REPORT OF THE INVESTIGATION

of the

POLLUTION OF THE STRAIGHT AND CANNON RIVERS

by the

MINNESOTA STATE BOARD OF HEALTH

in collaboration with

THE MINNESOTA COMMISSIONER OF GAME AND FISH

1928 - 1930

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MINNESOTA DEPARTMENT OF HEALTH

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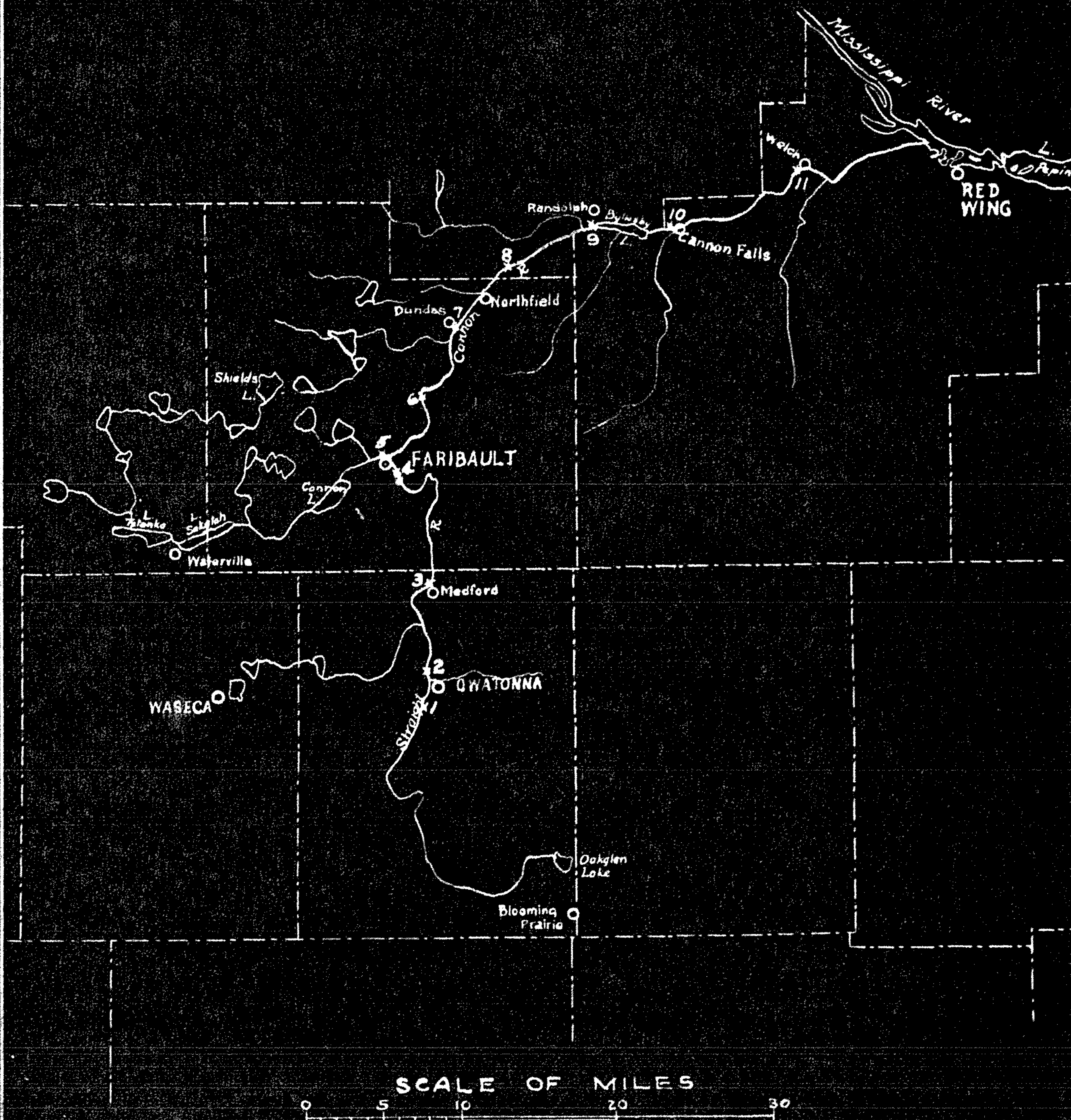
MAP
OF
STRAIGHT & CANNON RIVER SYSTEM



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S U M M A R Y

The investigation of the pollution of the Straight River was begun early in 1928. An attempt was made in February of that year to collect a set of samples of the river before the ice had gone out, but an early thaw and a day of rain resulted in the river being in flood with two or three feet of water over the ice. The work was carried on during the year and when the Cannon River survey was started in 1929, it was thought advisable to continue work on the Straight River for another year.

Samples were collected from the river above and below each municipality which contributes to the pollution in order to determine the effect on the river. The first station was located above Owatonna and therefore represents the river in its natural state with no pollution, except that coming from the land which drains to the river. The last station was at Welch which is below the last important source of pollution. Whenever possible, the stations were located at bridges or dams for the sake of convenience and uniformity in collecting samples. The samples were shipped to the laboratory of the Division of Sanitation in Minneapolis for the analyses which did not have to be made in the field.

The results indicate that the river is sufficiently polluted to be a menace to health and to fish life below Owatonna, Faribault and Northfield and that nuisances are common, particularly in the vicinity of sewer outlets in these cities as well as at Cannon Falls. Bathing in any section of the river between Owatonna and Welch is hazardous. Conditions are most pronounced below Owatonna where the flow is small and the ratio of sewage to diluting water is highest.

During the summer of 1928 an investigation was made of the sewage disposal at Owatonna. The investigation covered both the municipal system and the state school. Reports were made which carried recommendations for treatment of the sewage and industrial wastes before being discharged into the Straight River.

Information was collected at Faribault, Northfield and Cannon Falls for the purpose of determining the pollution being contributed by those municipalities. A considerable amount of pollution may be attributed to the various industrial wastes. Canning factories at Owatonna and Faribault discharge untreated wastes into the river during a short period each summer and other industries such as creameries and cheese factories, gas plants, the woolen mill and packing plants at Faribault, and the milk condensing plant at Northfield contribute wastes throughout the entire year. The heaviest load is thus placed on the stream in the summer time when all plants are operating and the river flow is low.

STRAIGHT AND CANNON RIVERS

The Straight River rises in the southeast corner of Steele County about four miles north of the Village of Blooming Prairie, Minnesota. The source of the river is a group of small lakes of which Oak Glen Lake is the most important. The river winds through a low, flat valley and is joined by several small tributaries before reaching Owatonna twenty-five miles from Oak Glen Lake. The entire length of the Straight River from its source to its mouth at Faribault, is about forty-five miles. The drainage area above Owatonna is approximately 250 square miles; the total drainage area is 443 square miles. The greater part of the drainage area is under cultivation and the run-off is rapid following the spring thaws and rains. As a result, the dry weather flow is very low. On August 6, 1929 the river was gauged above Owatonna and found to have a discharge of only 12.3 cu. ft. per second. This was by no means the low stage of the stream as observations have been made when the river was practically dry.

The river falls eight feet in passing over the dam at Owatonna and ten feet at the Clinton Falls dam. About one mile above Clinton Falls there is an outcrop of stratified limestone over which the river passes in a series of thin sheets and falls. After a short stretch of swift current below Clinton Falls, the rate of fall becomes less and the river becomes a meandering stream with numerous shallow pools. Just above Faribault the character of the river basin changes from a flat country to one of low sandstone bluffs. The Straight River follows the line of bluffs to its junction with the Cannon River at the north end of the City of Faribault.

