock & Dam No. 2. During the surveys in the winter of 1964-1965, they ranged from 1.49 to 2.59 mg/1, averaging 2.12 mg/1.

The bacteriological quality of this segment was better than in the previous one, but was still poor. The total coliform density 1.2 miles below Lock & Dam No. 2 ranged from 2,300 to 350,000 MPN/100 ml, averaging 74,500 MPN/100 ml during the June-October 1964 period. Additional contributions by the Hastings and Prescott sewage treatment plants offset the improvement in bacteriological quality that would have resulted from dilution by the St. Croix River. Below the St. Croix River the coliform density decreased progressively with distance downstream due to natural dieoff. Just above Lock & Dam No. 3 the coliform density ranged from 3,300 to 130,000 MPN/100 ml, averaging 31,000 MPN/100 ml during the June-October 1964 period. Fecal coliform densities averaged 10 to 20 percent of the total densities in this segment.

Floating algae were found in greater numbers in the four-mile reach immediately below Lock & Dam No. 2 than at any point upstream. Their monthly average density at the one-foot depth ranged from 10,690/ml (in May) to 34,450/ml (in October) and averaged 21,200/ml, over the April-December 1964 period. Although these densities were rather high, they created no problems. Their presence was apparent only by microscopic examination. Their increase in density was due, primarily, to the increased nutrient load.

Greater numbers of game fish were found in this segment than in any of the previous ones. The Minnesota Department of Conservation determined that in 1964 game fish made up 46% of the total fish population in this pool.

The water quality found in the four-mile reach between Lock & Dam No. 2 and the mouth of the St. Croix River was unsuitable for all uses practiced. It would have been considered suitable for rough fish if the maximum ammonia nitrogen level had not exceeded 2.0 mg/1 and the minimum dissolved oxygen concentration had not fallen below 3 mg/1.

The reach between the mouth of the St. Croix River and Lock & Dam No. 3 was considered suitable for rough fish but not for game fish. Ammonia nitrogen levels exceeded 1.0 mg/1 and the minimum dissolved oxygen concentration fell below 5 mg/1.

To make the entire segment between Lock & Dam Nos. 2 and 3 suitable for uses such as swimming, water skiing, boating, sport and commercial fishing, and navigation, the average total coliform density should be reduced to less than 1,000 organisms/100 ml; the maximum ammonia nitrogen concentration reduced to 1.0 mg/1; and the minimum dissolved oxygen concentration increased to 5.0 mg/1.

Lock & Dam No. 3 to Chippewa River.

This segment of river also lies in the pollution recovery zone. It receives waste water from three municipal sewage treatment plants, (Red Wing, Lake City, and Pepin), two processing industries, (Foot Tanning Co. and Pittsburgh Plate Glass Co.) and the Red Wing steam-electric generating plant. These sources have little effect on water quality, however. Lake Pepin, which is a predominant portion of this segment, serves as a settling basin for silt and organic sludge carried in from upstream.

The water quality in this segment was unsatisfactory from a bacteriological standpoint. The average total coliform density decreased from 31,000/100 ml at the upper end to 250/100 ml at the lower end during the summer and early fall of 1964. Fecal coliform densities were from 5 to 10 percent of the total coliform densities. Most of the coliforms found in this segment had entered from upstream. The three sewage treatment plants in this segment, however, also added significant amounts of coliforms.

The Red Wing sewage treatment plant, largest of the three, was monitored on ten occasions for pathogenic bacteria and viruses. Positive results were obtained nine of the ten times from effluent samples. In all, seven species of *Salmonella* in addition to Polio, Coxsackie, and ECHO viruses were isolated.

Algal densities out in the mainstream were generally lower than those found in the previous segment. In shallow areas along the shores, however, densities were very high. During the summer of 1965, a greenish "pea soup consistency" algal bloom was observed in Lake Pepin at Stockholm, Wisconsin's bathing beach. Rocks along the bathing beach were coated with a green slimy mass of algal cells. Another bloom was also observed at the Lake City Marina. The water was colored "pea green" and a thick green slime coated boat hulls. These and other observations demonstrate that algal populations can and do become a problem in the lower part of the study area.

Results of chlorophyll-a analyses on the plant cells found on artificial substrates placed in the river indicated that attached algae were about six times as abundant on those substrates in Lake Pepin as compared to those located elsewhere upstream. This increase in attached algal growths on substrates and free-floating algae in quiescent shallow areas was due largely to the nutrient and organic load received from upstream sources.

Nutrient concentrations in Lake Pepin were above values generally considered sufficient to produce algal blooms in lakes. Inorganic nitrogen levels averaged 0.70 mg/1 at the upper end and 0.54 mg/1 at the lower end. The orthophosphate level remained fairly constant throughout the entire segment, averaging 0.56 mg/1 (as PO_4).

Game fish were present in far greater numbers in this segment than anywhere else in the study area. The Minnesota Department of Conservation found that 68% of the fish population in Pool No. 4 were game fish. Flesh palatability tests made by a taste panel on fish caught at five stations distributed throughout this segment showed that flavor improved with distance downstream as far as midway through Lake Pepin. Beyond this point there was no detectable improvement.

In general, the water quality found in this segment indicated that it was suitable for maintenance of game fish as well as rough fish, esthetic enjoyment, and as a source of cooling water. The reach below the head end of Lake Pepin was also suitable for limited body contact activities and stock and wildlife watering. In addition to all of these uses, the reach below Lake City was also suitable for whole body contact activities (e.g. swimming and water skiing).

The upper reaches in this segment would also be suitable for all these water uses if the average total coliform density were reduced to less than 1,000 organisms/100 mg.

MINNESOTA RIVER

Mankato to Chaska.

This segment of river receives waste water from five sources in the Mankato area (Honeymead Products Co., Mankato sewage treatment plant, Archer Daniels Midland Co., Blue Cross Rendering Co., and Wilmarth electric plant) and one each from the cities of Le Sueur (Green Giant Co. plant) Henderson, and Belle Plaine (Minnesota Valley Milk Processing Association plant.)

Except for a moderately high turbidity and coliform density, the water in this 79.9 mile segment was of reasonably good quality. The turbidity (resulting primarily from erosion) generally ranged from 25 to 220 units. The high values occurred during and immediately following periods of surface runoff. No one portion of the segment was consistently more turbid than another.

During the summer and early fall of 1964 the total coliform density in the river at Mankato just above the mouth of the Blue Earth River averaged approximately 5,000 MPN/100 ml. Waste sources from the Mankato area increased the average density to about 80,000 MPN/100 ml. At the 7-consecutive-day, once in 10 year summer low flow these waste sources would be expected to increase the coliform density to approximately 400,000 organisms/100 ml at a point 10 miles downstream. Beyond this point, and until reaching Chaska, the density would show a general decrease because of bacterial dieoff.

Dissolved oxygen concentrations were consistently high (greater than 6.0 mg/1) in this segment. Waste loadings found during 1964 and 1965 do not have an appreciable affect on oxygen resources, even at low stream flows.

Algal densities at the one-foot depth were high throughout the entire segment, but were generally highest around Belle Plaine. Here, the density averaged 46,400/ml between April and December of 1964. Their presence in these numbers were generally obvious only upon microscopic examination, due partly to the natural turbidity of the water. At times, however, the water did have a greenish cast. Nutrient levels were well above values considered necessary to produce algal blooms in lakes. (Pools behind dams essentially become lakes at low stream flows). Inorganic nitrogen and phospnate (as PO_4) levels averaged about 1.0 mg/1 and 0.29 mg/1, respectively.

Bottom organism populations were very sparse (usually less than 10 mean numbers per square foot) throughout the entire segment. This was due to the sand and gravel bottom which provided few areas for organisms to attach themselves. The only region of organic sludge deposition was in the five-mile reach immediately below the Green Giant Company at Le Sueur. Pollution sensitive animals were present at most of the stations in this segment, but they generally accounted for less than 50% of the total kinds.

Because of the sparsity of bottom animals, turbid waters, and extreme range of flows there is a poor fish population in the Minnesota River. Of the fish present in this segment, only 15% were game fish. The palatability of fish caught at Mankato and Belle Plaine was also evaluated by a taste panel. Carp and walleye pike found in the vicinity of Mankato were considered in the intermediate range of palatability. Only carp were evaluated at Belle Plaine and they were of slightly lower palatability than those caught at Mankato.

The waters of this segment were considered suitable for use as a source of cooling water, esthetic enjoyment, and maintenance of a clean water associated organism community.

The waters were not suitable for irrigation, stock and wildlife watering, and limited body contact activities (e.g. boating and fishing) because the average coliform density along the entire segment exceeded 5,000 MPN/100 ml. The waters were not suitable for whole body contact activities (e.g. swimming and water skiing) because the turbidity exceeded 25 units and the coliform density exceeded 1,000MPN/100 ml along the entire length.

Chaska to Mouth.

This segment of river receives far greater quantities of wastes than the previous one. Its quality is lowest during late fall and winter while one seasonal industry, the American Crystal Sugar Company is in operation. This segment also receives waste from the municipal sewage treatment plants of Chaska, Shakopee, Savage, Burnsville and Cedar Grove. The M. A. Gedney Co., Rahr Malting Co., Owens-Illinois Glass Co., American Wheaton Glass Co., Cargill, Inc., Twin City Shipyard and Blackdog electric plant also discharge to this segment.

During the period between June and October 1964, while American Crystal Sugar Company was out of operation, the dissolved oxygen profile decreased steadily from Shakopee (river mile 25.0) to the mouth. Above Shakopee the dissolved oxygen concentration ranged from 5.9 to 13.4 mg/1, averaging 9.1 mg/1. Near the mouth, it ranged from 3.1 to 10.7 mg/1, averaging 6.6 mg/1.

Dredge sample of Minnesota River bottom just below American Crystal Sugar Co. outfall containing sugar beet sections.

Turbidity levels in this segment during the summer period were slightly higher than those found in the previous segment, especially near the mouth. The turbidity averaged 70 units at Chaska and 110 units near the mouth. It ranged from 25 to 240 units over the entire segment.

River temperatures exceeded 90°F at times of low stream flow in a one-mile reach immediately below the Blackdog steam-electric generating plant when cooling water was discharged directly to the river. On one occasion the temperature immediately below the point of discharge reached approximately 100°F.

The average total coliform density exceeded 5,000 MPN/100 ml over the entire segment. The density during summer was highest in the vicinity just below Shakopee. At that point (river mile 23.0) the coliform density ranged from 24,000 to 240,000 MPN/100 ml, averaging approximately 80,000 MPN/100 ml. Fecal coliform densities were between 10 and 20 percent of the total densities.

Algal densities and nutrient levels were of the same magnitude as those found in the previous segment. Although algal densities were high, they created no nuisance conditions.

There was a general increase in the number of bottom organisms below Chaska due primarily to the presence of organic sludge deposits. Pollution tolerant sludgeworms comprised the largest portion of the benthic population with as many as 237 and 487 per square foot being found in the fall and winter, respectively. Clean water associated animals were even less abundant in this segment than in the previous one. Game fish made up only 7% of the total fish population.

The palatability of carp caught in this segment immediately above the Blackdog power plant was also evaluated. They had the lowest level of palatability of all the fish assessed in the entire study area.

During the winter, dissolved oxygen levels were much lower and coliform densities were much higher in the lower 27 miles of river as a result of the additional wastes contributed by American Crystal Sugar Company. Ice cover also served to reduce dissolved oxygen levels by preventing reaeration. Except in a short reach of open water immediately below the Blackdog power plant, the dissolved oxygen concentration averaged less than 3 mg/1 along the lower 20 miles of river during a three-day survey in February 1965. Dissolved oxygen concentrations at the mouth varied from 0.0 to 4.0 mg/1, averaging 1.8 mg/1.

