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FINAL REPORT ON THE ANDROSCOGGIN RIVER

ODOR IN THE LEWISTON-AUBURN AREA

1943.

In accordance with an agreement made with Dr. A. D. Woolley on the 19th of May, 1943, daily observations on the conditions of the Androscoggin River odor in the Lewiston-Auburn area were begun on the 13th of June, 1943, and continued through the 30th of September, 1943. During October, 1943, weekly inspections were made. The majority of the regular observations were conducted at some time during the afternoon or early evening, but for variation some were made in the morning. Additional inspections were conducted whenever conditions appeared to warrant them. Weekly observations were recorded as to conditions in the region of the (a) U. S. Gage Station, River Road, Auburn, (b) Deer Rips and Galf Island Jams, and (c) Androscoggin "Pond".

The Daily Report contains data on

- (a) Air temperature at station #6
 - (b) Humidity at station #6
 - (c) Weather conditions
 - (d) Wind velocity
 - (e) Wind direction
 - (f) Volume over Lewiston Falls
 - (g) Color of river water
 - (h) River surface conditions
 - (i) Type of river odor
 - (j) Intensity of river odor
- This order will serve as an index to the subject matter of this Report.

After careful consideration of all the known factors, eight locations in the two cities were chosen for the daily observation stations.

Table #1
Location of Observation Stations

| | | Barron's Map | # |
|----|-------------------------------------|--------------|------|
| 1. | Spruce & Park Streets, Lewiston | " | 0.5. |
| 2. | South Bridge, Lewiston-Auburn | " | D.3. |
| 3. | North Bridge, Lewiston-Auburn | " | 0.5. |
| 4. | Main & Canal Streets, Lewiston | " | 0.5. |
| 5. | Holland & Spring Streets, Lewiston | " | B.4. |
| 6. | Campus & Bardwell Streets, Lewiston | " | C.4. |
| 7. | Book & Sixth Avenue, Auburn | " | D.2. |
| 8. | Oak & Hampshire Streets, Auburn | " | B.2. |

Air Temperature The temperature of the air was recorded by a Taylor "Temprite" outdoor thermometer kept in a shaded position at 111 Bardwell Street, Lewiston. In general the temperature stated in the reports is that at the beginning of observations.

Humidity The values contained in the reports are those obtained by the Wet & Dry bulb method, Taylor instrument, after vigorous agitation of the air for two minutes. These values are not precise, but should be sufficiently accurate for most uses. All readings were made at 111 Bardwell Street, Lewiston.

Weather Unless otherwise stated the record refers to the weather conditions in the two cities during the period of observation. Usually the terms employed would apply to the whole day.

Volume over Lewiston Falls The volume of water flowing over the Lewiston Falls was recorded in very general terms only, but they are sufficient for use in connection with the odor conditions in the North Bridge region. The larger the volume passing over the Falls, the larger is the turbulence, therefore greater opportunity for aeration and the liberation of dissolved gases. This year the volume was noted as large on eight days in the latter part of June and only five days to the 30th of September. Excluding June the volume was recorded as moderate on ten days. Water levels on the river system were higher during 1945 than in many previous years.

Color of River Water The color of Androscoggin River water is that observed from the North and South Bridges. In large masses the color of the river water which appeared to be medium brown in June slowly changed to a darker brown as the summer progressed until a decided blackish appearance was reached and this has remained to date. The turbulent water at the foot of the powerhouse at Gulf Island Dam was usually quite yellowish in color and hydrogen sulphide odor was nearly always present. On the 10th of October, 1945, the color of the turbulent water at this location was decidedly blackish and only pig pen odor was detected. The difference in color was quite impressive. This was the first time I had noticed this color change and also the first occasion when only pig-pen odor was recorded at this position.