The Cannon River rises in the vicinity of Shields Lake about ten miles northwest of Faribault. From Shields Lake the river flows southwest and west through Rice Lake and Lake Dora to Lake Cerman and thence south through Sabre Lake and Lake Tetonka. After leaving Lake Tetonka the river flows east through Lake Sakatah and Mud Lake and thence northeast and through Cannon Lake to Faribault and the junction with the Straight River. The entire length of the river above Faribault including the flow through the chain of lakes is approximately fifty miles and the drainage area is about 290 square miles.

After being joined by the Straight River at Faribault the Cannon River flows north to Northfield. Just north of Northfield the river bends east, flowing in this general direction to its junction with the Mississippi River just above Red Wing. There are several dams in the river below Faribault, the most important being the one which is located one and one-half miles above Cannon Falls. This dam is fifty-six feet high and forms a lake

Table I

Total Stream Flow in Cubic Feet per Second
Of Cannon River at Northern States Power
Company, Cannon Falls Hydro Plant

	1926	1927	1928	1929
Jan.	28	56	103	64
Feb.	82	394	495	162
Mar.	700	1,090	430	1,180
Apr.	179	816	545	823
May	119	470	554	542
June	58	605	143	286
July	40	153	63	160
Aug.	36	55	275	96
Sept.	167	106	172	72
Oct.	179	120	130	105
Nov.	96	91	105	
Dec.	64	67	80	

Drainage Area of Cannon River at Cannon Falls = About 1,200 Square Miles

Drainage Area of Cannon River above Faribault = About 290 Square Miles

Drainage Area of Straight River above Faribault = About 443 Square Miles

Drainage Area of Straight River above Owatonna = About 250 Square Miles

Table I-A

DISCHARGE IN CU.FT. PER SECOND OF STRAIGHT RIVER AT OWATONNA
(Based on the assumption that the flow is proportional to the drainage area contributing, or 21 per cent of the flow at Cannon Falls.)

	1926	1927	1928	1929
January	6	12	22	13
February	17	83	104	34
March	147	230	90	248
April	38	172	115	173
May	25	99	117	72
June	12	127	30	60
July	8	32	13	34
August	8	12	58	20
September	35	22	36	15
October	38	24	27	22
November	20	19	22	
December	13	14	17	

Table I-B

DISCHARGE IN CU.FT. PER SECOND OF COMBINED STRAIGHT AND CANNON RIVERS BELOW FARIBAULT
(Based on the assumption that the flow is proportional to the drainage area contributing, or 61 per cent of the flow at Cannon Falls.)

	1926	1927	1928	1929
January	17	34	63	39
February	50	240	302	99
March	427	665	262	720
April	109	498	332	502
May	73	286	338	208
June	32	369	87	175
July	24	94	38	98
August	22	34	168	59
September	102	65	105	44
October	109	73	79	64
November	59	55	64	
December	39	41	49	

covering 1,500 acres extending upstream to Randolph. The lake is known as Byllesby Lake. The flow of water below this lake is largely controlled by the operation of the dam.

Discharge records for the Cannon River are not complete and are admittedly inaccurate. A gauging station was maintained at Welch from 1909 to 1914, and for a short time in 1926, but was abandoned because it was felt that the records could not be relied upon. The Northern States Power Co. maintains records of discharge at the power dam above Cannon Falls and these records are the only ones available for any point on the river system. Table I gives the monthly average flows at this dam for 1926, 1927, 1928 and 1929, and Tables I-A and I-B give the calculated flows below Owatonna and below the junction of the Straight and Cannon Rivers at Faribault. These calculations assume a flow proportional to the drainage area contributing.

SOURCES OF POLLUTION

The first point at which sewage and industrial wastes are discharged into the Straight River, is Owatonna. The municipal system at Owatonna has three outlets discharging directly into the river and one discharging into Maple Creek, a small stream which enters the river near the north end of town. The system receives domestic sewage and the wastes from two creameries, an ice cream factory, a laundry, a gas plant, and a canning factory. The canning factory operates only during a short period each summer when corn and peas are canned. The sewage from the State School for Dependent Children is also discharged directly into the river at Owatonna. About half a mile below town the river receives the waste from a rendering plant. This waste is discharged intermittently throughout the year.

At Faribault the Straight River receives sewage from the part of the city lying on the east side of the river, and from the Central Avenue sewer and the gas plant on the west side. The east side system includes the sewage from the State School for Feeble Minded, which is passed through a settling tank of the Imhoff type and discharges through a separate outlet. The sewage from the State Schools for the Deaf and Blind, Shattuck Military Academy, Seabury Divinity School, St. Mary's School, Allen School, and the City Hospital is discharged into a municipal system which empties into the Straight River near the north end of town.

The greater part of the domestic sewage is discharged through the Central Avenue sewer which enters the Straight River from the west side about a block above the junction with the Cannon. This system includes sewage from hotels, the county jail, Baker School and Bethlehem School, and the wastes from three creameries and an ice cream factory. The waste from the gas plant enters the Straight River through a private outlet near the plant.

The Second Avenue sewer, discharging into the Cannon River, carries domestic sewage and the waste from a packing plant, a poultry killing plant, and a canning factory which cans corn during a period of about one month each summer. Waste and sewage from the Faribault Woolen Mills are discharged directly into the river a short distance above the Second Avenue sewer outlet.

The domestic sewage from Northfield enters the Cannon River through three outlets located below the dam. Two outlets on the east side carry the sewage from most of the business district and from Carleton College, Baker School, and a large residential district. The west side system carries the waste from a large creamery, and sewage from St. Olaf's College, the Odd Fellows' Home, and the residences on that side of the river. Wastes from the milk condensing plant are discharged through a separate outlet into the pool above the dam.

Table II

TOTAL POPULATIONS AND POPULATION EQUIVALENTS, OXYGEN DEMAND BASIS OF SEWAGE AND WASTES FROM MUNICIPALITIES ON THE STRAIGHT AND CANNON RIVERS

City	Total Population:	Gals. Sewage & Industrial Wastes per day:	Pop. Equivalent, sewage and wastes:	Equivalent vol. of Domestic Sewage:
Owatonna	8,500	650,000*	12,050	1,205,000
Faribault	15,000	1,000,000**	20,000	2,000,000
Northfield	6,500	250,000**	5,000	500,000
Cannon Falls	1,415	51,000**	1,325	132,000

*Measured

**Calculated

At Cannon Falls the Cannon River receives the sewage from a population of approximately 775. There are two creameries and two cheese factories discharging their wastes into the system. One sewer outlet is located on the south side of the river below the confluence of the Little Cannon and two others discharge into the Little Cannon, one on each side.

Below Cannon Falls is the Mineral Springs Sanatorium. The sewage from this Institution is partially treated by being passed through an Imhoff tank, but the institution has outgrown the present installation. It is understood that additional treatment facilities will be provided when additions to the buildings are completed.

SCOPE OF INVESTIGATION

The present investigation consisted of the collection of samples from the river above and below the principal municipalities in order to determine the extent of pollution and the progress of self purification. Sanitary surveys were made of each municipality discharging sewage and wastes into the river system for the purpose of learning the amount of pollutional material being introduced. A summary of the results of these surveys is shown in Table II. The investigation of the Straight River was begun early in 1928 and in 1929 was extended to include the Cannon River below Faribault. Considerable work has also been done on Lake Sakatah and other lakes of the Cannon River system.