Due largely to American Crystal Sugar Company's and Rahr Malting Company's discharges, coliform organisms in the river increased from 220 MPN/100 ml above the American Crystal Sugar outfall to 500,000 MPN/100 ml at a point 4.7 miles below the outfall. The coliform density decreased progressively with distance downstream below this point. Near the mouth, it averaged 9,600 MPN/100 ml.

The waters in this segment below Chaska were unsuitable for irrigation, stock and wildlife watering, navigation, and limited body contact activities because the average coliform density exceeded 5,000 MPN/100 ml.

The minimum dissolved oxygen concentration during the summer was too low below Shakopee and the maximum temperature was too high between river miles 8.4 and 3.0 for the waters to be suitable for the maintenance of game fish. Even if the DO and temperature had been suitable, however, it is very doubtful that game fish would have been present in great numbers because of the limited available food supply.

The waters were usually too turbid to be considered suitable for whole body contact activities (e.g. swimming and water skiing).

During the winter survey this segment was also considered unsuitable for all fish because of extremely low dissolved oxygen levels. In addition, ammonia nitrogen levels exceeded the limit considered suitable for game fish.

To make the waters in this segment suitable for uses such as boating, fishing, stock and wildlife watering, irrigation, and the maintenance of rough fish, the minimum dissolved oxygen level should be maintained above 3 mg/1 and the average coliform density maintained less than 5,000 organisms/100 ml.

ST. CROIX RIVER

Pollution in the St. Croix River is very slight. The water quality was suitable for all uses practiced in all except a few small isolated areas where coliform densities were high. These included the immediate vicinity of municipal waste outfalls belonging to Taylors Falls, St. Croix Falls, Osceola, Stillwater, Bayport, Hudson, and the Andersen Window Company industrial outfalls. The esthetic quality was affected in a few locations along the shoreline where algal blooms had occurred during late summer.

The municipal and industrial waste sources along the St. Croix River do not produce any significant changes in the general water quality even at very low flows. Agricultural and natural pollution, however, contribute nutrients in amounts generally considered sufficient to support nuisance algal blooms. Pollution from boats is sometimes evident in backwater areas, where debris is found occasionally.

To make the waters suitable for body contact activities, at all locations, waste effluents should receive more complete disinfection before being discharged. Better control of natural and agricultural sources is required if nutrient concentrations are to be lowered sufficiently to reduce algal densities in late summer. Greater control of discharges from boats is also required in order to protect the esthetic as well as the bacteriological quality of the waters.

OBSERVATIONS

STATE PROBLEMS

The problem of controlling water pollution is critically important in this urbanized society. The problem is very complex in the variety and depth of interests involved and in the governmental arrangements that exist to do something about it. Much of the authority of water pollution control, however, rests with the State governments. Therefore, progress toward solving the problem will be influenced in a very large measure by the effectiveness of State action.

When a State budget is prepared, water pollution control activities have to compete with other desirable programs for a share of available funds, particularly where it is a subsidiary activity of another agency (such as a Public Health Department). Up to now this has usually resulted in a shortage of funds and staff for most State water pollution control programs. The most serious impact of this shortage is the necessary concentration of available resources to meet urgent critical needs at the expense of comprehensive measures and long-range planning.

In view of the growing pressure that will be exerted on the State pollution control agencies as pollution problems become more intense and the public concern more insistent, there is a great need for a strong, efficient agency in every State with adequate resources in finance, personnel, and technical equipment.

In 1964 the Public Health Service contracted the Public Administration Service, Chicago, Illinois, for a study, the central purpose of which was to develop standards against which State agencies and other interests could gauge the adequacy of personnel complements and budgetary support for State water pollution control programs. Minimum and desirable staffing and budget needs were determined for each State. The needs estimated for Minnesota and Wisconsin (in 1964) are given in the table below along with actual staffing and budget figures. It should be kept in mind that these estimates were prepared in 1964, before the increased emphasis on water pollution control and the establishment of standards of water quality. Also, the estimates were based on salary and expense levels lower than those now prevailing.

COMPARISON OF NEEDED AND ACTUAL STAFFING AND BUDGET ALLOCATIONS
TO STATE WATER POLLUTION CONTROL AGENCIES

STATE	TOTAL STAFFING	AVERAGE SALARY $	TOTAL BUDGET $	TOTAL BUDGET PER CAPITA (CENTS)
Minnesota				
Minimum, 1964	58		530,000	15
Desirable, '64	104	6,849	946,000	27
Actual FY '66	35	---	338,336	
Actual FY '67	35		345,327	
Wisconsin				
Minimum, 1964	71		646,000	16
Desirable, '64	126	6,849	1,145,000	28
Actual FY '66	24	8,094	267,206	
Actual FY '67	81		1,193,832	

The investigators feel that staffing and budget needs for the State water pollution control agencies in the States of Minnesota and Wisconsin should be maintained no lower than the "desirable" level given in the preceding table.

METROPOLITAN PROBLEMS

The complicating factor in the water pollution problem is that water refuses to recognize city, county, or State boundaries. It simply flows downhill. When a city fails to clean up its own wastes, the chief victim is not the city itself but its neighbor downstream; similarly, when the city meets its responsibilities, it is the neighbor who appears to benefit most.

The problem is compounded when the cities within a given metropolitan area attempt to meet their responsibilities on an individual basis. Such an approach results in much duplication of effort, higher unit costs, and no guarantee that a solution will ever be obtained. Certainly, there is very little hope that the optimum solution could ever be achieved under such an approach.

Planning and action to alleviate metropolitan problems of sewage collection, treatment, and disposal can be handled best by a single authority. Through this approach efforts can be coordinated and directed most efficiently toward a set of consistent objectives. This reduces the possibility of one city inadvertently solving its problems at the expense of another. The metropolitan approach can also be economically advantageous since, within limits, the per capita investment for the construction and operation of sewage treatment facilities decreases as the size of the facility increases. Whether the best solution lies in the use of one or several plants is irrelevant; the important point is that all sewage facilities be planned as part of an integrated system encompassing the entire metropolitan area.

In the Minneapolis-St. Paul metropolitan area, there are approximately 80 communities. The two core cities operate a sanitary district created in 1933 to handle wastes from Minneapolis, St. Paul, and those adjacent outside areas which might contract with either of the two cities for sewage disposal. To date, approximately 30 communities have contractual arrangements with them. Plans prepared by the Minneapolis - St. Paul Sanitary District as required by Minnesota law, to eventually serve the remaining communities has met with resistance. The Minnesota Water Pollution Control Commission has approved the engineering aspects of these plans, considering them as an acceptable solution to the metropolitan sewage problem. Many of the suburbs, however, have expressed opposition to the plan, principally its financial aspects. Many of these suburban communities wish to form separate districts while others are providing for their own sewage disposal.

There has been an increasing awareness of the need for coordination in solving the metropolitan area sewage disposal problems on the part of city, county, and State officials, civic leaders, and most State legislators. Many of them have submitted proposals but unfortunately, none have been fully accepted by all the factions involved. Several bills pertaining to the metropolitan problem have been submitted to the legislature in previous sessions. Some passed; others died in committee. Although little progress toward a solution has actually been made, the concern shown by these activities offers a note of optimism.

The investigators feel that all communities within the metropolitan area should unify their positions and press for the establishment of an overall metropolitan sanitary authority. This authority should control all plant operations on a unified basis and provide for the coordination of local policy in the development of a regional water strategy. This authority should, however, fall under the jurisdiction of the Minnesota Water Pollution Control Commission.

CONCLUSIONS

Sewage and industrial wastes discharged to the Mississippi River from Minnesota cause pollution in the interstate waters of the Mississippi River which endangers the health and welfare of persons in Wisconsin and, therefore, is subject to abatement under the provisions of the Federal Water Pollution Control Act.

1. The following sources of waste water discharged to the Mississippi during the period of investigation:

- Anoka Sewage Treatment Plant
- Minneapolis Water Treatment Plants
- NSP Riverside Steam-Electric Generating Plant
- NSP High Bridge Steam-Electric Generating Plant
- Minnesota Harbor Service
- Twin City Shipyard
- Minneapolis-St. Paul Sanitary District Sewage Treatment Plant
- Swift and Company
- Union Stockyards
- Armour and Company
- King Packing Company
- So. St. Paul Sewage Treatment Plant
- Newport Sewage Treatment Plant
- Inver Grove Sewage Treatment Plant
- Northwestern Refining Company
- St. Paul Park Sewage Treatment Plant
- J. L. Shiely Company – Larson Plant
- J. L. Shiely Company – Nelson Plant
- General Dynamics–Liquid Carbonic Division
- St. Paul Ammonia Products Company
- Great Northern Oil Company
- Northwest Cooperative Mills
- Cottage Grove Sewage Treatment Plant
- Minnesota Mining and Manufacturing Company
- Hudson Manufacturing Company
- Hastings Sewage Treatment Plant
- Prescott Sewage Treatment Plant
- S. B. Foot Tanning Company
- Pittsburgh Plate Glass Company
- Red Wing Sewage Treatment Plant
- NSP Red Wing Steam-Electric Generating Plant
- Lake City Sewage Treatment Plant
- Pepin Sewage Treatment Plant

2. The following sources of waste water discharged to the Minnesota River during the period of field investigation:

- Honeymead Products Company
- Mankato Sewage Treatment Plant
- Archer Daniels Midland Company
- Blue Cross Rendering Company
- NSP Wilmarth Power Plant
- Green Giant Company
- City of Henderson
- Minnesota Valley Milk Producers Cooperative Assoc.
- Chaska Sewage Treatment Plant (includes Gedney Co. wastes)
- American Crystal Sugar Company
- Rahr Malting Company
- Shakopee Sewage Treatment Plant
- Owens-Illinois Forest Products
- American Wheaton Glass Company
- Savage Sewage Treatment Plant
- Minnesota Masonic Home
- Cargill, Inc.
- Twin City Shipyard
- Burnsville Sewage Treatment Plant
- NSP Blackdog Power Plant
- Cedar Grove Sewage Treatment Plant

3. The following sources of waste water discharged to the St. Croix River during the period of investigation:

- St. Croix Falls Sewage Treatment Plant
- Taylors Falls Sewage Treatment Plant
- Osceola Sewage Treatment Plant
- Stillwater Sewage Treatment Plant
- Andersen Window Company

Bayport Sewage Treatment Plant
United Refrigerator Company
Hudson Sewage Treatment Plant

4. The discharge of excessive amounts of wastes produced oxygen concentrations below 5 mg/1 in the following stream reaches:

a. Mississippi River between the Minneapolis-St. Paul Sanitary District sewage treatment plant and Lock and Dam No. 3 (39.4 mile reach) during summer of 1964.

b. Mississippi River between the Minneapolis-St. Paul Sanitary District sewage treatment plant and St. Croix River (25.0-mile reach) during the winter of 1964-1965.

c. Minnesota River between Shakopee and its mouth (25.4-mile reach) during the summer of 1964.

d. Minnesota River between Chaska and its mouth (27.7-mile reach) during the winter of 1964-1965.

5. The discharge of excessive amounts of wastes produced oxygen concentrations below 3 mg/1 in the following stream reaches:

a. Mississippi River between the Minneapolis-St. Paul Sanitary District sewage treatment plant and Lock & Dam No. 2 (21.1-mile reach) during the summer of 1964 and the winter of 1964-1965.

b. Minnesota River between Chaska and the mouth (27.7-mile reach) during the winter of 1964-1965.

6. Minnesota River temperatures exceeded 90 and 93°F on occasion in a one-mile reach immediately below the Northern States Power Company's Blackdog steam-electric generating plant.