Wind Velocity Unfortunately, data on wind velocity in this area are very meagre; those for 1945 are at present unavailable in a useful form and, for this reason, the Daily Reports do not contain wind velocities. In Lewiston and Auburn region, as elsewhere, the wind velocity usually drops to a very low number and often zero sometime after sunset and, with small variation, remains thus until sometime after sunrise when an increase may, though not necessarily, occur. This fact is emphasized because of its relation to what is known as early morning river odor. The term is used to include odor which may appear in the late evening, but usually after midnight and remains for an indefinite period, sometimes as late as eight or nine o'clock in the morning. These facts raise the question as to why the river odor spreads over wide

3.

city areas during periods of very small or zero wind velocities.

For obvious reasons the Daily Reports do not adequately cover this phase of the odor problem. Whenever the writer observed the odor in the early hours of the morning, the fact was recorded; also when such occurrences were reported to him, due note was made. The odor observed is usually a complex one. During 1943 the odors recorded were musty, pig-pen, and Hydrogen Sulphide, and, one one occasion, waste sulphite liquor-sulphur dioxide. Intensities were generally $\frac{1}{3}$, but at times $\frac{1}{4}$. This year local citizens have commented, more than usual perhaps, about the odor in the early morning. This may be due to the fact that the mills have operated through the night and a considerable number of persons pass to and from the shipyards at unusual hours.

Wind Direction

The direction of the wind as reported was that of a reading made at Station #6 before observations began and was usually checked at Station #7 in New Auburn about forty minutes later. These directions may not, and most of them do not, coincide with the Weather Bureau's report which are based on the average of a number of readings taken during the day.

The effect of the direction and velocity of the wind on the dispersal of river odor is of considerable importance. The Bates College Weather Bureau has daily wind direction data covering a ten year period. The Director, Dr. L. Fisher, has furnished the writer with ten year monthly "Means"; photographic copies of these for May, June, July, August, September, and October are enclosed and made part of this report.

Examination of these data for the decade 1933-43 reveals that the wind direction in the average year is

| | | | |
|-------|----------|----|---------|
| N. W. | 140 days | S. | 19 days |
| S. E. | 79 days | E. | 10 days |
| N. E. | 74 days | W. | 4 days |
| S. S. | 37 days | N. | 3 days |

and that for the average June, July, and August is

| | | | |
|-------|-----------|----|----------|
| N. E. | 25.7 days | S. | 9.6 days |
| S. W. | 22.1 days | E. | 2.0 days |
| S. E. | 14.1 days | W. | 1.8 days |
| N. E. | 12.2 days | N. | 0.6 days |

The Androscoggin River in this area flows almost due north and south; the Deer Rips and Gulf Island Dams are located North by North East of the city; the location of the Androscoggin "Pond" is essentially N.E.E. of Lewiston. In addition to the river and "pond" areas which are essentially quiescent regions, there are several important positions of turbulence, Gulf Island Dam, Deer Rips Dam, Lewiston Falls, and the Canal Gate House. Other less important positions should be included--Libbey-Gowen tail-race which is usually 10 to 15 feet above the river level and where part of the water dashes against a large rock, the Lewiston Bleachery tail-race, and the rips near the U. S. Gage Station about one mile below South Bridge.

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The prevailing summer winds in this area being N.W. and S.W. are such that any odor from the river in the city is more apt to be carried into the Lewiston area than into Auburn. This year observations tend to corroborate this statement, but too much emphasis should not be made on this point, as the peculiar land contour introduces complications. The Lewiston Falls is relatively close to the business sections of both Lewiston and Auburn and are directly N.W. of downtown Lewiston. While these Falls are important, they can be overrated as a factor in the release of odor. This year the water level has been unusually high yet the volume of water allowed to pass over the Falls was very often zero, and in "dry" summers water is seldom seen flowing over them. One of the highest concentrations of odor observed this year on the North Bridge was when the volume over the Falls was zero, the odor was pig-pen. However, given a high concentration of odor in the water and a large volume flowing over the Falls the release of odor could be very large, but such conditions were not observed this year. *and with favorable winds wide distribution,*

