

1960

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Recommended Citation

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PUBLIC HEALTH
CONSIDERATIONS
OF THE
KENDUSKEAG STREAM
BANGOR

NOVEMBER, 1960

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WILLIAM J. CARNEY
HEALTH OFFICER

City of Bangor, Maine

DEPARTMENT OF HEALTH

November 18, 1960

Mr. Joseph R. Coupal, Jr.
City Manager
City Hall
Bangor, Maine

Dear Mr. Coupal:

The attached report on the Kenduskeag Stream is submitted in accordance with your request of September 15, 1960.

It is my understanding that Dr. Frederick Whittaker expressed some concern over the possible health hazards generated by Kenduskeag Stream sewage.

This department with the laboratory assistance and consultation services of the State of Maine Water Improvement Commission have tried to describe this problem in the following pages.

Sincerely,

WJC/cc

William J. Carney
Director of Public Health

More than 350 years ago the first white man excreted his wastes into the Kenduskeag Stream. Today, the City of Bangor offers its citizens the same sewage treatment facilities as that given to the crewmen of Samuel de Champlain's ship in 1604.

This report attempts to describe the extent of pollution in the Kenduskeag Stream and point out the potential health hazard of this foul smelling watercourse that divides our city with the sewage of our citizens.

CONCERN 1960

In September 1960, the City Health Department received a call from a resident of Valley Avenue, advising us that a tank truck belonging to one of the construction companies was withdrawing water from a point in the stream where there would be a considerable amount of sewage. This tank truck pumped the sewage from the stream and sprayed it on the Interstate Highway in order to keep dust at a minimum. This unusual practice of distributing sewage was halted.

Several items of sanitary significant were noted in the Kenduskeag Stream:

1. The summer of 1960 was particularly dry and drought conditions existed in the stream.
2. As the stream decreased in size, sewage solids had accumulated on the sand bars.
3. A thick green scum mixed with feces formed in the shallow eddies of the stream.
4. The dam at Maxfield's retarded the flow of water. The dam together with diminished stream flow created a pool of sewage. Gas bubbles could be seen as anaerobic decomposition occurred in the accumulated sewage sludge.
5. Evidence of children playing on rocks not previously exposed, a fishing bobber wound around a telephone line, animals running along the banks of the stream, were of public health concern because of the abundance of human sewage in which these children and animals were playing.

Supply

STREAM POLLUTION SURVEY

In conjunction with the State of Maine Water Improvement Commission, a stream pollution study was undertaken in that portion of the Kenduskeag Stream that flows through the City of Bangor.

Water samples were collected from the stream at various locations:

1. Bridge at Six Mile Falls on Route #15.
2. 300 yards above Capehart Sewage Treatment Plant.
3. Bullseye Bridge, Griffin Road.
4. Old Flour Mill Dam near Bruce Road.
5. Valley Avenue Bridge above S.A. Maxfield's.
6. Covered Bridge, Harlow Street.
7. Washington Street Bridge.

Several bacteriological and chemical tests were performed. (Table I) A selection of these tests are described.

DISSOLVED OXYGEN (D.O.)

Oxygen is an important factor in the self-purification of polluted streams, because free oxygen readily unites with decomposing organic matter. Dissolved oxygen (D.O.) is different from the oxygen that is chemically united with hydrogen to form water. Dissolved oxygen is derived through solution from the air at the water surface and from the life processes of algae. It is lost by the oxidation of unstable organic matters. The dissolved oxygen content of water is dependent upon the amount and character of the unstable organic matters in the water. Tests made for dissolved oxygen are highly indicative of the sanitary condition of water. A succession of tests made on a stream below a point of heavy pollution will show a sharp reduction of dissolved oxygen content and a slow recovery of the oxygen as it is absorbed at the water surface. For comparative purposes, dissolved oxygen contents are expressed in terms of parts per million.

BIOCHEMICAL OXYGEN DEMAND (B.O.D.)

The oxygen in a stream when combined with the organic matter of sewage will react in a process known as aerobic decomposition. This will occur until the oxygen demand is satisfied. The amount of oxygen absorbed during this self purification process is known as the biochemical oxygen demand. The biochemical oxygen demand is an important indication of the amount of organic matter in a sample of water.

pH DETERMINATIONS

Alkalinity and acidity of water, is frequently expressed in terms of pH. A pH of 7 expresses neutrality, a water that is neither alkaline nor acid; less than 7 indicates acid, more than 7 indicates alkalinity. Fresh sewage is slightly alkaline, but as it becomes stale it becomes acid.