7. The average turbidity exceeded 25 jackson units in the following stream reaches during the summer of 1964:

a. Mississippi River between the Minnesota River and the head of Lake Pepin (59.0-mile reach).

b. Minnesota River from some point above Mankato (the limit of the study area) to the mouth.

8. Ammonia nitrogen levels exceeded 2.0 mg/1 in the Mississippi River between Lock & Dam No. 2 and the St. Croix River (3.9-mile reach) during the winter of 1964-1965.

9. Ammonia nitrogen levels exceeded 1.0 mg/1 in the following stream reaches:

a. Mississippi River between the Minneapolis-St. Paul Sanitary District sewage treatment plant and Lock & Dam No. 3 (39.4-mile reach) during the period of the survey.

b. Lower 15 miles of the Minnesota River during the winter of 1964-1965.

10. Phenol levels occasionally exceeded 0.01 mg/1 in a 20-mile reach immediately below the Minneapolis - St. Paul Sanitary District sewage treatment plant.

11. The average concentration of the nutrients, inorganic nitrogen and phosphorus, exceeded 0.3 (as N) and 0.03 (as P) mg/1, respectively, throughout the three major streams studied.

12. Average coliform densities exceeded 1,000 MPN/100 ml in the following stream reaches during all surveys:

a. Mississippi River from some point above Anoka (limit of study area) to Lake City.

b. Minnesota River from some point above Mankato (limit of study area) to the mouth.

13. Average coliform densities exceeded 5,000 MPN/100 ml in the following stream reaches during all surveys:

a. Mississippi River between St. Anthony Falls and the head of Lake Pepin (70-mile reach).

b. Minnesota River between the Blue Earth River at Mankato and the mouth (109.2-mile reach).

14. Pathogenic bacteria and enteric viruses were present in the following stream reaches:

a. Mississippi River between St. Paul and Grey Cloud Island (10 miles below the Minneapolis - St. Paul Sanitary District Plant).

b. Mississippi River immediately below Red Wing sewage treatment plant.

15. Algae reached nuisance proportions in the following locations:

a. Mississippi River's Lake Pepin in shallow areas along the shorelines.

b. St. Croix River's Lake St. Croix in shallow areas along the shorelines.

16. Bottom sediment consisted of a mixture of organic sludge and sand in the following stream reaches during 1964:

a. Mississippi River between Lock & Dam No. 1 and the Minneapolis-St. Paul Sanitary District sewage treatment plant (11.3-mile reach).

b. Mississippi River between Lock & Dam No. 2 and the head of Lake Pepin (30-mile reach).

c. Minnesota River along a five-mile reach immediately below the Green Giant Company (at LeSueur).

d. Minnesota River between American Crystal Sugar Company (at Chaska) and the mouth (27.7-mile reach).

e. All of Lake St. Croix (lower 23 miles of the St. Croix River).

17. Bottom sediment consisted almost solely of organic sludge in the following stream reaches during 1964:

a. Mississippi River between the Minneapolis-St. Paul Sanitary District sewage treatment plant and Lock & Dam No. 2 (21.1 mile reach).

b. All of Lake Pepin (lower 22 miles of Mississippi River under study).

18. Fish caught in the lower 10 miles of the Minnesota River and in the segment of Mississippi River between South St. Paul and the St. Croix River had lower levels of palatability than fish caught elsewhere in the study area.

RECOMMENDATIONS

GENERAL

River water quality shall be preserved or upgraded, as required, to permit maximum use and full recreational enjoyment of the waters. Remedial measures necessary to attain this goal are given in the recommendations. The recommendations are given in two groups: General and specific. General recommendations cover the broad objectives of pollution abatement in the Project area. Specific recommendations are given for the solution of particular problems and are offered in addition to, not in place of, the general recommendations.

These recommendations represent the initial phase of a long-range and more comprehensive water resource development program for the entire Upper Mississippi River Basin. They apply to problems needing immediate correction.

Although fertilization of the rivers and backwater areas is undesirable, no recommendations are made at this time concerning the installation of specialized treatment facilities designed to reduce nitrogen and phosphorus compounds in the waste effluents. Operation of treatment facilities so as to optimize nutrient removal will reduce the problem.

RIVER SEGMENT		(MAXIMUM OR MINIMUM CONCENTRATIONS FOR ANY ONE SAMPLE)	
FROM (RIVER MILE)	TO (RIVER MILE)	DO (Min.) mg/1	COLIFORM GUIDE (Maximum)[1]
Mississippi River			
871.6 (Anoka)	836.3 (MSSD)	No deterioration in present level (>5 mg/1)	A&C[2]
836.3 (MSSD)	815.2 (L&D No. 2)	3	B
815.2 (L&D No. 2)	763.5 (Chippewa River)	5	A
Minnesota River			
109.2 (Mankato)	30.0 (Chaska)	No deterioration in present level (>5 mg/1)	B
30.0 (Chaska)	0.0 (Mouth)	3	B
St. Croix River			
52.0 (Taylors Falls)	0.0 (Mouth)	No deterioration in present level (>5 mg/1)	A&C

[1]See following pages for explanation of Coliform Guide.
[2]Coliform Guide C applies to the segment between Anoka and St. Anthony Falls, only.

MUNICIPALITIES, INSTITUTIONS, AND INDUSTRIES

General Recommendations

It is recommended that:

Protection of Existing Water Quality

1. There be no further decrease in quality of any of the waters within the Study Area (Mississippi River between Anoka, Minnesota and the outlet of Lake Pepin; Minnesota River in and below Mankato, Minnesota; and St. Croix River in and below St. Croix Falls, Wisconsin.)

Enhancement of Water Quality

2. Water quality be enhanced as stipulated in the remaining recommendations to provide the following dissolved oxygen and coliform levels in the given segments of the Mississippi, Minnesota, and St. Croix Rivers during flows equal to or greater than the 7-consecutive-day, once in 10-year summer and winter low flows.
(Refer to Table on page 26).

(1) Coliform Guides

Coliform Guide A – Recreational whole body use. The water uses for which this guide is intended are those that entail total and intimate contact of the whole body with the water. Examples of such use are swimming, skin diving, and water skiing, in which the body is totally immersed and some ingestion of the water may be expected. The recommended guide value for coliforms is 1,000 per 100 milliliters (1,000/100 ml). For all waters in which coliform levels are below the guide value of 1,000/100 ml, the water is considered suitable provided there is proper isolation from direct fecal contamination as determined by a sanitary survey. Situations may arise wherein waters having coliform counts somewhat higher than the guide value can be used, provided supplemental techniques are used to determine safe bacterial quality. The analysis for fecal streptococci is more definitive for determining the presence of organisms of intestinal origin, and is suggested as the supplemental technique to be employed. A coliform level of 5,000/100 ml is considered satisfactory, provided the fecal streptococcus count is not more than 20/100 ml, and provided also that there is proper isolation from direct fecal contamination as determined by a sanitary survey.

The waters designated for whole body contact use should be maintained acceptable for this use at least between May and October, inclusive. During the remainder of the year when the weather is unsuitable for whole body contact activities, these waters should conform to Coliform Guide B.

Coliform Guide B – Recreational, limited body contact use and commercial shipping (barge traffic). The water uses for which this guide is intended are those that entail limited contact between the water user and the water. Examples of such uses are fishing, pleasure boating, and commercial shipping. Recommended guide value for coliforms is 5,000/100 ml. For all waters in which coliform levels are below this guide value, the water is considered suitable for use, provided there is proper isolation from direct fecal contamination as determined by a sanitary survey.

Coliform Guide C – Applies to municipal water source. Where municipal water treatment includes complete rapid-sand filtration or its equivalent, together with continuous post-chlorination, source water may be considered acceptable if the coliform concentration (at the intake) averages not more than 4,000/100 ml.

If the foregoing water quality is assured, then the water will be suitable for the following uses in each of the given river segments.

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WATER USE	RIVER SEGMENT
a. Source of municipal water supply	Mississippi River: Anoka – St. Anthony Falls St. Croix River: Taylors Falls – Mouth
b. Maintenance of habitat for Group I[3] fish	Mississippi River: Anoka – MSSD L&D No. 2 – Chippewa River Minnesota River: Mankato – Chaska St. Croix River: Taylors Falls – Mouth
c. Whole body contact recreational activities	Mississippi River: Anoka – Minnesota River L&D No. 2 – Chippewa River St. Croix River: Taylors Falls – Mouth
d. Maintenance of habitat for Group II[4] fish	All portions of three major streams
e. Irrigation	All portions of three major streams
f. Stock and wildlife watering	All portions of three major streams
g. Limited body contact recreational activities	All portions of three major streams
h. Source of non-potable industrial process water	All portions of three major streams
i. Source of cooling water	All portions of three major streams
j. Commercial fishing	All portions of three major streams
k. Navigation	All portions of three major streams
l. Hydroelectric power generation	All portions of three major streams
m. Esthetic enjoyment	All portions of three major streams

[3 & 4] See following for explanation of Group I and Group II fish.

(3) **Group I Fish** – Are those generally sought after by sport fishermen and include but are not limited to the following species: Walleyed Pike, Sauger, Northern Pike, Black Crappie, White Crappie, Largemouth Bass, Smallmouth Bass, Rock Bass, White Bass, Bluegill, Channel Catfish, Sturgeon, Flathead Catfish, Green Sunfish, Pumpkinseed Sunfish, and Brown Trout.

(4) **Group II Fish** – Are those generally sought after by commercial fishermen in this area and include but are not limited to the following species: Carp, Quillback, Sheepshead, Brown Bullhead, Bigmouth Buffalo, Northern Carp-sucker, Northern Redhorse, Longnose Gar, Shortnose Gar, Bowfin, Mooneye, Gizzard Shad, Common Sucker, Spotted Sucker, Yellow Bullhead, Black Bullhead, Golden Shiner, Perch, and River Sucker.

Treatment of Municipal Wastes

3. All municipalities and other institutions discharging sewage to the rivers under investigation provide at least secondary biological treatment plus continuous disinfection of the effluent. This treatment is to produce an effluent containing no more than:

a. 20 percent of the mass of 5-day (20°C) BOD originally contained in the influent.

b. 20 percent of the mass of suspended solids originally contained in the influent.

c. 5,000 coliforms/100 ml (except where "d" applies).

d. 1,000 coliforms/100 ml between May and October, inclusive, where receiving waters are used for whole body contact activities (see preceding list).

These limits are to be followed except where more stringent ones are given in the specific recommendations or are required by State Water Pollution Control agencies.

Reports by Municipal Treatment Plants

4. Municipal waste treatment plants maintain at least the minimum laboratory control and records as recommended by the Conference of State Sanitary Engineers at their 38th Annual Meeting in 1963 (See Appendix). In addition, all plants should maintain a record of chlorine feed rates and those plants of 2 million gallons/day capacity, or greater, should provide analyses for total and fecal coliforms on a once per week basis. Results of laboratory tests and other pertinent records should be summarized monthly and submitted to the appropriate State agency for review and evaluation. These records are to be maintained in open files of the State agency for use by all persons with a legitimate interest.

Phosphate Removal

5. New waste treatment facilities be designed to provide adequate capacity of individual units and components as well as maximum flexibility in order to permit later modification in operating procedures so as to effect the greatest amount of phosphate removal. Existing plant facilities should be operated so as to optimize phosphate removal.

Monitoring of Water Quality

6. The States of Minnesota and Wisconsin establish a program of monitoring and surveillance in area waters for evaluating progress in improvement of stream quality resulting from implementation of actions recommended by the conferees. The FWPCA should establish monitoring stations where appropriate on portions of the Mississippi and Minnesota Rivers within the State of Minnesota to aid in the evaluation. Water quality surveillance activities should be coordinated and all information made available to the States, the FWPCA, and other parties with a legitimate interest.