The Gate House and Canal being a part of the business area odor from these two sources can infiltrate readily into this region. Northwest winds distribute river odor from these points into the shopping area even at a low velocity. The turbulence and consequent release of odor at the Gate House are important. An odor gradient exists from this point usually falling rapidly in intensity inland, less rapidly along the direction of the canal, subject, of course, to wind direction and velocity. Odor from this position and along the canal seldom spread very far even with moderate wind, two or three hundred feet being the limit, usually not more than fifty to one hundred feet, but even at the lower limits large number of people pass through that area, not to mention those working there.

The North-North East position of the Dams and "Pond" is such that the wind during June, July, and August on an average will be favorable for the distribution of odor toward the two cities from these sources, for a considerable number of hours on about twelve days. This would be a minimum as relates to wind for the wind could remain N. N.E. for two hours or so and still may not affect the Soother Bureau's reported direction very much. A study of the Daily Reports reveals that on the occasions (7/21/43, 7/22/43, 8/4/43) of very wide distribution of odor the wind was in a northerly direction. On the 4th of August the odor intensity definitely increased as the region of the Dams was approached.

River Surface Conditions The surface of the river presented an every changing picture. For the purposes of this report only three variables are described (1) foam, (2) film, (3) sludge.

Foam Foam as observed on the Androscoggin River is usually one of two types, a large bubble foam which is apt to break down rapidly or a small bubble foam of much greater persistency. The latter is impressed by the frequency he observed foam disappearing to a film. In general a coarse foam tends to localize the escape of odor to the region

of turbulence, whereas a more persistent foam, due to the slower rate of collapse, produces a wider distribution of odor. Attempts to correlate the type of foam with the dominant odor were not successful. With approximately the same amount of agitation foam may change from one type to the other in a few hours and no noticeable change in odor occurs. However, the fact should be recorded that on several occasions fine foam was associated with pig-pen odor. (Does a fine foam afford an opportunity for re-solution of hydrogen sulphide?) Under certain conditions the small bubble foam drifts into sheltered positions along the shore and becomes the silty scum frequently seen along the river below the Lewiston Falls. The color of the foam is "off-white", usually toward a brownish tint, but may have grayish tone. The persistency and spreading characteristics of "fine" foam seem to suggest the presence in the water of a rather effective foaming and spreading agent.

Film

Films observed this year on the surface of the Androscoggin River may be classified in order of importance as (a) brownish, (b) bluish, (c) whitish, (d) colorless, (e) gray, (f) dull black, and (g) lustrous black. All these types with the exception of the last appear to have an oily-greasy base.

(a) Brownish Film The color of this film is due to finely divided suspended material which, on one occasion at least, was soil particles, but at times resembles brown sludge particles. When a small amount of this film is rubbed between thumb and finger the odor is invariably musty or pig-pen or both. Brownish film was frequently observed in large areas on the river, notably in the region of the Grand Trunk Railway bridge, while on the "Pond" it has been observed to cover acres of surface.

(b) Bluish Film A very thin film seldom found near regions of turbulence but often observed below the North Bridge. The film has many characteristics of hydrocarbon films but does not possess iridescence and has not been observed to carry suspended material. Generally seen covering relatively small areas.

(c) Whitish Film This film is always formed from foam. Relatively thick, very oily and has a remarkably close resemblance to a "spent" soap film containing wetting-out agents. The area occupied is best described as "spotty", individual units are seldom more than a few inches in diameter unless water currents force them into streamers. The almost daily appearance of this film especially in region below Lewiston Falls, regardless of odor conditions, would suggest that any connection it may have to odor cannot be specific.

(d) Colorless, transparent Film. Certain observations suggest a possible relation of this to other films especially the whitish film. Very thin and extremely difficult to detect, even an experienced observer may fail to notice it until its presence is revealed by a change in his position, or in light effects. During some days it presents a very greasy appearance.