The determinations made on samples collected from the rivers included the following: temperature, turbidity, total hardness, alkalinity, pH, dissolved oxygen, one, five, and ten-day biochemical oxygen demand, bacterial examination for total plate count at 37 degrees Centigrade, and organisms of the coli aerogenes group, and biological examination for plankton organisms and bottom forms. The samples were collected from 6 stations on the Straight River survey and 5 additional stations on the Cannon River survey. The stations were located as follows:

1. Bridge on cross road 1½ miles south of Owatonna.
2. Below rendering plant approximately ¾ mile north of Owatonna.
3. Old wagon bridge at Medford.
4. Bridge on road running through farm of State School for Feeble-Minded, South of Faribault.
5. Cannon River at Highway #1 just above junction with Straight River.
6. Bridge on cross road off Highway #1, about 3 miles north of Faribault.
7. Bridge at Dundas.
8. Bridge approximately 2 miles below Northfield.
9. Bridge at Randolph.
10. Above Mill Dam at Cannon Falls.
11. Above dam at Welch.

ANALYTICAL DETERMINATIONS AND THEIR SIGNIFICANCE

Temperature - Temperature determinations are valuable in interpreting many of the analytical results. The dissolved oxygen and biochemical oxygen demand are greatly affected by temperature and other climatic conditions. Bacterial growth may be accelerated or retarded by the temperature of the water and other biological agencies are likewise affected.

Turbidity - Turbidity may be used as one means of measuring the physical appearance of the water. While this determination does not measure pollution directly, particularly during and following rains, it nevertheless shows the rate at which suspended material settles out of the water. Turbidity affects other qualities of the water in controlling the transmission of light.

Alkalinity, Total Hardness and pH have no direct sanitary significance as related to this problem, but they are of interest in connection with interpretation of other data. These values did not vary greatly for different periods of sampling.

Dissolved oxygen and Biochemical Oxygen Demand - Dissolved oxygen is the amount of free oxygen in the water. It does not include the oxygen which is in combined form, but only that which is available for use by fish and other aquatic life or for oxidising organic matter in the water. When the oxygen becomes reduced, fish may suffer and die from suffocation and odors may be produced by the organic matter which is in the process of decomposition. Ordinarily the amount of dissolved oxygen may be used directly for measuring the effect of pollution but in the case of the Straight and Cannon Rivers the matter is complicated by an abnormal amount of algae in the water. In several instances the water was found to be supersaturated with oxygen as a result of photosynthesis in green plants. In the absence of sunlight this process may be reversed so that the plants will take oxygen from the water. Thus the oxygen content of the water may be greatly reduced during the night while an analysis made in the day time would indicate an abundance of oxygen. This condition interferes also with the determination of biochemical oxygen demand, as the green plants may use up a large amount of oxygen by converting it into carbon dioxide after the sample is placed in the incubator in the laboratory. Therefore the oxygen resources cannot be used satisfactorily as an index of pollution in this problem during the seasons of heavy algae growths. It is necessary in this case to consider the bacteriological and biological findings in order to determine the effect of pollution on these rivers.

Bacteriological - The bacteriological data show the progress of recovery from sewage pollution and also show the extent to which persons using the river water for drinking or bathing or otherwise coming in contact with the water, may be endangered. The determinations for bacteria growing at body temperature or 37°C. and for members of the coli aerogenes group which were made for this study show the abundance of organisms which are likely to have originated in domestic sewage. These determinations do not measure the extent of pollution by industrial wastes; in fact, certain industrial wastes which are most detrimental to fish life may even reduce the bacterial content of domestic sewage.

Chart No. I shows the effect of the pollution on the river below each municipality and also the progress of recovery as indicated by the bacteriological examinations.

EXTENT OF POLLUTION

The amount of oxygen required daily to satisfy the five-day biochemical oxygen demand of the sewage and wastes introduced into the river at Owatonna is 1,960 pounds. This is figured on the basis of a total population equivalent of 12,050 which was the number obtained by adding together the population equivalents of the sewage and wastes from all the sewer outlets discharging into the river and into Maple Creek. The factor used in the calculations was a daily 5-day biochemical oxygen demand of .165 pounds per capita. Allowing for an oxygen depletion of 4 parts per million in the river water, this would require a daily flow of 58.5 million gallons, or an average flow of 90 cu. ft. per second. Referring to Table I-A, it is seen that this flow is available only during high water periods. Furthermore the dissolved oxygen of the water entering Owatonna was sufficient to permit a depletion of 4 parts per million only three of the five times samples were collected during the survey just concluded. The current is sluggish except in times of very high water and a great amount of the settleable material in the sewage and industrial wastes settles to the bottom of the river. This settling is evidenced by the sludge deposits in the stream and along the banks which give rise to bubbling and offensive odors.

On the same basis the wastes and sewage from Faribault will require 5,280 pounds of oxygen per day in order to satisfy the 5-day biochemical oxygen demand. Allowing an oxygen depletion of 4 parts per million, a total flow of 97.5 million gallons per day or 150 cu. ft. per second will be needed. This flow occurs only during the spring months or during a season of heavy rainfall. (Table I-B)

The sewage and industrial wastes from Northfield have a 5-day oxygen demand of 700 pounds per day, requiring 43 cu.ft.per second of river flow for dilution on the basis of a depletion of 4 parts per million. It appears from the flow records that the dilution is sufficient for proper disposal throughout the year, but the results of the sampling on February 4,1930 and the sampling at Randolph a week earlier indicate that at that time the oxygen in the river was seriously depleted.

Aside from the odors and the nuisances produced by scum and sludge banks in the vicinity of the sewer outlets, the sewage and wastes from Cannon Falls are fairly well taken care of by the river. The river water enters Cannon Falls in a well-aerated state after passing over two dams. However, the river is not safe for the bathing that is done during the summer a short distance below town. Even at Welch which is 12 miles downstream, the bacteriological results show the effect of the discharge of sewage at Cannon Falls and at the Mineral Springs Sanatorium.

Authorities differ on the question of how much water is necessary for the satisfactory disposal of sewage by dilution, but it is generally conceded that unsatisfactory conditions will obtain, if the amount of diluting water is less than 2 c.f.s. per one thousand of population. Most writers recommend a flow of at least 8 c.f.s. per one thousand or a dilution ratio of 1 to 40 or 50. This amount will provide sufficient dilution to satisfy the requirements for fish life and for nuisance prevention, but it does not make the river water safe for drinking or bathing.

INTERPRETATION OF THE ANALYTICAL RESULTS

The analyses of samples collected from the Straight River above and below Owatonna show the effect of the pollution introduced into the river from that city in practically all cases. This effect is evidenced by increases in turbidity, oxygen demand, bacterial counts and coli aerogenes index. In most cases the dissolved oxygen content showed a reduction in spite of the aeration afforded the water by passing over the dam between Stations 1 and 2. This aeration undoubtedly accounts for the higher dissolved oxygen results below Owatonna on two occasions.

The sample collected at Station 1 on February 5, 1930 while the river was covered with ice above Owatonna, showed the lowest dissolved oxygen encountered at that station during the survey. This was no doubt due to the fact that under ice the water has no opportunity of coming in contact with atmospheric oxygen. Cold water absorbs oxygen readily, up to the point of saturation, when exposed to the air in passing over dams or falls or in an open channel without ice cover. Thus there was an increase in dissolved oxygen between Stations 1 and 2. The oxygen demand at Station 2 showed an increase of 19.4 parts per million over Station 1 on this date. The heavy algal growth was absent at this time and therefore did not interfere with the oxygen determinations.

At Station 3, (Medford, Minnesota) the river showed an improvement in all of the indices of pollution except on February 5, 1930 when the river above and below this point was covered with ice. On this occasion the sample showed only 0.85 parts per million of dissolved oxygen which would be fatal to fish life, and also productive of odors. While odors could not be noticed through the ice, the water itself had a very decided odor of decomposition and dead fish.