Bypassing and Spilling of Wastes

7. All present and future sewerage and sewage treatment facilities be modified or designed and operated to eliminate bypassing of untreated wastes during normal maintenance and renovation operations. The appropriate State agency (Minnesota Water Pollution Control Commission or Wisconsin Department of Resource Development) is to be contacted for approval prior to any expected bypassing of waste. All accidental or emergency bypassing or spillage should be reported immediately.

Pretreatment of Wastes

8. Wastes (such as sludge from the St. Paul water treatment plant) which discharge into a municipal sewerage system be pretreated to avoid any detrimental effect on waste treatment operation.

Protection Against Spillage

9. Programs be developed by those responsible for the facilities to prevent or minimize the adverse effect of accidental spills of oils, gases, fuels, and other material capable of causing pollution. The elements of such programs should include:

a. Engineering works such as catchment areas, relief vessels, and dikes to trap spillage.

b. Removal of all apilled materials in a manner acceptable to the regulatory agencies.

c. Immediate reporting (by those responsible for the facilities) of any spills to the appropriate State agency.

d. In-plant surveys and programs to prevent accidental spills.

Combination Storm and Sanitary Sewers

10. Combined storm and sanitary sewers be prohibited in all newly developed areas and be eliminated in existing areas wherever opportunity to do so is afforded by redevelopment. Present combined sewers should be continuously patrolled and operated so as to convey the maximum possible amount of combined flows to and through the waste treatment plant. In addition, studies to develop effective control of wastes from this source should be continued by the MSSD and should be initiated by the City of South St. Paul. Although the immediate problem is a bacterial one, both studies should also consider the discharge of BOD and solids. Methods to be used to control wastes from combined sewers and a time schedule for their accomplishment should be reported to the conferees within two years after issuance of the Conference Summary.

Treatment of Industrial Wastes

11. All industries discharging wastes to the rivers under investigation, unless otherwise specified, provide treatment sufficient to produce an effluent containing no more than 20 percent of the mass of 5-day (20°C) BOD and suspended solids originally contained in the untreated process waste. Settleable solids and coliforms in the effluent are not to exceed the following:

a. Settleable solids – 5 ml/1

b. Coliforms – 5,000/100 ml (except where "c" applies)

c. Coliforms – 1,000/100 ml between May and October, inclusive, where receiving waters are used for whole body contact activities (see preceding list).

Reporting of Industrial Wastes

12. Industries discharging wastes to the waters maintain operating records containing information on waste discharge rates and concentrations of constituents found in significant quantities in their wastes.

This information should be summarized and submitted to the appropriate State agency at monthly intervals for review and evaluation. These records are to be maintained in open files of the State agency for use by all persons with a legitimate interest.

Vessel Wastes

13. All watercraft provide adequate treatment on board or arrange for suitable on-shore disposal of all liquid and solid wastes.

Garbage and Refuse Dumps

14. Garbage or refuse not be dumped along the banks of the river and no open dumps be allowed on the flood plain. Material in present dump sites along the river banks should be removed and the appearance of the bank restored to an esthetically acceptable condition. Present open dumps on the flood plain should be converted to sanitary landfills operated acceptably to the appropriate State agencies.

Upstream Bacterial Control

15. Waste sources upstream from and outside of the study area on the Mississippi, Minnesota, and St. Croix Rivers and their tributaries be sufficiently controlled so that waters entering the study area conform to General Recommendation No. 2.

Specific Recommendations - Mississippi River

Specific recommendations are offered in addition to, and not in place of, the general recommendations.

Municipal Sources

It is recommended that:

MSSD to South St. Paul – Maximum BOD and Suspended Solids Loadings

1. Maximum waste loadings from all sources between and including the Minneapolis-St. Paul Sanitary District and the South St. Paul Sewage Treatment Plants be such that a minimum dissolved oxygen content of 3.0 mg/1 can be maintained during the 7-consecutive-day, once in 10-year low summer flow in the reach of river between Mississippi River miles 836.4 and 815.2. To attain this, combined wastes loads from these sources should not exceed 68,500 pounds/day of 5-day (20°C) BOD, exclusive of combined sewer overflows. Suspended solids loadings discharged to this reach (exclusive of combined sewer overflows) should not exceed 85,500 pounds/day in order to minimize sludge deposits.

Maximum Phenolic Loadings

2. Maximum loadings of phenolic wastes from the Minneapolis-St. Paul Sanitary District sewage treatment plant, Northwestern Refining Co., Great Northern Oil Co., and Minnesota Mining and Manufacturing Co., all combined, not exceed 110 pounds/day in order to maintain the stream concentration of this material under 0.01 mg/1 at stream flows equal to or greater than the 7-consecutive-day, once in 10-year low flow.

Bypassing at MSSD

3. An engineering study of the Minneapolis-St. Paul Sanitary District sewerage system be undertaken to determine what changes are required to make unnecessary the practice of bypassing wastes periodically for the purpose of cleaning the inverted siphon under the Mississippi River.

Hastings Plant

4. The BOD removal efficiency at the Hastings, Minnesota primary sewage treatment plant be increased from the 5 percent figure found during the survey to a minimum of 30 percent until secondary biological treatment facilities are in operation.

Industrial Sources

It is recommended that:

Water Treatment Plants of the City of Minneapolis

1. Treatment facilities be provided capable of producing an effluent with a suspended solids concentration not exceeding that found in other treated effluents being discharged to the same reach of river. At no time should the daily average suspended solids concentration exceed 50 mg/1.

The two water treatment plants of the City of Minneapolis discharge sand filter backwash water to the river without prior treatment. Together the two plants discharge approximately 0.69 mgd of backwash water having an average suspended solids concentration of 1,900 mg/1.

Swift & Co., Armour & Co., and So. St. Paul Union Stockyards

2. The industries in the South St. Paul area (Swift & Company, Armour & Company, and the St. Paul Union Stockyards) provide an effective method of control and correction of direct discharges to the Mississippi River. These include so-called clean waste waters, watering trough overflows, truck washing wastes, surface drainage, and hog pen flushings. The coliform densities of any of these discharges should not exceed 5,000/100 ml once the control devices are in operation.

Northwest Cooperative Mills

3. Additional treatment be provided to reduce the suspended solids concentrations of the compositing pond effluent to substantially the same levels found in other effluents being discharged to the same reach of river after satisfactory treatment. In no instance should the daily average suspended solids concentration exceed 50 mg/1.

The discharge from the compositing pond averages 46,000 gallons/day (gpd) and contains about 420 mg/1 of suspended solids.

Foot Tanning Company

4. Any additional facilities constructed for the company's waste produce an effluent of a quality acceptable to the Minnesota Water Pollution Control Commission (MWPCC) and in conformity with recommendations in this report. The possibility of discharging the settled waste to the Red Wing sewerage system in lieu of additional treatment should be considered and a report on the conclusions of such questions submitted to the MWPCC.

On April 1, 1966 the company submitted to the MWPCC plans and specifications for a primary clarifier and a study plan for evaluating secondary treatment methods.

Specific Recommendations - Minnesota River

Municipal Sources

No specific recommendations.

Industrial Sources

It is recommended that:

Green Giant Company

1. An additional pump be provided for standby purposes at the waste water sump for use when the main pump fails. The sanitary and miscellaneous process wastes should be handled as specified by General Recommendations 3 and 11.

This company had pump failures at the waste water collection sump where process waste is collected and pumped to ridge and furrow fields. When pump failure occurs, the waste is discharged directly to the river. Some sanitary and miscellaneous process wastes are discharged directly to the river without treatment as a normal practice

American Crystal Sugar Co. and Rahr Malting Co. Maximum BOD and Suspended Solids Loadings

2. Maximum waste loadings from all sources between and including the American Crystal Sugar Co. and the Rahr Malting Co. be such that a minimum dissolved oxygen content of 3.0 mg/1 can be maintained during the 7-consecutive-day, once in 10-year low winter flow in the reach of river between Minnesota River miles 29 and 0. To attain this, combined waste loads from these sources should not exceed 12,000 pounds/day of 5-day (20°C) BOD during winter when there is no ice cover in the vicinity of the Blackdog power plant. At times of complete ice cover, the maximum waste loading of 5-day (20°C) BOD from these sources should not exceed 6,500 pounds/day. In no case, however, should treatment efficiency be less than that specified in the General Recommendations.

Northern States Power Company Blackdog Plant

3. A water temperature of not greater than 90°F be maintained in the lower Minnesota River. To attain this, the existing cooling pond should be utilized to its fullest extent during the summer at stream flows less than 1500 cfs. During these periods the thermal addition to the Minnesota River should not exceed 13.5 billion BTU/day.

Specific Recommendations - St. Croix River

Municipal Sources

No specific recommendations.

Industrial Sources

No specific recommendations.

FEDERAL INSTALLATIONS

Federal installations contribute less than 0.1 percent of the pollution entering the three major streams studied. Although their contributions are small, full consideration is still given to Federal installations, in compliance with Section 11 of the Federal Water Pollution Control Act as amended (33 U.S.C. 466 et seq.)

U. S. Army - Nike Missile Installations

General Recommendations

It is recommended that:

1. A minimum of one hour per day be devoted to proper treatment, plant operation and maintenance.

2. The treatment facilities be operated such that removal efficiencies approach those for which the plants were designed.

3. Laboratory analyses and records maintenance consistent with recommendations of the Conference of State Sanitary Engineers for plants of 0.25 mgd capacity be carried out. A report of these functions, including results of analyses, are to be furnished to the Federal Water Pollution Control Administration upon request.

Specific Recommendations

Nike Site No. 20, Roberts, Wisconsin

No specific recommendations.

Nike Site No. 40, Farmington, Minnesota

It is recommended that:

1. Discharge of effluent to the roadside ditch be terminated as soon as possible. The present outfall sewer line should be extended so as to discharge the effluent into the unnamed creek which at present ultimately receives the waste.

2. Continuous chlorination facilities be activated immediately with disinfection sufficient to produce a free chlorine residual of 0.5 mg/1 after a 15 minute contact at peak flow rates.

Nike Site No. 70, St. Bonifacius, Minnesota

No specific recommendations.

Nike Site No. 90, Bethel, Minnesota

It is recommended that continuous chlorination facilities be activated immediately with disinfection sufficient to produce a free chlorine residual of 0.5 mg/1 after a 15 minute contact at peak flow rates.

U. S. Air Force - Air Defense Command

Osceola, Wisconsin Station

It is recommended that a schedule of maintenance practices be instituted consistent with accepted procedures for operation of oxidation ponds so as to insure satisfactory treatment.

U. S. Army Corps of Engineers

Locks and Dams

It is recommended that:

1. Present plans be continued concerning improvement or replacement of inadequately sized treatment facilities.

2. At stream flows of 7,000 cubic feet per second (cfs) or less (as measured at the St. Paul gage), as much water as possible be passed over bulkheads before the Taintor gates at Lock & Dam No. 2. At flows of 3,000 cfs or less, the equivalent of the inflow to Pool No. 2 should be passed over the bulkheads.

Floating Dredge Thompson

It is recommended that a planned schedule of analyses be continued on effluent from the waste treatment facilities so as to insure adequate removals prior to overboard discharge of effluent.

U. S. Air Force - 934th Troop Carrier Group

Officers Club

It is recommended that the present single compartment septic tank be changed to a two compartment tank. A subsurface tile field of adequate size should be installed to supplement the present field.