(e) Grayish Film Often occupying appreciable areas, this film appears to have a greasy base and to support fine grayish particles. The color resembles that often seen on the under side when floating sludge masses are lifted from the water. The odor of the film is variable but frequently musty.

(f) Dull Black Film This thin but greasy film contains very black suspended matter and may be seen in many different areas on the river, but most frequently between Deer Rips and Gulf Island Dam. Close examination has not been made on this film has not been observed within arms reach of the shore. Often forms narrow, short, and irregularly shaped streams.

(g) "Glossy" Black Film. Seldom reported this year. Occupies small surface areas nearly always in the region of sludge containing blue-green algae. The destruction of this film may furnish the black particles mentioned under (f).

The relation of film on river surfaces to the odor problem is a subject for speculation. Some of these films are very tenacious and may retard the escape of odor from the water. When these occupy large areas, as they frequently do, especially in the "pond" region, they may be a factor in the distribution of river odor. The Daily Reports contain references to the fact that large volumes of gas visibly rise to the surface from the bed of the river and also to the delaying of escape of the gas into the air because of the tenacity of the surface film. Presumably, methane is the major constituent of this gas and any delay in its escape would favor the solution of any slightly water soluble compounds which might be present. Further, these films may function as an effective barrier between the air and water thus retarding the absorption of oxygen.

Sludge (3) This is the term used to describe the compact masses of fibrous material observed floating in the water or stranded along the shore. The same type of fibrous substance in loose form has been noted under water lying on the river bed near the shore line in the "pond" area. Generally a dark brown color on the portion exposed to the air and light, but gray, copper color, blue green, and black variations exist. The portion under the water may be whitish, light brown, blue-green, gray, or even black. The center of one sludge mass was a brilliant yellow.

Sludge was seen on practically every visit to the "pond". At times the number of floating or stranded masses would be very small, especially after even moderate velocity winds, on other visits the area covered could have been measured in acres. These masses, if not broken up in the "pond" area, eventually drift down to Gulf Island Dam and may accumulate there in very large numbers. They are, of course, disintegrated when passed over the Dam but more frequently are dispersed in the whirlpool motion at the entrance to the water intake to the turbines. On the 15th of August the water passing the South Bridge contained large numbers of pieces of sludge about the size of a man's

finger; the volume of water over the Lewiston Falls was reported as large. For two days only, the 30th and 31st of August, sludge masses were observed floating in the region below the North Bridge. Examination of the fibres from sludge masses revealed that while they varied in length, diameter, and strength, they were usually short, of small diameter, and possessed little strength. When squeezed while still very wet and allowed to air dry, there remained a light brown compact and quite cohesive material. The dimensions of some fibres measured in the laboratory gave; length 1.0 cm to 0.1 cm, and diameter 0.3 mm to 0.04 mm.

There appears to be a definite relation between this sludge and pig-pen odor, but what part it plays, if any, relative to hydrogen sulphide is obscure. In the "pond" region hydrogen sulphide was once found to be present in a concentration of 0.005 p.p.m. by the lead acetate test, in an air in which only pig-pen could be identified by the nose. Air in ~~most~~ contact with sludge removed from the water and bottled tightly produces first a light brownish stain and after many hours a black stain on moistened lead acetate paper. Efforts to obtain quantitative data with the lead acetate instrument from sludge removed to the laboratory have, to date, given no worthwhile information, due in part to technical difficulties and to lack of time.

Blue-green Algae

Blue green algae may be seen growing on small sludge masses (about 5" to 4" diameter) at widely separated places along the river. This year, they have been found, only very infrequently, below the Lewiston Falls, but were often seen in the region about one-half mile above the Falls and extending up toward Deer Lips Dam. Never very numerous at any one time, they can be detected readily by their vivid color. The presence of glossy black film is also evidence of their growth nearby. In this area on the 30th of August about 100 feet of the shore line from the edge of the water to about one foot into the river was a mass of blue-green algae; odor, pig-pen, intensity /3. Blue-green algae has been observed growing on large sludge masses stranded, but partly under water along the shore of the "pond."