Results from Station 4 above Faribault indicate that the river at this point has practically recovered from the effects of the pollution introduced at Owatonna. Bacterial results compare with those from Station 1 in most cases and other results show a similar improvement. The sample taken in February, 1930 had a much higher dissolved oxygen content than any sample taken farther upstream. This may be explained by the fact that the level of the water under the ice had been lowered by removing a small dam a short distance below, thus affording the water an opportunity of contact with the air.

Station 5 on the Cannon River above the junction with the Straight was established for the purpose of determining the effect of this stream upon the combined river below. The Cannon receives no sewage pollution above Faribault with the exception of a small amount of sewage from Waterville on Lake Sakatah 20 miles upstream. The effect of this sewage extends only a short distance into Lake Sakatah, according to results of investigations on that lake, and certainly is not felt at Faribault. However, the samples from Station 5 indicate some organic pollution which may be a result of organic growths in the series of lakes or of drainage from the farm lands adjacent to the lakes and the river.

The effect of the addition of sewage and industrial wastes from Faribault are measured by the samples collected from Station 6 as compared with those collected from Stations 4 and 5. It will be noticed that the bacteria and coli aerogenes index do not show such an increase below Faribault as they do below Owatonna. This is a result of the greater volume of diluting water provided by the combined flows of the Straight and Cannon Rivers below Faribault.

Samples from Station 7 at Dundas show the progress of recovery from the pollution from Faribault and with the samples from Station 8, give a measure of the effect of the increased pollution below Northfield.

On February 5, 1930 the dissolved oxygen at Station 7 was only 5.4 parts per million and during the passage through Northfield, it was reduced to 3 parts per million at Station 8 in spite of the reaerating effect of the fall over the dam. In the investigation of Byllesby Lake at Randolph on

January 29, all samples collected at various points of the lake showed an abundance of oxygen with the exception of the one taken near where the Cannon River enters. Here the oxygen was less than 1 part per million. This indicates that considerable organic material is deposited in the upper end of the lake where the current of the incoming river is reduced.

Station 9 at Randolph was established for the purpose of determining the quality of the Cannon River water as it enters Byllesby Lake. Using the results from this station and those from Station 10 above the dam at Cannon Falls, it is seen that the river probably recovers from any sewage pollution in passing through the lake and over the dam at the foot of the lake.

The samples from Station 11 at Welch compared with those from Station 10 show increases in numbers of bacteria and organisms of the coli aerogenes group in passing through Cannon Falls. Oxygen conditions were satisfactory at Welch at the times when samples were collected.

During the investigation of the pollution of the Mississippi River, by Mr. H. R. Crohurst, Sanitary Engineer of the U. S. Public Health Service in 1926 and 1927, and that made by the Minnesota State Board of Health in 1928, samples were collected from the Cannon River at the bridge on Highway No. 3. The results of sampling at this point are given in accompanying tables. These results show that the Cannon River is at times carrying a pollution load greater than that carried by the Mississippi at the point where it enters Minneapolis.

The fact that no samples were collected which were entirely devoid of oxygen illustrates the principle of reaeration which takes place in a polluted stream. Falls, ripples, and algae are some of the factors which keep the oxygen from being entirely depleted. In the winter when the water is covered with ice, there is no such opportunity for reaeration and the oxygen content is reduced to a minimum. It can be seen from the results of the sampling in February, 1930 that much more time is required for the river to recover from pollution under ice than in the open seasons.

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STRAIGHT RIVER INVESTIGATION

Results of Physical, Chemical, Biochemical and Bacteriological Analyses

Sta. No.:	Date:	Temp. °C.:	Turb:	Total Hard-ness	Alk.:	pH:	D.O.	% Saturation:	BIOCHEMICAL OXYGEN DEM. 1-day	5-day	10-day	Bacteria per c.c. : 37° 48 Hrs:	Coli Aerog. per c.c.
1	6-13-28	15.5	4	280	238	8.1	8.0	79	0.31	1.41	2.21	4,500	1
2	"	17	8	316	270	7.9	4.6	47	3.2	6.45		70,000	1,000
3	"	19	3	276	239	8.4	10.5	*	0.55	2.85	4.50	9,400	10
4	"	22	1	274	236	8.4	10.0	*	0.1	1.1	1.9	12,500	10
5	"	20.5	28	198	172	8.3	8.4	92		1.05	7.0	6,500	10
6	"	19	5	226	220	8.3	8.42	90		2.45	7.2	36,500	100
1	9-7-28	17	9	273	238	8.3	7.45	76	0.4		1.7	14,500	1
2	"	18	5	258	225	8.3	9.6	*	0.45	1.5	2.2	11,500	100
3	"	21	4	250	226	8.3	8.3	92	0.5	1.5	2.2	10,000	100
4	"	23	3	256	229	8.4	10.25	*	0.65	1.65	2.16	3,200	10
5	"	23	26	183	163	7.9	9.0	*	1.3			7,800	10
6	"	22	4	240	218	8.1	7.0	79	1.1	3.53	4.1	140,000	1,000
1	6-18-29	23.5	10	314	219	8.3	6.1	71		1.35		2,300	10
2	"	24.5	15	305	275	8.2	4.6	54		8.0		150,000	10,000
3	"	26.5	9	273	238	8.3	6.0	74		2.0		11,000	10
4	"	28	20	279	234	8.4	8.2	*		2.75		1,500	10
5	"	26	30	161	141	8.5	9.2	*		8.6 plus		1,100	1
6	"	27.5	30	228	190	8.4	9.65	*		11.0 plus		11,500	100
7	"	28	20	225	194	8.4	11.4	*		7.84		8,000	10
8	"	25	25	234	205	8.4	8.0	95		9.52 plus		12,000	100
9	"	25	23	225	197	8.4	9.45	*		11.46		2,100	10
10	"	23	10	225	192	8.4	8.95	*		7.2		1,000	1
11	"	25.5	8	229	200	8.4	9.15	*		6.3		1,100	10

* Supersaturated

Table III

Table continued on next page

Results of Physical, Chemical, Biochemical & Bacteriological Analyses, continued:

Sta. No.	Date:	Temp. °C.	Turb:	Color:	Total Hardness:	Alk:	pH:	D.O:	% Saturation:	5-day B.O.D.	Bacteria per c. c.: 37° 48 Hrs:	Coli Aerogenes per c. c.
1	7-30-29	27.5	15	30	292	248	8.4	11.3	*	3.25	19,000	1
2	"	27	45	30	299	267	8.2	3.75	46	13.19	1,100,000	100,000
3	"	26.5	8	30	261	241	8.4	8.7	*	1.55	14,000	1
4	"	27	10	35	256	234	8.4	12.9	*	3.45	2,700	0
5	"	27	45	35	182	175	8.4	9.0	*	12.63	19,500	10
6	"	28	30	40	227	206	8.4	9.05	*	4.35	7,600	10
7	"	28	10	40	209	190	8.4	10.7	*	2.55	1,000	1
8	"	29	35	45	209	195	8.4	8.3	*	5.9	8,000	100
9	"	26.5	15	45	214	199	8.4	8.8	*	2.4	4,000	1
10	"	26.5	10	40	244	200	8.4	10.6	*	7.90	550	0
11	"	24.5	15	30	232	214	8.4	8.8	*	3.15	1,900	10
1	2-5-30	0	8		263	228	7.3	5.7	39	0	600	1
2	"	0	40		170	141		5.9	40	19.4	64,000	1,000
3	"	0	10		146	122		0.85	0.6	2.0	2,600	100
4	"	0	4		335	295		9.9	68	3.3	300	1
5	"	0	6		275	271		8.9	61	4.5	200	10
6	"	0	6		273	249		6.2	42	5.2	4,000	100
7	"	0	5		286	275		5.4	37	7.4	2,100	100
8	"	0	7		298	281		3.0	20	12.4	4,200	10
10	"	0	1		288	266		8.8	60	2.7	20	1
11	"	0	1		270	254		11.5	78	2.7	300	10

* Supersaturated

Table III (cont.)