SCHEDULE FOR REMEDIAL PROGRAM

MUNICIPALITIES, INSTITUTIONS, AND INDUSTRIES

In light of the excellent progress the MWPCC has made in making various industrial firms and municipalities aware of the need for abatement facilities, the following time schedule for the foregoing remedial program is recommended. The time periods given commence with the issuance of the *Conference Summary by the Secretary of the* Interior.

a. Submission of preliminary plans for remedial facilities within 6 months.

b. Submission of final design for remedial facilities within 12 months.

c. Financing arrangements for municipalities completed and construction started within 18 months.

d. Construction completed and plants placed into operation within 36 months.

e. Existing schedules of the State agencies calling for earlier completion dates are to be met.

FEDERAL INSTALLATIONS

Schedules for Federal installations requiring only operational and maintenance changes shall be initiated immediately. Changes required at Nike Site No. 40 and the Ft. Snelling Officers Club should be completed and made operational within 6 months.

SCHEDULE MODIFICATIONS

It is recognized that modifications in this schedule may be necessary. These may include:

a. A lesser time where the control agency having jurisdiction considers that a practical method of control can be in operation prior to the time stated.

b. In a few industries and municipalities some variation from this schedule may be sought from the appropriate State and local pollution control agencies. In such cases after review the conferees may make appropriate recommendations to the Secretary of the Department of the Interior.

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APPENDIX

TABLE 1

SUMMARY OF FEDERAL INSTALLATIONS

FACILITY	TYPE OF TREATMENT	FINAL DISPOSAL
U.S. Air Force		
Osceola Air Force Station	Secondary	Ground
934th Troop Carrier Group Officers Club	Primary	Marsh area near Minnesota River
U.S. Army Corps of Engineers		
Upper St. Anthony Falls	Primary	Ground
Lower St. Anthony Falls	Primary	Ground
Lock & Dam No. 1	Primary	Ground
Lock & Dam No. 2	Primary	Ground
Lock & Dam No. 3	Primary	Ground
U.S. Army		
Nike Site No. 90		
Administration Site	Secondary	Tributary to Rum River
Launch Site	Primary	Ground
Dog Kennels	Primary	Ground
Nike Site No. 70		
Administration Site	Secondary	Slough
Launch Site	Primary	Ground
Dog Kennels	Primary	Ground
Nike Site No. 40		
Administration-Launch Site	Secondary	Unnamed Creek
Radar Control Site	Primary	Ground
Dog Kennels	Primary	Ground
Nike Site No. 20		
Administration Site	Secondary	Pond
Launch Site	Primary	Ground
Dog Kennels	Primary	Ground
Twin Cities Army Ammunition Plant		
Cooling & Storm Water	None	Round Lake (Company Owned)
Zeolite Softener Backwash Water	None	Rice Creek (Tributary on Mississippi River)
Other Wastes	(to municipal system)	

TABLE 2

SUMMARY OF DOMESTIC WASTE CHARACTERISTICS

SOURCE	RIVER MILE	AVG. FLOW RATE MGD	POPULATION SERVED	TYPE OF TREATMENT: PRI-MARY	SEC-ONDARY	TER-TIARY	CONT. Cl_2	SUMMER Cl_2	INFLUENT	EFFLUENT	AVERAGE CONSTITUENT CONCENTRATIONS: 5-DAY BOD mg/1	COD mg/1	SUSPENDED SOLIDS: TOTAL, mg/1	VOLATILE, mg/1	NITROGEN: TOTAL, mg/1	NO_3 mg/1	TOTAL PHOSPHATE mg/1	COLIFORM DENSITY (DURING SUMMER): TOTAL MPN	FECAL MPN	REMOVAL EFFICIENCY PERCENT: BOD	TOTAL SUSPENDED SOLIDS
MISSISSIPPI RIVER																					
Anoka STP[1]	871.5	0.96	9,500		x		x		x		259	455	238	223	-	-	-	9.4×10^7	4.3×10^7	93	81
										x	19	164	46	33	30.5	0.7	24.7	$>2.7 \times 10^5$	$>2.6 \times 10^5$		
Mpls.-St. Paul San. Dist. STP[2]	836.3	188.6	1,200,000	x					x		251	585	316	226	24.7	-	13.8	-	-	31	66
										x	174	378	107	81	22.2	-	13.5	$>1.6 \times 10^7$	4.3×10^6		
So. St. Paul STP[2]	832.4	14.2	25,000		x				x		1,298	-	855	750	-	-	-	-	-	79	89
										x	272	-	92	70	44.5	-	19.1	3.9×10^6	2.5×10^6		
Newport STP[1]	831.0	0.058	800		x			x	x		157	161	117	95	-	-	-	1.12×10^7	3.03×10^6	91	71
										x	14	78	34	25	4.6	16.4	22.6	5.5×10^4	9.5×10^3		
Inver Grove STP	830.3	0.020	230		x		x				(Effluent seeps into ground before reaching River)									-	-
St. Paul Park STP	829.0	0.35	5,100		x				x		217	368	190	168	-	-	-	8.1×10^7	1.4×10^7	72	67
										x	61	216	61	46	38.2	0.5	40.2	8.7×10^6	2.8×10^6		
Cottage Grove STP[1]	819.6	0.425	6,500		x		x		x		240	535	196	162	-	-	-	8.2×10^6	2.3×10^6	77	72
										x	56	210	55	51	39.5	<1	54.2	4.2×10^6	1.3×10^6		
Hastings STP	813.8	0.80	8,070	x					x		>188	307	205	176	-	-	-	9.2×10^7	4.1×10^7	>5	42
										x	180	348	118	99	24.8	1.2	30.0	6.6×10^7	2.0×10^7		
Prescott STP[1]	809.8	0.135	1,350	x				x	x		366	672	316	248	-	-	-	1.6×10^8	2.5×10^7	33	58
										x	246	354	133	86	47.0	1.8	38.8	2.1×10^7	5.0×10^6		
Red Wing STP	790.2	2.2	11,000		x				x		232	409	256	209	-	-	-	3.3×10^7	1.3×10^7	66	81
										x	78	144	48	12	7.9	3.6	23.0	2.0×10^6	4.4×10^5		
Lake City STP[1]	772.6	0.26	3,150	x				x	x		223	499	203	172	-	-	-	6.3×10^7	4.9×10^7	53	60
										x	94	250	81	67	35.8	0.5	25.8	2.3×10^7	1.6×10^7		
Pepin STP	767.2	0.054	900	x					x		508	684	255	213	-	-	-	2.3×10^8	7.1×10^7	40	38
										x	303	594	157	133	62.6	0.8	74.4	1.1×10^7	5.5×10^6		

1. Coliform densities were measured while chlorination facilities were operating.
2. Also receives industrial wastes.
3. Coliform densities were measured while the plant was not chlorinating.

TABLE 2 (Continued)

SUMMARY OF DOMESTIC WASTE CHARACTERISTICS

SOURCE	RIVER MILE	AVG. FLOW RATE MGD	POPULATION SERVED	PRI-MARY	SEC-ONDARY	TER-TIARY	CONT. Cl_2	SUMMER Cl_2	INFLUENT	EFFLUENT	AVERAGE CONSTITUENT CONCENTRATIONS: 5-DAY BOD mg/1	COD mg/1	SUSPENDED SOLIDS: TOTAL, mg/1	SUSPENDED SOLIDS: VOLATILE, mg/1	NITROGEN: TOTAL, mg/1	NITROGEN: NO_3 mg/1	TOTAL PHOSPHATE mg/1	COLIFORM DENSITY (DURING SUMMER): TOTAL MPN	COLIFORM DENSITY (DURING SUMMER): FECAL MPN	REMOVAL EFFICIENCY PERCENT: BOD	REMOVAL EFFICIENCY PERCENT: TOTAL SUSPENDED SOLIDS
MINNESOTA RIVER																					
Mankato STP[1,2]	106.5	4.54	21,480	x			x		x		139	258	130	105	-	-		6.82×10^7	7.4×10^6	<32	45
										x	96	227	71	55	15.1	1.3	7.1	3.9×10^6	9.0×10^5		
Henderson	70.0	0.04	500		NONE															0	0
Chaska STP[2]	29.4	0.46	2,300		x				x		686	-	286	241	-	-	-	$>2.2 \times 10^7$	$>5.9 \times 10^6$	94	49
										x	41	-	145	87	15.3	0.2	12.3	1.34×10^7	$<4.0 \times 10^6$		
Shakopee STP[3]	23.9	0.31	4,700	x				x	x		204	380	224	184	-	-	-	3.60×10^7	1.82×10^7	42	60
										x	118	276	90	85	35.0	0.8	32.1	2.55×10^7	1.53×10^7		
Savage STP[1]	14.4	0.22	1,700		x		x		x		>127	263	89	72	-	-	-	1.7×10^7	4.2×10^6	91	73
										x	> 11	85	24	14	12.8	2.4	12.5	6.7×10^4	3.4×10^4		
Burnsville STP[1]	10.5	0 51	4,400		x		x		x		>122	260	288	135	-	-	-	1.0×10^7	3.3×10^6	>92	83
										x	10	71	48	35	17.7	0.6	19.8	4.8×10^5	1.4×10^5		
Cedar Grove STP[1]	7.3	0.09	2,200		x		x		x		303	521	311	253	-	-	-	2.7×10^7	8.7×10^6	93	81
										x	21	149	59	45	21.0	0.8	31.6	3.5×10^5	1.1×10^5		
ST. CROIX RIVER																					
St. Croix Falls STP	51.9	0.18	1,100		x			x	x		181		184	96	-	-	-	-	-	46	48
										x	55		64	52	18.6	0.1	-	-	-		
Taylors Falls STP[1]	51.8	0.070	500		x			x	x		122	198	115	98	-	-		1.4×10^7	5.7×10^6	83	67
										x	20	94	38	32	9.5	3.7	16.9	7.4×10^5	1.7×10^5		
Osceola STP[1]	44.3	0.097	930	x				x	x		240	460	252	202	-	-		1.8×10^6	1.0×10^6	40	62
										x	144	301	95	76	36.7	0.6	28.7	1.2×10^6	5.8×10^5		
Stillwater STP[1,2]	21.2	1.79	7,480	x				x	x		180	275	105	95				$>3.9 \times 10^7$	3.54×10^7	53	32
										x	84	174	71	52	15.9	0.6	17.7	1.3×10^6	1.3×10^6		
Bayport STP[1]	19.4	0.40	3,000		x		x		x		247	320	178	103				6.3×10^6	3.1×10^6	96	96
										x	9	43	8	6	9.4	4.3	15.9	1.0×10^6	5.5×10^5		
Hudson STP	16.3	0.56	5,000		x			x	x		130	-	212	184	-	-	-	-	-	82	87
										x	23.1	-	28	26	18.1	6.8	-	-	-		

1. Coliform densities were measured while chlorination facilities were operating.
2. Also receives industrial wastes.
3. Coliform densities were measured while the plant was not chlorinating.