Odor Intensity

The system employed for reporting river odor intensities is based upon one used by the American Public Health Association for recording odor of potable water. The definitions of intensity are so worded as to make the terms descriptive and understandable. Admittedly limited, the writer has found this system to be very convenient and practical.

Table #2
Intensity Terms
Definition

| Number | Term | Definition |
|--------|------------|---|
| 0 | None | No odor perceptible |
| 1 | Very faint | An odor that would not be detected ordinarily by the average person but that could be detected by an experienced observer. |
| 2 | Faint | An odor that the average person might detect if his attention were called to it but that would not attract his attention otherwise. |

| Number | Term | Definition (Intensity terms continued) |
|--------|-------------|---|
| 3 | Distinct | An odor that would be detected readily. |
| 4 | Decided | An odor that would force itself upon the attention of any individual. |
| 5 | Very strong | An odor of such intensity that the area is made very disagreeable. |

The intensity of river odor was determined on the basis of the effect produced upon the observers olfactory nerves. This method is, of course, an imperfect one, subject to many limitations and is unsatisfactory from an analytical point of view, but it is the only known method for obtaining river odor intensities, with the exception of hydrogen sulphide. The olfactory nerves are very sensitive to many compounds in gaseous state and can detect concentrations of a very low order of magnitude. Parenthetically, the "man in the street" uses the olfactory method and his reactions and comments are governed accordingly.

Frequency of odor intensities covering 108 days, the period from 13 June 1943 to 30 September 1943 are used for the eight observation stations in Table #3. No records were made on two days and on certain days more than one set of observations were made. Zero intensities are omitted.

Table #3
Frequency of Odor Intensity

| Station | Intensity | 1 | 2 | 3 | 4 | 5 |
|---------|-----------|---------|---------|--------|--------|---|
| #1 | June 1 | July 2 | Aug. 1 | none | none | |
| | July 6 | | | | | |
| | Aug. 2 | | | | | |
| #2 | June 4 | June 12 | June 1 | none | none | |
| | July 1 | July 22 | July 10 | | | |
| | Sept 6 | Aug. 23 | Aug. 6 | | | |
| | | Sept 16 | Sept 3 | | | |
| #3 | July 1 | June 9 | June 8 | June 1 | July 1 | |
| | Aug 2 | July 31 | July 12 | July 3 | | |
| | | Aug. 25 | Aug. 4 | Aug. 3 | | |
| | | Sept 24 | Sept 6 | | | |
| #4 | June 5 | June 9 | June 5 | July 3 | none | |
| | July 1 | July 4 | July 28 | Aug 1 | | |
| | Sept 1 | Aug. 20 | Aug. 9 | | | |
| | | Sept 25 | Sept 4 | | | |
| #5 | July 1 | July 2 | July 3 | July 1 | none | |
| | Sept 1 | Aug. 1 | Aug. 1 | Aug 2 | | |
| | | Sept 1 | | | | |
| #6 | none | July 2 | July 3 | July 2 | none | |
| | | Aug. 3 | Aug. 3 | | | |
| #7 | July 1 | July 1 | none | none | none | |
| #8 | July 1 | none | none | none | none | |