Summary of Physical, Chemical, Biochemical & Bacteriological Analyses; Cannon River on Highway #3. Monthly Mean from June, 1926 to August, 1927, inclusive; from Preliminary Report of Investigation of Pollution of Mississippi River, by United States Public Health Service

Month:	No. of days samp:	Temp. °C.:	Alk. p.p.m:	Turb. p.p.m:	pH:	Bacteria per C.C. On Agar at 20°C. 48 Hrs.	Bacteria per C.C. On Agar at 37°C. 24 Hrs.	Organisms of Coli Aerog. Group per c. c.:	Dissolved Oxygen Initial p.p.m.	Dissolved Oxygen % Saturation	Dissolved Oxygen Loss in 5 days at 20°C.
July	19	20.8	202	10		13,000	11,000	14	7,09	78.5	1,75
Aug.	22	19.7	196	100		15,000	11,500	12	7.43	80.6	1.35
Sept.	20	18.5	196	37		6,500	5,700	22	8.52	90.2	1.65
Oct.	20	20.6	198	6		4,000	3,800	13	9,86	108.5	1.42
Nov.	11	1.6	204	3		1,300	600	11	12.68	90.6	1.57
Dec.	6	0	240	4		1,200	325	10	10.58	72.3	2.64
Jan.	9	0	290	6		1,800	500	4	10.19	69.7	1.44
Feb.	11	0	265	5		12,000	2,200	1	9,48	64.8	1.73
Mar.	13	1.8	155	107		13,000	1,700	2	9.59	68.8	2.86
Apr.	13	7.5	195	14	8.0	5,000	650	3	10.83	90.2	2.58
May	11	14.7	205	20	8.2	4,700	700	16	8.76	85.6	4.21
June	13	18.3	194	259	8.1	8,900	3,800	14	7.73	81.4	2.51
July	11	22.0	216	19	8.2	3,900	1,000	4	7.05	79.8	1,56
Aug.	11	21.7	217	10	8.2	4,100	900	3	7.99	89.9	1.69

Table IV

Table V

Summary of Physical, Chemical, Biochemical & Bacteriological Analyses, Cannon River at Bridge on Highway #3 From the Report of the Investigation of Pollution of the Mississippi River, by the Minnesota Department of Health

Month:	Date 1928:	Temp. °C.:	Turb. p.p.m.:	pH:	D. O. p.p.m:	% Saturation:	Biochemical Oxygen Dem. parts per million 1-day:	5-day:	10-day:	Bacteria per c.c. 37.5°C. 48 Hrs. Agar	Organisms of Coli aerog. Group per c. c.
Jan.	31	0	4	8.0	10.35	71	0.80	1.80	2.80	1,500	10
Feb.	15	1	12	8.1	10.10	71	1.50	4.55	6.10	4,500	10
Mar.	3	0	8	7.9	11.80	80.5	1.60	3.80	5.40	1,900	10
	15	0	65	7.6	11.40	78	3.40	7.20		2,000	10
	30	7	12	7.8	11.20	92	0.80	3.25	4.02	1,000	.1
Apr.	12	7	40	8.1	10.85	89				1,200	10
	26	8	28	8.0	9.90	83		2.70	3.55	750	10
May	10	18	25	8.4	9.70	*	1.25	3.30	5.95	1,500	10
	24	20	8		7.95	87	1.55	3.05	4.46	3,400	1
June	6	19	3	8.2	9.20	98.5	0.90	1.65	2.85	5,900	10
	21	22	6	8.4	8.30	94	0.25	0.80		5,500	10
July	3	25	4,000	7.85	6.50	77.5	1.35	0.43	5.55	48,000	100
	19	27	19	8.0	5.30	65.5	0.65	2.55	4.40	16,500	1
Aug.	2	20	13	8.3	7.45	81.5	0.20	1.85		7,300	10
	17	23	14	8.2	9.40	*	1.65	3.05	4.10	7,900	10
	29	19	30	8.0	8.30	89	1.05	4.50	6.40	10,500	10

* Supersaturated

BIOLOGICAL DATA

Living organisms, like certain man-made instruments such as barometers and thermometers, react very definitely to changes which occur in their environment. It is natural that all organisms should not be entirely similar as to the extent or nature of these reactions, but all are nevertheless endowed with the ability to detect in some measure the environmental changes which may occur. The nature of the organisms' reaction to the conditions of a given environment may be either negative or positive, and certain motile forms of life finding a locality suitable will move in, while others avoid the spot. In the case of certain non-motile organisms, the problem becomes one of adaptability to the environment in question. If the organisms are flexible enough to meet the changes which are typical of a locality, they may thrive and increase, but if their limit of tolerence is exceeded, death or at least decimation in numbers is the result. Thus an environment will be characterised by certain motile organisms which have voluntarily chosen the locale as the most favorable within reach, and other organisms (non-motile) which have adapted themselves to the environment sufficiently to carry on.

Many tropical animals would find arctic temperatures and living conditions entirely unfavorable, while the arctic fauna would scarcely be fitted for life in the equatorial regions. Since the environmental conditions are so important in determining the type of animal and plant life which prevails in any locality, a thorough knowledge of these environmental conditions and the reactions of living organisms to them would enable one to predict the type of life which will be found in a given locality. Conversely, a knowledge of the types of organisms which are present would indicate the kind of environment from which they came. It is this latter method of evaluating an environment which is used to supplement the chemical and bacteriological studies of a polluted lake or stream.

Certain hardy organisms, such as sludge worms, protozoa, fungi, etc., thrive and increase in environments which are so heavily polluted that many other forms of life are totally excluded. The decomposition products of organic waste with which the water of these polluted lakes and streams are laden seem to have no detrimental effect on these hardy organisms. The only limiting factor seems to be the lack of food, or other conditions associated with crowding. Occasionally however, certain toxic industrial wastes such as the by-products of gas manufacture, enter the environment and eliminate even the hardiest forms.

Forms of life notably absent from the heavily polluted locality are predominant in clean unpolluted waters. These organisms need an abundance of oxygen, clean terrigenous bottom sediment, water relatively free from gases produced by organic decomposition, and other conditions which are characteristic of clean water. Naturally a few of the hardy organisms which are able to carry on in polluted water may also be present in an unpolluted environment, but the number would be very limited, due to the lack of suitable food and possibly to the competition offered by cleaner forms.

Unless some factor such as pollution has changed an aquatic environment, the fauna is usually represented by a variety of organisms rather than a few typical forms. In heavily polluted environments, on the other hand, only a limited number of kinds of organisms occur, for where much putrescible material is present only a fes species find conditions favorable.

A polluted stream or lake is also characterized by dense population of organisms and in many cases astounding numbers of individuals occur.* One

*More than 2,000,000 sludge worms have been found per square yard of bottom area in certain polluted streams.

or two of the few species represented dominate the environment and all other organisms form the minority. Changes are sudden and often catastrophic to living organisms in polluted water, while in cleaner environments, changes are slow and more uniform.