TABLE 3

SUMMARY OF DOMESTIC WASTE LOADING RATES TO STREAMS

SOURCE	RIVER MILE	AVG. FLOW RATE MGD	AMOUNT OF GIVEN CONSTITUENT DISCHARGED							
			5-DAY BOD lb./day	Suspended Solids		Nitrogen		Total Phosphate lb./day	Coliforms	
				Total lb./day	Volatile lb./day	Total lb./day	NO_3 lb./day		Total No./day	Fecal No./day
MISSISSIPPI RIVER										
Anoka STP	871.5	0.96	150	365	265	245	6	195	$>1.0 \times 10^{13}$	$>9.5 \times 10^{12}$
Mpls-St. P.San. Dist.	836.3	188.6	268,000	170,000	126,000	35,600	-	20,800	$>1.1 \times 10^{17}$	3.1×10^{16}
So. St. Paul STP	832.4	14.2	32,200	10,900	8,270	5,200	-	2,300	2.1×10^{15}	1.3×10^{15}
Newport STP	831.0	0.058	7	16	12	2	8	10	5.9×10^{12}	1.2×10^{11}
Inver Grove STP	830.3	0.020	(Effluent seeps into ground before reaching River)							
St. Paul Park STP	829.0	0.35	175	180	135	110	2	155	1.1×10^{14}	3.7×10^{13}
Cottage Grove STP	819.6	0.42	195	195	180	140	-	190	6.8×10^{13}	2.1×10^{13}
Hastings STP	813.8	0.80	1,190	790	660	165	8	200	2.0×10^{15}	6.1×10^{14}
Prescott STP	809.8	0.135	280	150	95	50	2	45	1.1×10^{14}	2.6×10^{13}
Red Wing STP	790.2	2.20	1,430	880	220	145	65	420	1.7×10^{14}	3.7×10^{13}
Lake City STP	772.6	0.26	205	175	145	75	1	55	2.3×10^{14}	2.3×10^{14}
Pepin STP	767.2	0.054	135	70	60	90	<1	5	2.2×10^{13}	1.1×10^{13}
MINNESOTA RIVER										
Mankato STP	106.5	4.54	3,560	2,680	2,080	570	50	270	6.7×10^{14}	1.5×10^{14}
Henderson	70.0	0.04	85 (Est)	100(Est)	65(Est)	15(Est.)		15(Est.)	2.0×10^{14}(Est)	
Chaska STP	29.4	0.46	160	560	470	60	1	45	2.3×10^{14}	6.9×10^{13}
Shakopee STP	23.9	0.31	305	235	220	90	2	85	3.0×10^{14}	1.8×10^{14}
Savage STP	14.4	0.22	>20	45	25	25	4	25	5.6×10^{11}	2.8×10^{11}
Burnsville STP	10.5	0.51	40	205	150	75	3	85	9.3×10^{12}	2.7×10^{12}
Cedar Grove STP	7.3	0.09	15	45	35	15	1	25	1.2×10^{12}	3.8×10^{11}
ST. CROIX RIVER										
St. Croix Falls STP	51.9	0.18	85	100	80	30	<1	40(Est.)	-	-
Taylors Falls STP	51.8	0.070	10	20	20	5	2	10	2.0×10^{12}	4.5×10^{11}
Osceola STP	44.3	0.097	115	75	60	30	<1	25	3.3×10^{13}	1.7×10^{13}
Stillwater STP	21.2	1.79	1,250	1,060	775	235	9	265	8.8×10^{13}	8.8×10^{13}
Bayport STP	19.4	0.40	30	25	20	30	15	55	1.5×10^{13}	8.3×10^{12}
Hudson STP	16.3	0.56	110	130	120	85	30	100(Est.)	-	-

TABLE 4

SUMMARY OF INDUSTRIAL WASTES CHARACTERISTICS

INDUSTRIAL WASTE SOURCE	RIVER MILE	AVG. FLOW RATE MGD	TYPE OF TREATMENT	AVERAGE CONSTITUENT CONCENTRATIONS																						
				pH mg/l	Alka-linity mg/l	5-Day BOD mg/l	COD mg/l	SOLIDS TOTAL mg/l	SOLIDS VOLA-TILE mg/l	SOLIDS TOTAL SUSP. mg/l	SOLIDS VOL. SUSP. mg/l	SOLIDS SETT. mg/l	NITROGENS ORGA-NIC mg/l	NITROGENS AMMO-NIA mg/l	NITROGENS NO_3 mg/l	PHOSPHATES TOTAL mg/l	PHOSPHATES ORTHO mg/l	CHLO-RIDE mg/l	FLUO-RIDE mg/l	SUL-FATE mg/l	OIL & GREASE mg/l	PHENOL	CHRO-MIUM	TOTAL MPN	FECAL MPN	FECAL STREPT. No/100 ml
MISSISSIPPI RIVER																										
Mpls. Water Trtmt Plants Filt. Backwash Water Lime Sludge	859.0 857.8 858.3	0.7 1.6	None Settling Ponds	8.4 10.2	42	1.7 -				1,900 37	300 -													<2 -	<2 -	
Riverside Power Plant	856.9	592.6[1]	None for Cooling Water																							
Highbridge Power Plant	840.5	449.3[1]	None for Cooling Water																							
Minnesota Harbor Service	840.4		Settling Pond																							
Twin City Shiphard	837.3		Screens																							
Swift & Company	833.4	5.0	None for Cooling Water																							
Union Stockyards	833.2	2.0	None for Direct Discharge																							
Armour & Company	833.0	2.4	None for Cooling Water																							
King Packing Company	832.5	1.73	None for Cooling Water	7.7	350	2.5 Est.	4.9	325	97	7	5	-	12.8	8.1	0.0	0.3	0.2	9	-	-	-	-	-	-	-	-
Northwestern Refining Company	830.0	1.44	Oil Separator, lagoons	8.4	320	22	74	653	139	17	13	-	1.6	25.2	<0.2	2.7	1.2	100	1.5	-	7.6	1900	-	$<1.7x10^4$	$<4.5x10^3$	
J. L. Shiely Company Larson Plant Nelson Plant	826.5 825.0	1.44 8.64	Settling Pond Settling Pond																							
General Dynamics Liq. Carb. Div.	824.2	0.70	None	7.2	540	-	6.5	574	210	35	28	-	0.2	0.6	5.9	0.5	0.6	-	-	-	-	-	-	-	-	-
St. Paul Ammonia Products Company	824.2	0.66	Oil Separator, Settling Pond	8.0	390	14	52	2602	474	21	<14	-	5.8	92.4	84.4	7.9	5.8	-	-	-	17.8	33	-	$3.8x10^2$	$1.2x10^2$	-
Great Northern Oil Company	824.0	3.23	Oil Separator, Sec. Sett. Ponds	7.6	240	16	110	1087	220	39	30	-	0.6	62.8	0.1	3.2	1.6	65	-	-	1.6	159	-	$1.3x10^4$	$8.9x10^3$	-
Northwest Coop. Mills Pond Leakage (INC 371) Comp. Pond Eff(INC 370)	823.8	0.070 0.046	Storage Pond Settling Pond	4.9 6.2	1200 870	16 34	130 260	17920 10850	5405 4707	2249 419	463 228	1.4 17.2	113.1 119.2	471.6 424.0	4.4 4.1	9030 2790	7400 1970	- -	260^2 20^2	- -	- -	- -	- -	- $7.9x10^5$	- $1.7x10^5$	- -
Minn. Mining & Mfg. Co. Cooling Water (IMM 359) Treated Waste (IMM 358) Cooling and Waste (IMM 357)	817.2	4.08 1.68 5.76	None for C. Wtr. Neut. & Sett. Tanks, Ponds (See Above)	8.1 7.5 7.5	300 370 370	16 220 120	48 490 180	357 1212 736	105 214 169	9 38 86	6 24 39	- - -	0.4 6.9 19.4	4.7 98.6 36.8	2.1 9.7 5.3	10.8 58.2 44.7	7.6 42.9 33.3	- - -	- - 11.3	- - -	- - 3.4	26 741 466	- - -	<64 $>9.4x10^5$ $>5.9x10^4$	<6 $<2.8x10^3$ $<4.0x10^3$	- - -
H.D. Hudson Manufacturing Company	814.2	-	Chem. Precip.																							
Foot Tanning Company Raw Waste (IFT 381) Treated Waste (IFT 380)	792.8	1.03 1.03	(Inf. to Lagoons) Screens & Lagoons	7.6 9.1	670 480	330 170	1100 490	7110 5744	1551 545	1233 59	578 35	54 1.7	<0.2 0.2	33.0 27.6	1.7 0.9	25.0 5.4	0.9 0.3	- -	- -	- -	- -	- -	- 14	$>1.2x10^4$ <17	$>9.4x10^3$ <13	
Pittsburgh Plate Glass Company	790.7	1.0	None for Cooling Water																							
Red Wing Power Plant	789.4	53.9[1]	None for Cooling Water																							

1. Maximum rate of discharge.
2. Based on one sample.

TABLE 4 (Continued)

SUMMARY OF INDUSTRIAL WASTES CHARACTERISTICS

INDUSTRIAL WASTE SOURCE	RIVER MILE	AVG. FLOW RATE MGD	TYPE OF TREATMENT	pH mg/l	Alkalinity mg/l	5-Day BOD mg/l	COD mg/l	SOLIDS: TOTAL mg/l	SOLIDS: VOLATILE mg/l	SOLIDS: TOTAL SUSP. mg/l	SOLIDS: VOL. SUSP. mg/l	SOLIDS: SETT. mg/l	NITROGENS: ORGANIC mg/l	NITROGENS: AMMONIA mg/l	NITROGENS: NO_3 mg/l	PHOSPHATES: TOTAL mg/l	PHOSPHATES: ORTHO mg/l	CHLORIDE mg/l	FLUORIDE mg/l	SULFATE mg/l	OIL & GREASE mg/l	PHENOL	CHROMIUM	COLIFORMS: TOTAL MPN	COLIFORMS: FECAL MPN	FECAL STREPT. No/100 ml
RUM RIVER																										
Cornelius St. Sewer, Anoka	0.8	0.1±	None	7.6	480	4.2	13	382	141	18	7	-	1.2	2.5	2.8	14.3	10.6	30	-	16	0.3	-	0.02	4.5×10^3	2.0×10^3	-
Taylor St. Sewer, Anoka	0.7	Low	None	7.8	410	7.8	28	430	153	27	13	-	1.1	3.7	3.0	13.2	6.8	29	-	32	6.0	-	-	2.0×10^2	1.8×10^2	-
Taylor St. Sewer, Anoka	0.6	Low	None	7.6	480	16	33	474	129	46	9	-	<1.4	7.1	3.7	11.6	2.9	28	-	120	8.0	-	-	1.7×10^2	1.9×10^2	-
BLUE EARTH RIVER																										
Honeymead Products Company	0.6	4.3	Oil Separator, Acidulation	7.2	350	58	78	700	172	24	20	-	1.2	2.2	0.2	7.2	2.8	-	-	-	16.8	-	-	9.2×10^5	3.1×10^5	-
MINNESOTA RIVER																										
North Star Concrete Products Company	108.2	0.86	Settling Pond																							
Archer Daniels Midland Co.	106.0	0.042	None for Cooling Water	7.9	460	5.0	9.0	636	138	102	18	-	1.2	0.8	0.9	7.0	2.0	-	-	-	1.8	-	-	2.4×10^4	3.1×10^3	-
Blue Cross Rendering Company	105.5																									
Treated Waste		0.036	Trickling Filtr	7.1	990	1200	2700	4347	2086	1559	777	-	23.4	142.6	2.8	68.4	46.6	1800	-	-	387	-	-	$>2.7 \times 10^7$	$>2.4 \times 10^7$	-
Cooling Water		0.058	Grease Trap	7.7	530	700	1000	543	121	27	22	-	0.9	44.8	0.2	5.9	3.4	-	-	-	1.7	-	-	2.7×10^4	$<1.3 \times 10^4$	-
Wilmarth Power Plant	105.2	33.1[1]	None for Cooling Water																							
Green Giant Company	75.4																									
Wastes (IGG 236)		1.25	Irrigation Flds	7.7	630	1200	1900	5768	2881	371	221	1.0	30.2	4.2	1.3	20.9	15.8	-	-	-	-	-	-	3.0×10^7	5.6×10^5	-
San. + Misc. (IGG 235)		0.014	None	7.7	560	200	500	4282	959	135	109	0.5	11.6	2.3	0.6	5.1	2.9	-	-	-	-	-	-	5.7×10^6	2.1×10^6	-
Cooling Water (IGG 233)		0.216	None	8.0	520	54	180	861	226	26	18	0.1	2.9	0.5	0.1	3.1	1.0	-	-	-	-	-	-	1.1×10^6	1.1×10^6	-
Minnesota Valley Milk Processing Association	49.8	0.27	None--Aeration Ditch not in use	7.9	590	130	280	1390	425	120	49	-	9.7	1.6	0.2	22.0	14.6	-	-	-	-	-	-	$<8.2 \times 10^5$	$<2.4 \times 10^5$	-
American Crystal Sugar Co.	27.7	7.0	None	9.0	530	650	1000	10150	1365	766	<165	-	11.3	1.3	1.4	6.8	2.7	-	-	-	-	-	-	$>1.0 \times 10^7$	2.5×10^6	8.9×10^2
M. A. Gedney Company	27.5	0.40	Stab. Ponds																							
Rahr Malting Company	25.4	2.0	Screens	-	-	300	690	5087	720	38	>34	-	6.7	1.3	3.8	-	-	-	-	-	-	-	-	1.3×10^7	6.1×10^4	7.7×10^3
Owens-Illinois Glass Company	20.9	0.02	"Rated" Aeration	7.8	280	11	58	393	183	34	28	-	0.6	0.1	<0.1	1.9	1.4	-	-	-	7.9	-	-	73	45	-
American Wheaton Glass Co.	20.7	0.20	None for Process Wastes	8.0	230	8.3	23	290	136	33	9	<0.1	0.0	0.0	3.5	0.2	0.2	-	-	-	20.8	-	-	4.0×10^2	57	-
Cargill, Inc.	13.4	3.32	Screens & Oil Separation	7.9	360	25	68	620	122	33	22	-	2.0	3.0	<0.1	9.0	4.0	4	-	-	2.7	-	-	$>3.9 \times 10^5$	$<2.1 \times 10^4$	-
Twin City Shipyard																										
Cargill Location	13.2		Screens																							
Blackdog Location	8.0		Screens																							
Blackdog Power Plant	8.4	371.5[1]	Cooling Pond																							
ST. CROIX RIVER																										
Andersen Window Company	20.2																									
Upper Waste Disch. (IAW 157)		0.014	None	7.7	500	40	110	472	258	54	41	0.75	16.0	35.2	<0.6	2.3	0.4	-	-	-	-	-	-	1.1×10^5	$<2.5 \times 10^3$	-
Middle Waste Disch. (IAW 156)		0.216	None	7.7	490	4.9	12	286	90	18	12	<0.1	<0.5	<0.2	1.2	6.6	0.9	-	-	-	-	-	-	2.8×10^2	<86	-
Cooling Water (IAW 155)		0.216	None for Cooling Water	7.6	510	1.4	5.4	239	63	9	4	<0.1	0.6	0.5	0.4	0.9	0.2	-	-	-	-	-	-	$<3.6 \times 10^3$	$<2.0 \times 10^2$	-
United Refrigerator Company	16.5	0.059	None	7.8	-	4	-	268	106	256	6	-	-	-	-	0.8	-	-	-	-	-	-	3.4			