COLIFORM ORGANISMS (MOST PROBABLE NUMBER)

Intestines of men and warm blooded animals, contain bacteria known as coliform organisms. They are usually harmless to their hosts and are excreted in large numbers in the bowel discharges. When the discharges enter water, coliform bacteria are present and can be easily detected by simple laboratory tests. The polluted water is diluted in the laboratory into minute amounts and an estimate of the total number of bacteria in the sample is made depending upon the extent the sample must be diluted before negative results are obtained. The most probable number of coliform organisms per 100 milliliters is a bacteriological measurement of the extent of water pollution. Three of the samples were reported with a most probable number of 11,000,000 coliform organisms per 100 milliliter portion. There are nearly 1000 milliliters in a quart. These results thus indicated approximately 110,000,000 coliform organisms per quart of water.

BACTERIOLOGICAL AND CHEMICAL ANALYSIS
AVERAGE OF RESULTS OCT. 11, 12, 17, 19
KENDUSKEAG STREAM, BANGOR

SAMPLING POINT	DISSOLVED OXYGEN P.P.M.	BIOCHEMICAL OXYGEN DEMAND	pH	COLIFORM ORGANISMS M.P.N.
SIX MILE FALLS BRIDGE	10.8	1.1	7.35	1500
ABOVE CAPEHART SEWAGE PLANT	10.6	0.9	7.35	170
BULLSEYE BRIDGE, GRIFFIN ROAD	12.4	2.3	7.8	900
FLOUR MILL DAM, BRUCE ROAD	11.9	1.9	7.8	2700
VALLEY AVENUE BRIDGE	4.6	13.3	7.1	5,000,000
COVERED BRIDGE, HARLOW STREET	3.8	30.2	7.1	6,000,000

STREAM CLASSIFICATION

The Maine State Legislature has classified the Kenduskeag Stream above Bullseye Bridge as Class B-2. Below Bullseye Bridge it is Class D. Waters of Class B-2 are acceptable for recreational boating, fishing, industrial and potable water supplies after adequate treatment. Class D waters, the lowest classification, are considered as primarily devoted to the transportation of sewage and industrial wastes without the creation of a nuisance condition.

INTERPRETATION OF RESULTS

As the Kenduskeag Stream reaches the outskirts of Bangor, there is little evidence of pollution. All of the usual indices of pollution are quite normal and within the standards of the B-2 Classification established by the Legislature. After passing the outfall of the Capehart Sewage Treatment Plant, some changes are apparent. Observation of the stream bed reveals great masses of vegetation. This excessive growth of algae in the stream is the direct result of fertilization with phosphates and nitrates in the treated sewage. The natural phenomenon of photosynthesis accounts for the increase in dissolved oxygen and pH, while the sewage itself accounts for the small increase in biochemical oxygen demand. In general, the tests indicate that the quality of the water is consistent with Class B-2, downstream as far as the old Flour Mill Dam at the Bruce Road.

Downstream from Bruce Road Dam, four sewage outfalls enter the Kenduskeag Stream. Within a distance of approximately 400 yards, the household sewage from 1643 dwelling units spills into the stream.

At the bridge on Valley Avenue, the changes that have taken place in the stream reflect the excessive load of pollution that has been added from these sewers. The coliform organisms, which are indicators of potential hazards from pathogenic bacteria are measured in the millions. The dissolved oxygen is reduced to about one-half of normal. The biochemical oxygen demand increases sharply.

At the Covered Bridge, on Harlow Street, near the head of the tide, the effects of additional pollution are clearly shown by a continuation of the trend first seen at the Valley Avenue Bridge.

Interpretation of samples collected at the Washington Street Bridge is complicated by the influence of the tide. Only twice a day at extreme low tide would samples reflect the waters of the Kenduskeag Stream. Even at low tide, much of the flow remains Penobscot River water that is still receding. Only two samples were collected at the Washington Street Bridge. The most accurate interpretation of these samples is that this stream segment shows a high degree of pollution with the quality varying with the tide.