Since the bottom sediments are formed by the settling out of substances suspended in the water, this material reflects the average condition of the stream. If much organic matter is carried by the stream, the bottom mud will contain much of this material and active decomposition will take place. If the suspended matter is inert, the bottom muds will also be inert and decomposition products will not be formed. The process of sedimentation thus shifts any biological activity associated with the putrefaction of organic matter from the water itself to the bed of a stream or lake. As a result, the type of organisms which find the deposits suitable will ultimately depend upon the character of the material which is carried by the water. Thus, the nature of the supernatant water may be determined by a quantitative and qualitative study of the organisms which occur in the bottom sediment.

In the survey of the bottom fauna of the Straight River, the samples of sediment were collected by means of dredges, especially constructed for this type of work. Two dredges, each of which takes a sample from a definite area of bottom, were used. The light Ekman dredge was very useful in soft oozy sediments but could not be used where heavy bottom sediments interfered with its spring-operated jaws. Where such heavy sediments were encountered the heavier Peterson dredge was used and found to be very satisfactory. The samples of bottom sediment which had been taken with the aid of these dredges were passed through a 30-mesh sieve which retained the living organisms and allowed the fine mud and organic matter to pass through. The organisms thus separated from the sediment were then ready for identification and enumeration. The results were recorded as the number of bottom organisms per square yard of bottom area. (See Table No. VII).

The Straight River above Owatonna is a clear, shallow stream flowing through cultivated country, occasionally passing over riffled shallows to clean quiet pools. The wealth of dissolved oxygen and the natural flow of the water favor clean water forms such as the larvae of the may-fly (Hexagenia), and the case-building young of the caddis fly. In the samples of sediment taken during the summer of 1929, sludge worms also occurred, but they had limited themselves chiefly to those portions of the stream where decaying leaves and surface drainage from the near-by fields had provided food. Their number was limited and entirely insignificant when compared to their abundance in other sections of the stream where pollution existed. Fresh water sponges and a variety of other organisms were present on the rocks and in the sandy bottom sediment, yet the total number of individuals was much less than that at points farther downstream where polluting substances had been introduced.

It was noted that after receiving the sewage wastes of Owatonna the appearance of the river changed markedly. Instead of being a clean looking stream as in the upper section of the river, it had become leaden gray in color and very turbid. In shallow places where a thin layer of the water flowed over the slime-covered rocks, long gray streamers of the sewage fungus Sphaerotilus could be seen forming a carpet on the bottom of the stream. Floating solids and disagreeable odors characterised the water.

The slimy, noisome sludge which had settled out of the water at this point was teeming with life in the form of sludge worms. These scavengers thrive and increase where few other organisms can survive, and here they occurred at the rate of 57,000 per square yard of bottom area. An examination of the water itself for these minute microscopic organisms which are carried along by the current showed that the protozoa* were much more abundant at this point than at points upstream or at the next sampling point downstream. Green flagellated organisms which react to pollution in the same way as protozoa, were also most abundant immediately below Owatonna.

By the time the stream had progressed one and one-half miles the water had become more clear and the character of the bottom sediment had changed. Instead of an organic mud swarming with life, a thick layer of tarry silt and organic matter almost barren of living organisms, covered the sandy substratum. The iridescent film sometimes visible on the stream at the preceding sampling stations, was not in evidence here, but the bottom mud was permeated with globules of tarry material having the odor of creosote. Great clouds of this oily substance were dislodged and carried downstream when the bottom sediment was disturbed. A few hardy sludge worms were the only living organisms found in samples of this deposit. An examination of the scum which was found adhering to rocks and sticks in the stream showed that the organisms occurring in the scum were tolerant forms like the alga Oscillatoria and the sulphur bacterium Beggiatoa. Their presence indicated that the stream had not as yet recovered from the effects of recent pollution.

At a point approximately one mile above Clinton Falls, the Straight River spreads out over a series of limestone shelves. The surface of this rocky formation constantly bathed by a thin layer of polluted water was covered with a gray-green carpet of algae and fungi. The organisms which went into the makeup of this carpet were all pollutional in character. The effect of a passage of a thin layer of water over this living carpet and over the miniature cascades between the shelves of rock seems to be very

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* An abundance of protozoa indicates strong pollution

beneficial to the river in summer, for very little evidence of pollution existed at the succeeding sampling point near Medford. In winter, however, the ice cover and reduced activity of living scavengers permit polluting substances to pass downstream before they are oxidized or transformed into harmless materials. The evidences of pollution may then extend even beyond Medford.

At Medford the Straight River is somewhat deeper than it is immediately below Owatonna and the current has become more sluggish. The bottom is sandy with very little silt or organic matter in evidence. In the samples of bottom material which were taken during this investigation, the worm-like larvae of Chironomid midges were the dominant forms. A few sludge worms and juvenile clams were present but constituted an unimportant minority. The occurrence of cleaner forms such as may-fly larvae (Heptagenia) and the less tolerant forms of Chironomid larvae indicated that the river had, to a considerable extent, recovered from the sewage pollution contributed by the City of Owatonna.

Only a very limited number of sludge worms (Tubificidae) occurred in the samples of sediment which were taken immediately above Faribault. Chironomid larvae were the dominant organisms and six species of these were represented. The most abundant species was Chironomus decorus, which is fairly tolerant to pollution. However, the absence of large numbers of Tubificidae indicates that the effects of sewage pollution from Owatonna have almost disappeared at this point.

Although Tubificidae were the dominant organisms in samples taken three miles below Faribault, they were present in relatively small numbers only, and there was no indication that the pollution was serious. The presence of a considerable number of Chironomid larvae was additional evidence that the pollution was not as heavy as it had been below Owatonna. An examination was made of samples of the scum which was found floating downstream from more heavily polluted portions above this point. These samples contained organisms which were distinctly pollutional, and it is evident that there is a more heavily polluted zone a short distance above the section of the river from which these samples were taken. Examination of the water itself showed that the Protozoa were more abundant in samples from this station than at the sampling point immediately above Faribault, or at the sampling point farther downstream. The rapid recovery from pollution may, at least in part, be assigned to the diluting effect of the water from the Cannon River and the shallowness of the stream below the junction of the Straight and Cannon.

The organisms present in the bottom sediment two miles below Northfield illustrated the effect of slight sewage pollution where active flow and shallow water tend to ameliorate conditions. A great variety of organisms were represented, many of them cleaner forms. Pollutional forms were abundant but not entirely dominant. The abundance of living organisms may undoubtedly be assigned to the fertilizing effect of polluting substances where oxygen is high and toxic substances are rapidly carried away by an active current.

At the point where the Cannon River enters Byllesby Lake, scarcely any current was noticeable. The bottom material contained considerable organic matter which had been dropped as the current was reduced. Sludge worms were predominant and were more abundant than at the sampling station below Northfield. A number of cleaner forms were also present in the sample. There is little evidence that the effects of the Northfield sewage are serious at this point during the summer.

No evidence of serious pollution existed in samples collected at Cannon Falls, but at Welch a few miles below the point where Cannon Falls sewage is added, some evidence of pollution existed. A few may-fly larvae and Chironomids

Table VI

BOTTOM FAUNA - STRAIGHT AND CANNON RIVERS

AUGUST, 1 9 2 9

Location of Sampling Points

Sample Number:	Location at which Sample was Taken:
31369 31370 31371	Near bridge at crossroad one and one-half miles south of Owatonna.
31415	Below rendering plant approximately 3/4 mile north of Owatonna.
31416	One and one-half miles below Owatonna
31417	Medford
31418	Near State School for Feeble-Minded above Faribault.
31419	Cannon River above junction with the Straight River.
31421 31422	Three miles below Faribault.
31423	Two miles below Northfield.
31424	Near head of Byllesby Lake at Randolph
31425	Above Mill Dam at Cannon Falls.
31426 31427	Above the Mill Dam at Welch

BOTTOM FAUNA - STRAIGHT AND CANNON RIVERS
AUGUST, 1 9 2 9

Number of Organisms per Square
...Yard of Bottom Area...