1. Maximum rate of discharge.
2. Based on one sample.

TABLE 5

SUMMARY OF MORE SIGNIFICANT INDUSTRIAL WASTE LOADING RATES TO STREAMS

(Results are in Pounds/Day, except where noted otherwise)

SOURCE	RIVER MILE	AVG. FLOW RATE MGD	OPERATION Hours per Day	Days per Week	Mos. per Year	5-Day BOD	COD	SOLIDS TOTAL	VOLA-TILE	TOTAL SUSP.	VOLA-TILE SUSP.	TOTAL KJELDAHL NITRO-GEN	PHOSPHATES TOTAL PO_4	ORTHO PO_4	FLUOR-IDE	OIL & GREASE	PHENOL	CHRO-MIUM	COLIFORMS TOTAL No./Day	FECAL No./Day	HEAT Billion BTU/Day (At Full Capacity)
MISSISSIPPI RIVER																					
Mpls. Water Treatment Plant	858.9	2.3	24	7	12					11,000	1,800										
Riverside Power Plant	856.9	592.6[1]	24	7	12																80.6
Highbridge Power Plant	840.5	449.3[1]	24	7	12																74.2
Northwestern Refining Company	830.0	144	24	7	12	270	840	7,800	1,700	200	150	320	33			90	23		<5.3 x 10^{11}	<2.5 x 10^{11}	
General Dynamic Liq. Carb. Div.	824.2	0.70	24	5-7	12	17	38	3,300	1,200	200	150										
St. Paul Ammonia Products Company	824.2	0.66	24	7	12	80	290	14,000	2,600	110	<70	450	45			95	0.2				
Great Northern Oil Company	824.0	3.23	24	7	12	440	3,000	29,000	5,900	1,000	800	1,700	85			40	4.2		1.6 x 10^{12}	1.1 x 10^{12}	
NW Coop Mills (Pond Leakage) (Normal Eff.)	823.8		24	7	12	 10 13	 75 100	 10,400 4,100	 3,100 1,800	 1,300 160	 270 85	 340 200	 5,250 1,070	 4,300 750	 5± 150±				1.4 x 10^{12}	3.0 x 10^{11}	
Minnesota Mining & Mfg. Company	817.2	5.76	24	7	12	3,600	8,400	29,000	6,500	800	540	1,600	1,200	850	450		10		>1.3 x 10^{13}	<8.7 x 10^{11}	
Foot Tanning Co. (When Bypassing) (Normal Oper.)	792.8	 1.03 1.03	18-24	6	12	 2,800 1,500	 9,100 4,200	 61,000 49,000	 13,300 4,700	 10,600 500	 5,000 300	 290 240	 212 46					120			
Red Wing Power Plant	789.4	53.9[1]	24	7	12																4.18
BLUE EARTH RIVER																					
Honeymead Products Company	0.6	4.3	24	7	12	2,100	2,800	25,000	6,200	860	720	120	260	100		600			1.5 x 10^{14}	5.1 x 10^{13}	
MINNESOTA RIVER																					
Blue Cross Rendering Company	105.5	0.094	15	6	12	700	1,300	1,570	680	480	240	72	23			120			>3.7 x 10^{13}	>3.4 x 10^{13}	
Wilmarth Power Plant	105.2	33.12[1]	24	7	12																4.1
Green Giant Co. (When Bypassing) (Normal Oper.)	75.4	 1.48 0.23	15	7	4	 13,000 120	 20,000 380	 60,000 2,000	 30,000 400	 3,900 60	 2,300 45	 370 8	 220 6	 170 2					 1.4 x 10^{15} 1.2 x 10^{13}	 2.6 x 10^{14} 1.0 x 10^{13}	
Minnesota Valley Milk Processing (Before Trtmt.)	49.8	0.27	9-16	7	12	290	620	3,000	950	250	100	25	49						<8.3 x 10^{12}	<2.4 x 10^{12}	
American Crystal Sugar Company	27.7	7.0	24	7	4	38,000	59,000	590,000	80,000	44,800	9,600	740	400	160					2.8 x 10^{15}	6.6 x 10^{14}	
M. A. Gedney Co.	27.5	0.4	24	7	12		(Not	discharging	directly	to	stream,	yet.)									
Rahr Malting Co.	25.4	2.0	24	7	12	5,000	11,730	80,000	10,000	600	<600	136							1.0 x 10^{15}	4.7 x 10^{12}	
Cargill, Inc.	13.4	3.32	24	7	12	700	1,900	17,000	3,400	900	600	140	250	110		70			>4.8 x 10^{13}	<2.6 x 10^{12}	
Blackdog Power Plant	7.5	371.5[1]	24	7	12																56.6[2]
ST. CROIX RIVER																					
Andersen Window Co	20.2	0.45	8	5	12	15	45	1,000	300	55	30	8	14	2					<9 x 10^{10}	<3 x 10^{9}	
United Refrig. Co.	16.5	0.059	8	5-6	12	2		132	52	6	3		0					1.7			

1. Maximum rate of discharge.
2. When bypassing cooling pond.

EXCERPTS FROM

"RECOMMENDATIONS FOR MINIMUM PERSONNEL, LABORATORY CONTROL AND RECORDS FOR MUNICIPAL WASTE TREATMENT WORKS"

BY

The Conference of State Sanitary Engineers

in cooperation with

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

Public Health Service

1963

PLANT CAPACITY 0.25 MGD

Laboratory Control

In a plant of this size, the operator shoulc conduct the following tests:

(1) Settleable solids (Imhoff Cone) once or twice a week using grab samples. The grab samples should be taken at a time of representative flow and should reflect varying days of the week and hours of the day.

(2) Relative stability (methylene blue) daily, Monday through Friday.

(3) Chlorine residual of effluent daily, Monday through Friday; twice daily when stream conditions require.

(4) For activated sludge plants, in addition to the above tests, sludge index tests daily and a colorimetric dissolved oxygen test weekly.

Records

Usually personnel and time limitations will permit the keeping of only minimal records. However, two types of records should be kept: (1) a diary-type log showing a necessarily wide variety of useful and important information such as unusual maintenance work, failure of a piece of equipment, accidents, unusual weather, flooding, bypassing, complaints, visitors, etc; and (2) a tabular record showing the observation or results of each laboratory test made and other available measured data such as plant flow, volume of sludge, or time sludge pumped. Emphasis is placed here on the need for the operator to record the data available to him with strict regularity and in a form best suited to his schedule.

PLANT CAPACITY 0.5 MGD

Laboratory Control

For a plant other than activated sludge the following tests should be conducted:

(1) Settleable solids (Imhoff Cone) daily, Monday through Friday. Tests should be made at varying hours during the day.

(2) Relative stability (methylene blue) daily, Monday through Friday. Tests should be made at varying hours during the day.

(3) Colorimetric pH of raw waste water occasionally.

(4) Chlorine residual of effluent daily; twice daily when stream conditions require.

(5) Total solids of digested sludge occasionally and when the sludge is drawn to the drying beds.

(6) pH of digested sludge occasionally and when the sludge is drawn to the drying beds.

For an activated sludge plant the following tests should be conducted:

(1) Settleable solids (Imhoff Cone) daily.

(2) Relative stability (methylene blue) daily.

(3) Sludge index daily.

(4) Mixed liquor dissolved oxygen (colorimetrically) daily.

(5) Sludge depth measurements in primary and secondary settling tanks daily.

(6) pH of digested sludge when sludge is drawn.

(7) Total solids of digested sludge when sludge is drawn.

Records

A diary should be kept similar to the 0.25 MGD plant, but with a full-time operator it should be more comprehensive. Regularity is emphasized.

The laboratory control record also is slightly more detailed because of the additional tests specified and with a full-time operator should be maintained with ease. Consultation with State regulatory agency representatives, university personnel, and/or other experienced personnel, and attendance at short courses in his State will assist the operator to establish and maintain suitable

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records. These records should be accurate and complete for the items specified.

PLANT CAPACITY 1.0 MGD

Laboratory Control

For primary and trickling filter plants the following tests are specified:

(1) Settleable solids (Imhoff Cone) daily.

(2) Relative stability (methylene blue) daily.

(3) BOD's of raw waste, final effluent, and of such other components as possible once a week and preferably twice a week. Samples should be 3-hour composites taken at 11 a:m., 12 noon, and 1 p.m.

(4) Suspended solids of raw waste, final effluent and of such other components as possible once a week and preferably twice a week. Samples should be 3-hour composites taken at 11 a.m., 12 noon, and 1 p.m.