PUBLIC SEWAGE DISPOSAL

How much sewage enters the Kenduskeag Stream?

In an attempt to answer this question, a count was made of the number of dwelling units contributing sewage to the four outfalls between the Flour Mill Dam and the Valley Avenue Bridge. The quarterly water consumption figures of 20 dwelling units in the 16th Street area were recorded. These figures were exclusive of summer months consumption. It was estimated that the average family in this area utilized 269 gallons of water per dwelling unit, per day.

Many factors must be considered when estimating the amount of sewage leaving an outfall. Metered water which does not enter the disposal system, would lower the estimate of sewage. Leaks in the sewer line and infiltration of ground water would increase the estimate of sewage. Some authorities assume that the average rate of sewage flow, including a moderate allowance for infiltration, equals the average rate of water consumption. Using this criterion it is estimated that approximately 500,000 gallons of household sewage a day enters the Kenduskeag Stream in the 400 yards below the Bruce Road outfall.

WATER VOLUME IN THE KENDUSKEAG STREAM

How much water is in the Kenduskeag Stream?

The United States Geological Survey maintains a water gauging station on the Kenduskeag Stream above Six Mile Falls. This gauge measures the stream flow. Unfortunately, the gauge was being recalibrated during the time of this study. However, some interesting information derived from past records is presented. A curve of flow duration made from the records of a ten year period from 1948 to 1957, show that the stream flow is less than 7,000,000 gallons per day, about ten percent of the time and less than 3,500,000 gallons per day, about 5 percent of the time.

A hydrograph of low August and September flows for four selected years showing average flows for 7 consecutive days indicates extended periods when the water flow in the Kenduskeag Stream does not exceed 3,500,000 gallons per day. In one year, the average flow for 7 consecutive days was at a low of approximately 750,000 gallons per day. The 1650 dwelling units polluting the stream in the 400 yards below the Bruce Road contribute approximately 500,000 gallons of sewage per day. In all, the sewage from approximately 4500 dwelling units enters the stream at some point.

All of the sewage from the east side of the city except the section bounded by State Street, Palm Street and Mount Hope Avenue and some between York Street and the Penobscot River enters the Kenduskeag Stream. All of the sewage on the west side of the city except the section bounded by Hammond Street, Union Street and the Penobscot

River enters the Kenduskeag Stream.

It is evident that at certain times of the year, in certain sections of the Kenduskeag Stream there is less water flowing in the stream than there is sewage. During this time, the Kenduskeag Stream is more sewage than water. Environmental conditions are ripe for epidemic of intestinal disease.

PRIVATE SEWAGE DISPOSAL

How many people live in areas without a sewer?

If you live in those areas of Bangor, fortunate enough to be serviced by a city sewer; flushing the toilet, pulling the plug in the bathtub or pushing the button on the garbage disposal unit is often your only concern with sewage disposal. Once you have performed these actions, you can forget about sewage disposal until you whiff your own wastes floating down the Kenduskeag Stream or the Penobscot River.

People in other areas of the city are not so fortunate. They must dispose of their own wastes on their own land. Private sewage disposal facilities exist in 380 dwelling units in the urban portion of the city where either public water or sewers are available. This figure does not include private sewage disposal facilities in the more rural sections of Bangor. A pit privy exists within a few hundred feet of the corner of West Broadway and Union Streets, certainly considered by most to be a built up urban section of our city. (Table II)

The basic point to be emphasized in these statistics is that when municipal water is extended to an area of our city, the area develops. Public sewers should also be extended to these areas because health problems are created when water is provided and sewage disposal facilities are not available.

PROBLEMS FOR THE FUTURE

In the area between Broadway and the Kenduskeag Stream, where most people seem to predict the growth of the city, any development will increase the sewage in the four sewers entering the 400 yard stretch of stream below the Bruce Road. In the

immediate future, the sewage from the new high school will enter this area, there are plans for a mobilehome park of 156 units on the Strickland Road, a sub-division of 150 housing units on the Strickland Road, the Elm Farm Food Company plans to construct a Shopping Center on Broadway, other sub-divisions are planned on Broadway, and a proposal for additional facilities for Husson College has been suggested. On the other side of the stream, the sewage from the new Fourteenth Street School has already been added to the 500,000 gallons previously estimated in this report. The problem of sewage disposal in the Kenduskeag Stream continues to increase.