Sample No.	31370 Grab*	31369 31371	31415	31416	31417	31418
Tubificidae		217	97,200	216	360	36
Musculium transversum					108	
Sphaerium (striatimum?)					304	
Sphaerium sp.		35				
Perla sp.	1					
Hexagenia sp.		12				
Heptagenia sp.	1				36	
Caenis sp.	1					
Hydropsyche sp.	31					
Climacia sp.	1					
Atherix sp.	1					
Ceratopogon sp.						36
Tanytarsus sp. B (Malloch)	4					
Cricotopus trifasciatus	1	6				
Chironomus decorus	1					2,268
" digitatus	1				72	
" flavus	6	41			144	36
" sp.	5	364			1,008	
Protenthes culiciformis	1					
Genus incertus A (Malloch)						36
" " B (Malloch)						108
" " D (Malloch)	2					36
Genus incertum	3	35				

*The numbers occurring in this column represent the number of organisms taken in one grab sample and not the number of organisms per square yard of bottom area.

BOTTOM FAUNA - STRAIGHT AND CANNON RIVERS
AUGUST, 1 9 2 9

Number of Organisms per Square
...Yard of Bottom Area...

Sample No.	31419	31421 31422	31423	31424	31425	31426 31427
Gordius sp.	36					
Tubificidae	1,296	259	188	505	141	2,041
Glossiphonia nepheloidea	108		47		12	
" stagnalis			583		12	
Herpobdella punctata	252	54	117			
Egg cases of leeches			70			
Pisidium sp.	108					
Mussels (large)			present			
Pleurocera acuta tracta	216		117			
Heliosoma (antrosa?)	72					
Valvata bicarinata normalis	2,304					
Sialis			23			
Hexagenia sp.						18
Heptagenia sp.			12			
Caenis sp.			58	12	12	
Hydropsyche sp.			70			
" pupae			70			
Ceratopogon sp.				12		72
Tanypus monilis			12			18
" carneus				23		
Cricotopus trifasciatus			23		12	
Chironomus decorus		29		58	23	216
" digitatus		41			45	54
" flavus		165		23	23	
" viridicollis		17				
" sp.		47		45	12	56
Protenthes culiciformis				12	70	108
Mites			176		12	
Simulium	36					

STRAIGHT AND CANNON RIVER SURVEY

Organisms Found in Samples of Scum Collected from the Straight River on October 17, 1929

One-Half Mile Below Owatonna: (Samples #31861 and 31862)

Oscillatoria tenuis
Sphaerotilus natans
Beggiatoa
Lyngbya spirulinoides
Nitzschia palea
Cryptomonas
Euglena
Paramoecia
Amoeba
Neidium productum
Rotifer sp. (citrinus)
Tubificidae

Three Miles Below Owatonna: (Sample #31863)

Oscillatoria tenuis
Sphaerotilus natans
Stigeoclonium
Lyngbya spirulinoides
Spirogyra
Nitzschia palea
Neidium productum

were present in samples of the sediment, but the sludge worms were entirely predominant, and other organisms formed a small minority.

Fishes apparently find the river immediately below Owatonna uninhabitable, for during this survey none were to be found in this portion of the stream. At Medford, however, a number of fishes were taken by seining. Sticklebacks, young suckers and Johnny darters were common. In the early part of Feb., 1930 hundreds of these little fishes were found dead along the margin of the ice or frozen into the undermost layers of the ice. The fishes were suffocated when a serious oxygen reduction occurred while the river was covered with ice. It has been previously mentioned that evidences of heavy pollution do not extend to Medford during the summer, but from this occurrence it is evident that pollution does affect this portion of the stream during the winter.

Below Northfield a greater variety of fishes occurred than at Medford. Several small black crappies and log perch were taken, in addition to the ever-present shiners and chubs. There was no evidence, however, that fishes were harmed by waste at this point, since no dead fishes were found here either during the summer or early part of February when smothered fish were found at Medford. It is possible that fishes in this portion of the river are unharmed by pollution.

Carp have been observed a short distance below Faribault and at the head of Byllesby Lake near Randolph. It is doubtful that even these hardy fishes remain in the stream during the winter when dissolved oxygen is seriously reduced. During the past winter (1929-1930) oxygen was seriously reduced in the Cannon River near Randolph, and any fishes which remained in that portion of the stream were undoubtedly suffocated. The carp and other fishes which frequent the river near Randolph probably retire to the deeper portions of Byllesby Lake during the winter months and thus escape the oxygen reduction in the river.

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STRAIGHT AND CANNON RIVER SURVEY
Fishes Taken in Seine Hauls

Straight River Near Medford, Oct. 17, 1929: (Sample #31865-A)

Catastomus commersonii	Sucker
Semotilus atromaculatus . . .	Chub
Notropis cornutus	Shiner
Etheostoma iowae	Darter
Eucalia inconstans	Stickleback

Cannon River Below Northfield, Oct. 18, 1929: (Sample #31865-B)

Boleosoma nigrum	Johnny darter
Pomoxis sparoides	Black Crappie
Percina caprodes	Log perch
Notropis hudsonius	Spot tailed minnow
Catastomus commersonii	Sucker
Semotilus atromaculatus . . .	Chub
Notropis cornutus	Shiner
Cyprinid (unknown)	

THE PUBLIC HEALTH ASPECTS OF THE POLLUTION OF THE
... STRAIGHT AND CANNON RIVERS ...

The greatest hazard, from a public health standpoint, of stream pollution comes from using the water for drinking and domestic uses. Intestinal diseases such as typhoid fever, paratyphoid, dysentery and diarrhea, are often contracted by drinking water into which sewage has been discharged. There are no municipalities which take their water supply from either the Straight or Cannon River, and most persons who are familiar with the conditions would not drink the water under any circumstances, but it is often the case that strangers, seeing a stream that is clear and apparently unpolluted, use the water for drinking, washing or cooking without knowing the danger to which they are subjecting themselves.

Another danger to health is in connection with milk production. The entire country through which the Straight and Cannon Rivers flow, is agricultural, and in many cases cattle are pastured along the river banks. Cows wade in the stream and may contaminate their bodies and udders, especially where the water is carrying a heavy load of pollution. This contamination may get into the milk at the time of milking, even though measures are taken to prevent it. A small amount of contamination entering the milk from the hands of the milker, or from milking equipment which has been in contact with polluted water, may develop rapidly, as milk is a favorable medium for the growth of bacteria.

Bathing in polluted waters is dangerous, not only because of the chance of contracting intestinal diseases by taking water into the mouth and digestive tract, but also because of the possibility of infecting the eyes, ears, nose or throat with some of the streptococci which are normal inhabitants of the intestinal tract and of sewage. If the swimmer has any open sores or abrasions, these may become infected by contact with the polluted water. It is therefore unsafe to bathe in any water which is known to be polluted, especially if the polluting material is domestic sewage. In the section of the Straight and Cannon Rivers from Owatonna to Byllesby Lake and from Cannon Falls to below Welch, the bacterial quality of the water fails to conform with the standards set forth by the Joint Committee on Bathing Places of the American Public Health Association and the Conference of State Sanitary Engineers.