A study of this tabulation reveals that, during the period covered, river odor was almost continuously present in the region of the Gate House (station #4), the North Bridge (station #3), and the South Bridge (station #2). Comparing odor intensities at these three locations they are apt to be the highest at station #4, somewhat lower at station #3, and lowest at station #2. The facts, that at these important positions odor intensities labelled #2 are much more frequently reported than #3 together with so few #4 intensities are the basis for the statement that odor intensity has been generally low in these areas during 1943. Stations #7 and #8 were remarkably free from river odor; both have relatively high elevations above the river level. The lack of odor at station #1 is surprising. Located 600 feet East of the Canal, it is shielded from that water by many buildings, an important factor when only low intensities exist. Frequencies given for station #6 represent the occurrence of wide distribution of odor in Lewiston area; intensities reported here have added significance. This position, which was under almost continuous observation, is the most remote from the river of all the observation stations, the nearest river bank is 3500 feet distant. Station #6 is about three miles South of Deer Lips Dam and about four miles from Gulf Island Dam, hence river odor reaching this position must have travelled at least a mile and if the "pond" area was the origin the distance would be nearer six miles.

Odor Types

The odor from the Androscoggin River is usually a complex one and this year even in its simplest form did not match that of its only known chemical constituent, hydrogen sulphide, in its commercially pure form. The use of such descriptive terms as musty, pig-pen, etc. refer to the composite effect upon the olfactory nerves produced by the presence of several unknown gaseous components.

The principal types of individual odors emanating from the Androscoggin River during the period of observation, in the order of increasing importance, were sulphite, earthy, pig-pen, hydrogen sulphide, and musty. Each of these types have occurred alone but very frequently one will be the dominant odor and others contributing "undertones." At times the odor is very complex and defies description.

The frequency of occurrence of the principal odor types during June, July, Aug. and September, 1943, is listed in Table #4.

Table #4
Odor Type Occurrence

| Month | Musty | Hydrogen Sulphide | Pig-pen | Earthy | Sulphite |
|-----------|-------|-------------------|---------|--------|----------|
| June | 8 | 0 | 0 | 17 | 0 |
| July | 27 | 15 | 15 | 10 | 1 |
| August | 20 | 16 | 15 | 0 | 6 |
| September | 24 | 15 | 11 | 0 | 0 |

Musty

The usual connotation of this term is the nearest description that can be applied to this river odor. Reminiscent of a damp cellar odor with a watery, stale undertone. During the current season this odor has been most prominent and was reported 87 times. Although present in June this odor was not prominent but as the earthy odor disappeared a musty one seemed to take its place. Mustiness may originate on or be associated in some manner with sludge. Samples of floating sludge taken from the "pond" and kept in sealed bottles at out-of-doors temperature lost the pig-pen odor after a few days and then for several weeks possessed an odor resembling the musty odor of the river. When a small quantity of sludge is placed in a large bottle containing traces of hydrogen sulphide the blend produces an odor which approximates that found, at times, over the river surfaces.

Hydrogen Sulphide

This odor is the only one associated with Androscoggin river odors which can be definitely ascribed to a single chemical compound. The odor is usually described as that of rotten eggs. Hydrogen sulphide odor is always objectionable to human beings and it is even more so when present with other river odors. Hydrogen sulphide was reported present 42 times during July, August, and September, 1943. The presence of this gas was not detected in the two cities until 18th of July when it was observed with pig-pen. Three days later in the early morning there was city wide distribution of odor which approached that of river hydrogen sulphide, and the day following this type of odor returned for about two hours. At no other time did the observer record a large area with essentially hydrogen sulphide; other and later appearances had additional components.

To obtain, if possible, quantitative information on the hydrogen sulphide content of the river odor thirty-nine determinations were made by utilizing the well known lead acetate reaction with equipment constructed especially for this purpose. These tests were rejected later.

Method employed

A measured volume of air is drawn over a piece of cotton cloth (of known brightness) kept moist with 5% solution of Lead Acetate. The cloth is held tightly between the rubber portion of two crucible holders, Walter's type, in such a manner that all air drawn into the system must pass through the moistened cloth. All air passing through the equipment is measured by a gas meter. An automobile engine is used as a vacuum pump. Air is drawn into the equipment usually at the rate of one cubic foot per minute, but at times this rate may drop to one-half this value. The amount of aqueous lead acetate used varied with the tests. In general, just sufficient solution was used to keep the cloth moist and depending upon the humidity this amount varied from two drops per minute, per cubic foot, to five drops per cubic foot per minute.