SOLUTIONS TO THE PROBLEMS OF SEWAGE DISPOSAL

The Proposed Municipal Budget for 1961 was submitted by the City Manager to the City Council on November 1, 1960. A section of this document is quoted herewith:

4. Sewers.

- A. Kenduskeag Stream Interceptor. With the construction of a section of the Kenduskeag Stream Interceptor under the new parking project, and with the increasing amount of pollution being discharged in the Kenduskeag Stream, it seems important to consider at this time the continuation of the Interceptor Sewers up to approximately the location of the Interstate Highway. This would take in the last two major outfalls and would eliminate almost all of the sewage now discharging into Kenduskeag Stream. The City Engineer has estimated the cost of this portion of the project to be \$300,000.
- B. Treatment Plant Site. It is obvious that sometime in the not-too-distant future it will be necessary to construct a sewage treatment plant. While land is still available in the lower Main Street area where the treatment plant should be constructed, it seems evident that the city should take steps to acquire the necessary tract of land. It is estimated that acquisition of a site somewhere between the Maine Central Railroad and the river on lower Main Street would cost about \$30,000.

EFFECTS OF THE KENDUSKEAG STREAM PROJECT

When the voters of Bangor approved the referendum to develop the Kenduskeag Stream Project, the interceptor sewers on both sides of the stream between State and Washington Streets, were included. It is most economical and practical to construct these interceptor sewers while the major development of the stream is in process.

The proposed interceptor will extend only slightly beyond the Washington Street Bridge, at which point all of the wastes picked up from Hammond and State Streets

and along Broad and Exchange Streets will be returned to the Kenduskeag Stream. All the sewage entering the stream above State Street will continue to flow unabated.

The Kenduskeag Stream will remain a nuisance and a health hazard until:

1. The Kenduskeag Stream interceptor has been completed.
2. Interceptor sewers on both sides of the stream are connected, below the Washington Street Bridge.
3. The sewage is then transported to a treatment plant or to a discharge plant further down the Penobscot River.

PUBLIC HEALTH SIGNIFICANCE OF PROPER SEWAGE DISPOSAL PRACTICES

The abatement of the nuisance created by the sewage of our citizens flowing through the heart of our City is such an obvious improvement that it does not require documentation.

The major public health problem resulting from the lack of sewage treatment is the threat of an epidemic of intestinal diseases. The treatment of these diseases has virtually eliminated many of them from common occurrence. Immunization and vaccination has decreased the incidence of others. Yet, epidemics still occur.

An epidemic represents a definite phase in the equilibrium of a reaction in which three factors are involved; a pathogenic organism, people, and the environment which surrounds both. The Kenduskeag Stream is a hazardous environment. The people are susceptible. The pathogenic organism will someday complete the reaction. An epidemic will occur. This fact is as inevitable as the sewage itself.

Bangor has two choices. Either we can wait for the epidemic to come, and feel guilty because we didn't act sooner; or we can act now and prevent the occurrence of an epidemic.

TABLE I

ANALYSIS OF SAMPLES FROM KENDUSKEAG STREAM
October 1960

STATION	10/11	10/12	10/17	10/19	Avg.
	Dissolved	Oxygen	in p.p.m.		
1. Six Mile Falls Bridge	10.6	10.8	10.5	11.2	10.8
2. Above Capehart Sewage Plant	10.5	10.1	11.1	10.5	10.6
3. Bullseye Bridge, Griffin Rd.	13.0	12.3	9.9	14.4	12.4
4. Flour Mill Dam, Bruce Rd.	13.8	10.5	10.9	12.5	11.9
5. Valley Avenue Bridge	2.8	4.0	7.4	4.1	4.6
6. Covered Bridge, Harlow St.	3.0	3.5	4.6	3.9	3.8

The water temperature varied between 11° C. and 8° C.

Percent Saturation of Dissolved Oxygen

1. Six Mile Falls Bridge	96	96	93	95	95
2. Above Capehart Sewage Plant	93	89	98	89	92
3. Bullseye Bridge, Griffin Rd.	115	109	87	124	109
4. Flour Mill Dam, Bruce Road	120	93	96	106	104
5. Valley Avenue Bridge	20	36	65	35	39
6. Covered Bridge, Harlow St.	27	31	41	33	33

Biochemical Oxygen Demand in p.p.m.