(5) pH of digested sludge when drawn or when operating difficulties are experienced or anticipated.

(6) Total solids of digested sludge when drawn or when operating difficulties are experienced or anticipated.

(7) DO of receiving stream at least twice a week above and below the plant discharge.

(8) Chlorine residuals of effluent daily; twice daily, when stream conditions require.

For activated sludge plants the following tests are specified:

(1) Settleable solids (Imhoff Cone) daily.

(2) Relative stability (methylene blue) daily.

(3) BOD's of raw waste, final effluent, and of such other components as possible twice a week. Samples should be 3-hour composites taken at 11 a.m., 12 noon, and 1 p.m.

(4) Suspended solids of raw waste, mixed liquor, and final effluent once a week. Samples should be 3-hour composites taken at 11 a.m., 12 noon, and 1 p.m.

(5) pH of digested sludge when drawn or when operating difficulties are experienced or anticipated.

(6) Total solids of digested sludge when drawn or when operating difficulties are experienced or anticipated.

(7) Depth of sludge in primary and final settling tanks daily.

(8) Sludge index daily.

(9) Dissolved oxygen (colorimetric) of mixed liquor daily.

(10) DO of receiving stream at least twice a week above and below the plant discharge.

(11) Chlorine residual of effluent daily; twice daily, when stream conditions require.

Records

For a plant of this size considerable care and technical competence is required in assembling and recording the data. Included in the supervision be the understanding and patience needed to interpret the control procedure carried on. To establish and maintain adequate records, some guidance will be needed from State regulatory agency representatives, university personnel, and/or other experienced individuals.

PLANT CAPACITY 5.0 MGD

Laboratory Control

Following are recommended test procedures for plants other than activated sludge:

(1) Settleable solids daily.

(2) Relative stability daily.

(3) Dissolved oxygen of raw waste, effluent and receiving stream above and below the plant discharge 5 days per week.

(4) pH of raw waste and effluent 5 days per week.

(5) BOD's of raw waste and effluents 3 times per week on 24-hour composite samples.

(6) Suspended solids of raw waste and effluents 3 times per week on 24-hour composite samples.

(7) pH of digested sludge when drawn or as necessary to control digester operation.

(8) Total and volatile solids of digested sludge when drawn or as necessary to control digester operation.

(9) Volatile acids of digested sludge when drawn or as necessary to control digester operation.

(10) Chlorine residual of effluent daily, twice daily when stream conditions require.

For activated sludge plants the recommended test procedures are as follows:

(1) Settleable solids daily.

(2) Relative stability or nitrates 5 days per week on 24-hour composite samples.

(3) Dissolved oxygen of raw waste, effluent and receiving stream above and below discharge 5 days per week.

(4) pH of raw waste and final effluent daily.

(5) BOD's of raw waste and effluents 5 days per week on 24-hour composites.

(6) Suspended solids of raw waste and effluents 5 days per week on composite samples.

(7) Sludge index daily on each shift.

(8) Mixed liquor DO (colorimetric) daily on each shift.

(9) Sludge depth in primary and final settling tanks daily on each shift.

(10) pH of digested sludge when drawn or as needed to control digester operation.

(11) Total and volatile solids of digested sludge when drawn or as needed to control digester operation.

(12) Volatile acids of digested sludge when drawn or as needed to control digester operation.

(13) Chlorine residual of effluent daily, twice daily when stream conditions require.

Records

The size of this plant makes it desirable to keep daily records of all operations – many of them on a shift basis. With a full-time superintendent and a staff of trained men, including a chemist in an activated sludge plant, there should be no difficulty in maintaining the records in a highly competent manner. The specified personnel should assure the interpretation and use of the control information in such a way as to obtain the maximum treatment efficiency.

Since this falls in the large plant category there may be considerable flexibility in the form of records and various control procedures. In addition to the recorded laboratory control and diary-type log information, this plant may need to record a number of other determinations. Some of these might include alkalinity, ORP, heavy metals, or certain components indicative of particular industrial waste problems.

There are frequent needs to record other information which contributes markedly to the control procedure. Some of these data include the following:

(1) Weather and wind direction in the event of odor problems.

(2) In addition to the raw waste flow, a record of bypassing.

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(3) Amount of course solids handled; i.e., grit screening, dried sludge hauled from beds, or sludge removal from digesters.

(4) Primary and secondary settling tank cleanup – hours of hosing or skimming and/or maintenance, etc.

(5) Trickling filter maintenance – nozzle cleaning, dosing or recirculating pump operation, humus sludge pumping to primary tanks, etc.

(6) Activated sludge operation – air volume and blower operation, volume of sludge return and waste, replacement or cleaning diffusers, etc.

(7) Sludge handling – in addition to volume of sludge pumped and time, such information as amount of recirculation or transfer of digested sludge, gas mixing, supernatant withdrawal, final sludge to drying beds or filters, disposal of sludge from beds, conditioning chemicals for filters, incineration, etc.

Records of the above operations may be kept in a form most convenient to the superintendent. Because of the wide variation in plants of this size and individual needs, the way these records are kept will vary considerably.

PLANT CAPACITY 10.0 MGD (or larger)*

Laboratory Control

Required test procedures for plants other than activated sludge are:

(1) Settleable solids daily.

(2) Relative stability daily.

(3) Dissolved oxygen of raw waste, effluent and receiving stream above and below discharge 5 days per week.

(4) pH of raw waste and effluent daily.

*Note enclosed in parentheses has been added by the Twin Cities-Upper Mississippi River Project.

(5) BOD's of raw waste and effluents daily, Monday through Friday, based on 24-hour composite samples.

(6) Suspended solids of raw waste and effluents daily, Monday through Friday, based on 24-hour composite samples.

(7) pH of digested sludge when drawn or as needed to control digester operation.

(8) Total and volatile solids of digested sludge when drawn or as needed to control digester operation.

(9) Volatile acids of digested sludge when drawn or as needed to control digester operation.

(10) Chlorine residuals of effluent daily, twice daily when stream conditions require.

For an activated sludge plant the required test procedures are:

(1) Settleable solids daily.

(2) Relative stability or nitrates daily on 24-hour composite samples.

(3) Dissolved oxygen of raw waste, final effluent and receiving stream above and below discharge 5 days per week.

(4) pH of raw waste and final effluent daily.

(5) BOD's of raw waste and effluents daily, Monday through Friday, on 24-hour composite samples.

(6) Suspended solids of raw waste and final effluents daily, Monday through Friday, on 24-hour composite samples.

(7) Sludge index daily on each shift. Solids should be determined in conjunction with the BOD and suspended solids determinations.

(8) Mixed liquor DO (colorimetric) daily on each shift.

(9) Sludge depth in primary and final settling tanks daily on each shift.

(10) pH of digested sludge when drawn or as needed to control digester operation.

(11) Total and volatile solids of digested sludge when drawn or as needed to control digester operation.

(12) Volatile acids of digested sludge when drawn or as needed to control digester operation.

(13) Chlorine residual of effluent daily, twice daily when stream conditions require.

Records

The comments on records for the 5.0 MGD plant also apply to the 10.0 MGD plant. The administrative personnel should select the record style best suited to their specific needs. Many more items of control data also may be desirable, based on the superintendent's judgment and on special conditions.

With a larger staff the 10.0 MGD plant may be able to carry on special projects beyond that possible in the smaller plants. Such projects may include special studies on industrial wastes or operational research projects. These projects may result in published information which can be valuable to many others with similar problems.

A plant of this size normally is expected to produce an annual operating report containing comprehensive records of the year's activities and performance. This procedure enables the superintendent to transform the daily records into summany and unusual information which is quite helpful to others.

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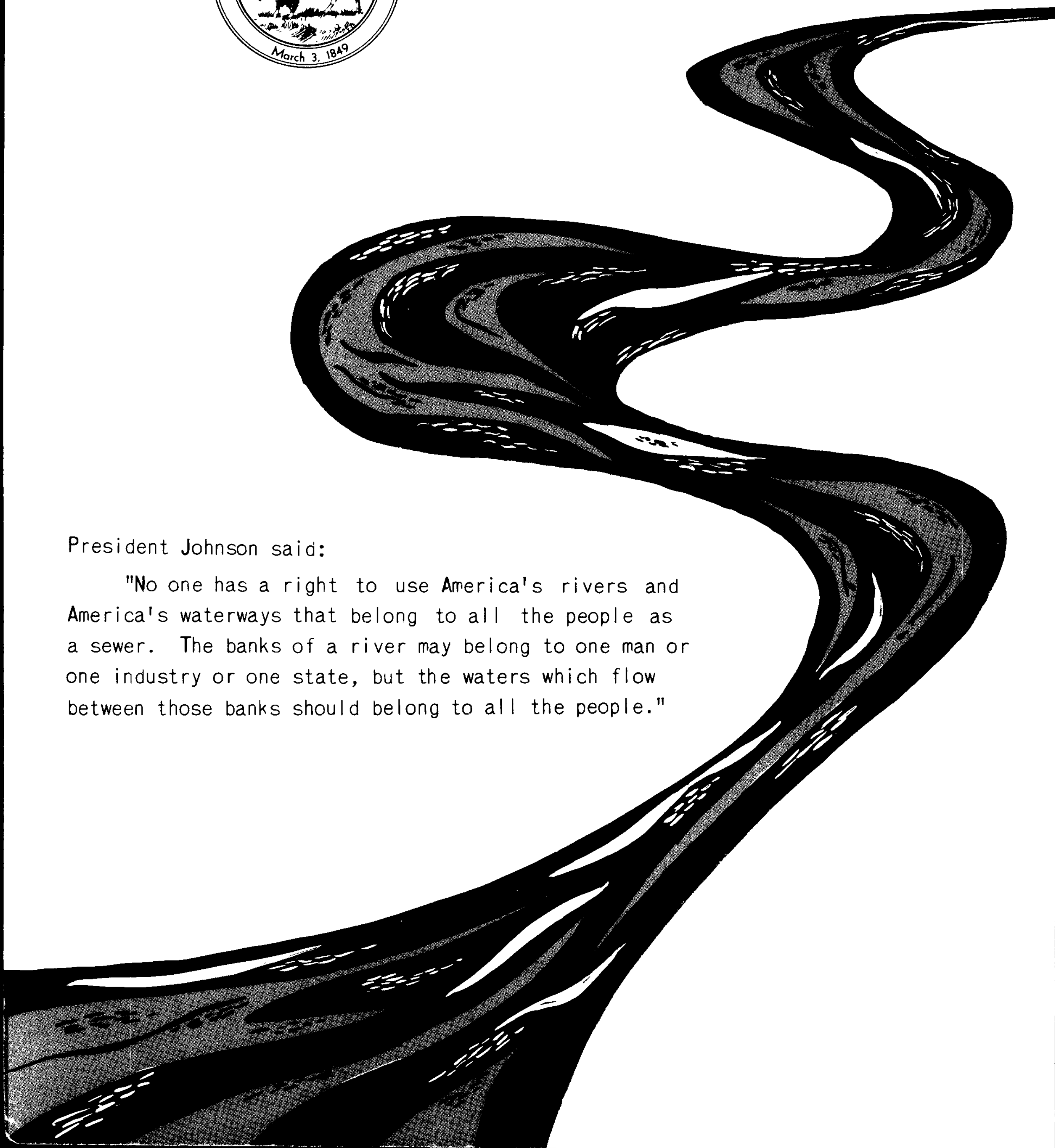
U S DEPARTMENT OF THE INTERIOR
March 3, 1849



President Johnson said:

"No one has a right to use America's rivers and America's waterways that belong to all the people as a sewer. The banks of a river may belong to one man or one industry or one state, but the waters which flow between those banks should belong to all the people."