Observations

The following statements are based on the results obtained in thirty-nine determinations.

1. Unless the concentration of Hydrogen Sulphide is relatively high as at the Gulf Island Dam, there seems to be no relation between odor as determined by the nose and the color obtained on the test cloth.

2. At Gulf Island Dam I have not been able to obtain accurately duplicateable results. However, there is more consistency in results obtained here than elsewhere, provided that the variables are duplicated as near as possible. The variables due to air currents are beyond control; the air is always turbulent in the region of the Dam. Position, volume of air employed, and rate of flow through the instrument can be kept reasonably constant. Concentrations of hydrogen sulphide recorded here range from 0.01 to 1.9 p.p.m.

3. At Gulf Island Dam where the odor appears to approach closer to that of pure hydrogen sulphide than anywhere else, the concentration is such that, at certain times, nasal fatigue is an important factor. While experience in making decisions based on nasal odor is of great value, the fact remains that desensitization of the olfactory nerve endings by hydrogen sulphide, may affect one's judgement. It might be possible, within certain concentration limits, to smell a hydrogen sulphide odor and say that is approximately so many parts per million of hydrogen sulphide. However, I have not been able to reach that desired state with hydrogen sulphide in the odors from the Androscoggin river, there are too many complicating factors.

4. The tests appear to confirm the observations that this year the river odor in the Lewiston-Auburn area is very complex. All of the determinations made in the canal and North Bridge regions were conducted at times when I was under the impression that hydrogen sulphide might be or was present. There must be a component or components present which deceive the observer or the nose must be able to detect such extremely small concentrations of hydrogen sulphide that they do not affect Lead acetate solution.

5. The presence of hydrogen sulphide in pig-pen odor, when it was not detected by the nose, was demonstrated when 0.005 p.p.m. was obtained. Other tests under apparently similar conditions at other times gave negative values.

6. This year hydrogen sulphide concentrations in Lewiston and Auburn, when tested, have yielded low values ranging from zero to 0.005 p.p.m. even when the odor ~~was~~ intensity was unpleasantly high.

7. The writer has found no quantitative relation between the Androscoggin River odor and its hydrogen sulphide content.

Table #5
Results of analytical data. Lead acetate method.

| Date | Location | Odor Type | Odor Intensity (visual) | L.S. P.D.M. (brightness) |
|--------------|------------|-------------------------|----------------------------|-----------------------------|
| 21 July 1943 | G.I. Dam | H.S. | 4 | 1.90 |
| 21 July | " | H.S. | 4 | 1.70 |
| 21 July | " | H.S. | 4 | 0.36 |
| 22 July | " | H.S. | 5* | 0.25 |
| 22 July | " | H.S. | 5* | 0.30 |
| 22 July | " | H.S. (sulphite) | 4 | 0.25 |
| 22 July | " | H.S. | 7* | 0.040 |
| 22 July | " | H.S. | 7* | 0.04 |
| 22 July | " | H.S. | 7* | 0.05 |
| 4 Aug. | " | H.S. | 4 | 0.07 |
| 4 Aug. | " | H.S. | 4 | 0.08 |
| 4 Aug. | " | H.S. | 4 | 0.066 |
| 6 Sept. | " | H.S.-P.P. | 3 | 0.05 |
| 6 Sept. | " | H.S.-P.P. | 3 | 0.01 |
| 27 July | Canal | H.S., Musty | 2 | 0.00 |
| 28 July | " | H.S., Musty | 3 | 0.005 |
| 29 July | " | H.S., Musty | 3 | 0.00 |
| 1 Aug. | " | H.S., Musty | 3 | 0.00 |
| 3 Aug. | " | Musty, H.S. + | 4 | 0.00 |
| 9 Sept. | " | Musty, H.S. | 3 | 0.000 |
| 14 Aug. | H. B. | Musty, H.S. | 4 | 0.00 |
| 14 Aug. | " | Musty, H.S. | 4 | 0.00 |
| 9 Sept. | " | Musty, H.S. | 3 | 0.005 |
| 9 Sept. | " | Musty, H.S. | 3 | 0.005 |
| 28 July | Switz. Rd. | H.S.-P.P. (sulphite) | 3 | 0.012 |
| 8 Sept. | " " | P.P., H.S. | 3 | 0.005 |
| 1 Aug. | T.C.B. | Pig-pen | 3 | 0.00 |
| 1 Aug. | " | Pig-pen | 3 | 0.00 |
| 25 July | Pond | Pig-pen | 3 | 0.00 |
| 25 July | " | Pig-pen | 3 | 0.005 |
| 4 Aug. | Station #6 | Complex | 3 | 0.00 |