1. Six Mile Falls Bridge	1.8	.6	1.0	1.0	1.1
2. Above Capehart Sewage Plant	1.6	.4	.4	1.0	.9
3. Bullseye Bridge, Griffin Rd.	4.6	.7	1.0	3.0	2.3
4. Flour Mill Dam, Bruce Road	2.2	1.3	2.2	1.8	1.9
5. Valley Avenue Bridge	11.4	16.2	6.6	19.0	13.3
6. Covered Brige, Harlow St.	46	25	22	28	30.2

Coliform Organisms in M.P.N. Per 100 ml.

	10/11	10/12	10/17	10/19
1. Six Mile Falls Bridge	93	1,100	150	230
2. Above Capehart Sewage Plant	150	43	390	93
3. Bullseye Bridge, Griffin Rd.	150	2,300	930	230
4. Flour Mill Dam, Bruce Road	390	930	9,300	230
5. Valley Avenue Bridge	2,400,000	11,000,000	4,600,000	1,500,000
6. Covered Bridge, Harlow St.	11,000,000	11,000,000	1,500,000	930,000

pH

1. Six Mile Falls Bridge	7.4	7.4	7.3	7.3
2. Above Capehart Sewage Plant	7.3	7.4	7.3	7.2
3. Bullseye Bridge, Griffin Rd.	8.4	8.3	7.4	8.2
4. Flour Mill Dam, Bruce Road	8.4	7.9	7.4	7.4
5. Valley Avenue Bridge	7.0	7.3	7.1	7.0
6. Covered Bridge, Harlow St.	7.3	7.2	7.0	7.0

TABLE II
STREET

	NUMBER HOUSES PRIVATE WATER SUPPLY	NUMBER HOUSES PRIVATE SEWAGE DISPOSAL	MUNICIPAL WATER AVAILABLE	MUNICIPAL SEWAGE DISPOSAL AVAILABLE
Harvard St. (above Colby)	2	3	yes	no
Yale St.	2	5	yes	yes
Dartmouth St.	1	5	yes	no
Hickory St.	4	4	no	no
Park Row	0	0	yes	yes
Opal St.	0	1	yes	no
Colby St.	0	0	yes	yes
Boylston St.	6	10	yes	no
Green St.	3	6	no	no
Cherry St.	1	3	yes	no
Stacy Ave.	2	3	yes	no
Upper Fern St.	5	6	yes	yes
Stillwater Ave. to Fern St.	1	1	yes	yes
Upper Birch St.	1	1	yes	yes
Hamlin Ave.	0	4	yes	no
Ash St.	0	2	yes	no
Thatcher St. (beyond Crosby)	0	9	yes	no*
New York St.	6	6	no	no
Hammond St. from overpass to Dow Field	0	8	yes	no
Hammond St. from Dow Field to Hermon Line	0	52(1)	yes	no
Odlin Rd. from Dow Field to Bulge	0	7	yes	no
Odlin Rd. from Bulge to Viner's	0	3	yes	no
Eighth St. (rear W. Broadway)	1	1	no	no
Essex St. from Interstate Highway	0	12	yes	no
Mount Hope Ave.	0	5	yes	no
Young St.	0	5	yes	no
Meadowbrook Rd.	0	3	yes	no
State St. (beyond E.M.G.H.)	0	30(2)	yes	no
Summit Ave.	0	1	yes	no
Hogan Rd., State St. to Mount Hope Ave.	0	13(3)	yes	no
Forest Ave. (beyond Milford St.)	0	5	yes	no*
Broadway (beyond W.L.B.Z.)	0	11	yes	no
Kenduskeag Ave. from Montgomery to Orphanage	0	31	yes	no
Ohio St., Westland St. to Davis Rd.	0	110(4)	yes	no
Lee St.	0	5	yes	no
Whitney St.	0	2	yes	no
Union St. from Dunning Blvd. to Griffin Rd.	0	5	yes	no
Bruce Rd.	2	2	no	no
TOTALS	37	380	33 yes 5 no	6 yes 32 no

*Indicates a change in these areas. Since this information was obtained, new sewer lines have been installed.

- (1) 37 Trailers
- (2) 18 Motel Units
- (3) 4 Trailers
- (4) 56 Trailers