Boating in polluted waters is likewise dangerous in that persons are likely to get their hands and clothing in contact with the water, either directly or by handling lines and nets which are wet with the polluted water. Contamination may later be carried to food or to open sores and result in an infection.

Flies constitute an important source of disease in this connection. As high water recedes it leaves on the banks deposits of sludge and scum which may be attractive to flies. The flies may carry material from these deposits into the home and leave it on food or dishes or in the milk or water which is used for drinking. This material may very easily contain disease-producing bacteria.

GENERAL CONCLUSIONS

This investigation was undertaken for the purpose of determining the extent and effect of the pollution of the Straight River from its source to its junction with the Cannon River at Faribault, and of the Cannon River from above Faribault to its junction with the Mississippi River above Red Wing.

Information obtained shows that the river system is receiving polluting material from Owatonna, Faribault, Northfield and Cannon Falls in amounts sufficient to have considerable effect on the quality of the water. Both sewage and industrial wastes contribute to this effect. The sources of pollution are sufficiently far apart to permit the water to be greatly improved before entering the next municipality in each case.

The runoff is rapid following rains and thaws because of the nature of the watershed and consequently the stream flow is very low during the winter when the water is covered with ice and during the summer when the water temperature is highest. These factors increase the seriousness of the situation since they limit the ability of the water to purify itself.

The most serious conditions of pollution exist below Owatonna where the stream flow is low. Analyses of samples show that, during most seasons at least, the pollution contributed at Owatonna has practically disappeared by the time the Straight River enters Faribault. Because of the greater stream flow below Faribault, the concentration of pollutional material is less than it is below Owatonna, but here the flow is more rapid and the effect on the stream is still evident as the water enters Northfield. The effect of the discharge of sewage and waste from Northfield extends to Byllesby Lake, but is not measurable below this lake. The pollution contributed at Cannon Falls and at the Mineral Springs Sanatorium affects the river at least as far as Welch and was evident at the Bridge on Highway No. 3 during the investigation of the pollution of the Mississippi River in 1926 to 1928.

The investigation shows that a hazard exists from a public health standpoint, especially in the grossly polluted areas, to persons bathing, wading or in any way coming in intimate contact with the river water or the deposits of sludge. Nuisances are common in the vicinity of sewer outlets and at points where sludge banks have been formed. Certain portions of the stream, particularly the section immediately below Owatonna, are not suitable for fish life in the present state of pollution.

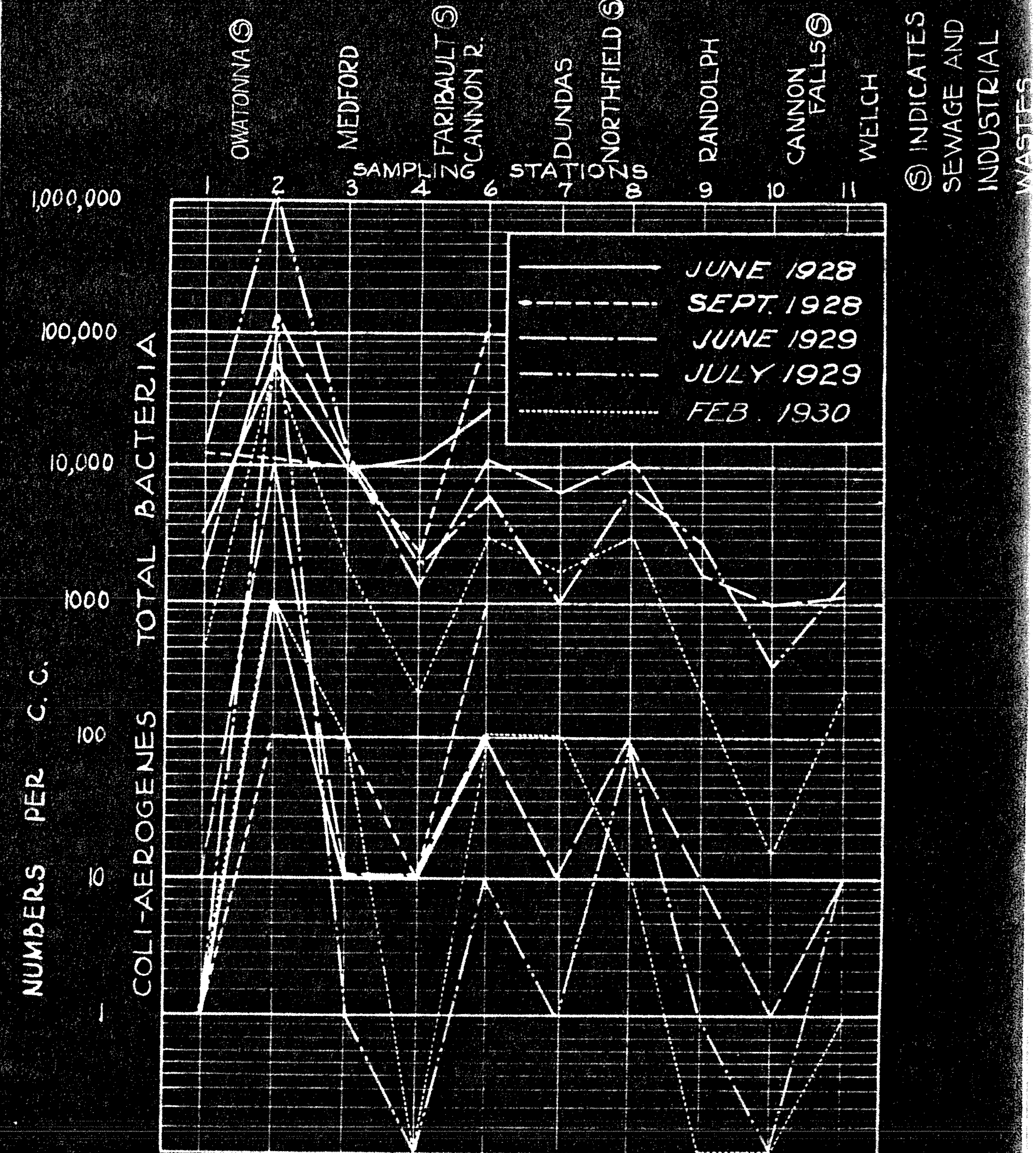
STATEMENT OF REQUIREMENTS

It is the opinion of the Minnesota State Board of Health and the Minnesota Commissioner of Game and Fish that the strength of the sewage and industrial wastes discharged into the Straight and Cannon Rivers should be controlled to such an extent that the public health hazard will be reduced to a minimum, that fish life will not be jeopardized by the pollution, that the health of livestock will not be endangered, and that the present local nuisances will be eliminated. Owing to the limited discharge of the Straight River during certain seasons, it may be difficult to maintain fish life in that section of the stream from the dam at Owatonna to Medford during low water periods.

In order to meet the above requirements it will be necessary to develop comprehensive plans and make the necessary provisions for the collection and treatment of the sewage and industrial waste discharged into the Straight and Cannon Rivers.

ACKNOWLEDGEMENTS

During the course of this investigation the municipalities and institutions involved were very generous in giving information and assistance. This Department is especially grateful to the officials of the cities of Owatonna and Faribault where the city engineers gave considerable time to the collection of samples of sewage and wastes and compiling information on populations. The State Board of Control through the superintendents and engineers of the institutions at Owatonna and Faribault, gave valuable information on populations, sources of wastes, etc.



BACTERIA - TOTAL NUMBER OF BACTERIA PER C.C. AT 37°C. - 48 HOURS, AND NUMBER OF ORGANISMS OF COLI-AEROGENES GROUP PER C.C. ON DATES OF SAMPLING