* near the water surface 15 feet below observer; intensity /3 at observers position.

Pig-Pen

The name is quite descriptive of the odor, which is very similar to the somewhat sweetish but unpleasant odor usually present in pig-pens. Probably of protein origin, the components of this odor may be degradation products of certain amino acids. Pig-pen odor as observed along the Androscoggin River appears to vary in different locations, being somewhat "sweeter" in the "pond" region than in the Lewiston area where it possesses a more "cadaverous" flavor. This odor was the dominant one in the entire "pond" area during the period of investigation; it was present on nearly every visit in intensities of /3 or /4 and occasionally /5.

Circumstantial evidence seems to favor assigning pig-pen odor constituents a very low value for their solubility in water and perhaps a low density. After formation probably with methane, it rises to the surface and escapes, leaving very little in solution. Conditions generally experienced at the Gulf Island Dam are of interest in this connection. The air just above the dam has a pig-pen intensity of say /3 or /4; at the foot of the dam, a hydrogen sulphide intensity of perhaps /3 or /4; and a half mile below the dam, pig-pen intensity /2 or /3, or H.S.-pig pen /2 or /3. This year's conditions imply that quiet water is associated with pig-pen, turbulent water with hydrogen sulphide. The writer has been impressed with the rapidity with which the intensity of pig-pen decreases as one leaves the shore at the "pond" even with favorable wind. On the other hand, memory is vivid concerning the periods when pig-pen plus has blanketed the city for hours at high intensity.

Earthy

This odor is that usually associated with fresh wet earth. Present on the first day of the observations (13 June) it remained a prominent river odor until it disappeared on 14 July and did not reappear. Its place was taken by the musty odor.

Sulphite

An odor resembling waste sulphite liquor but more potent and more penetrating suggesting the effect of sulphur dioxide. Although only reported six times this season, three appearances were over wide areas including that on the 4th August when this odor was present at varying intensities for several hours during the day. The odor returned again in the evening and for two hours penetrated heavy rain and reached an intensity of /5. On this occasion the observer experienced a dryness and slight tightening of the throat.

Other odors

In addition to the odors previously described several others were noted but only infrequently; grassy, fetid, moldy, etc. They are not believed to be of importance, at least as they relate to this year's odor problem.

Distribution of Odor The distribution of Androscoggin River odor may be classified as that found (a) in the immediate vicinity of the river (b) localized over considerable area and (c) covering at least the two cities.

(a) Only on rare occasions during this inspection period was objectionable odor absent from the river, frequently of low intensity but at times quite serious. For reasons, not obvious, the odor often remains over the river and cannot be noticed a few feet inland from the water line in spite of favorable wind conditions. Diffusion of odor up to two or three hundred feet from river or canal system is frequent, especially during the night and early hours of the morning. This distribution is an important part of the odor problem as the river and canal are such an intimate part of the cities organization and a considerable number of people work and live in this area.

(b) Odor localized over a considerable area may be due to wind conditions, land contour, and volume of odor distributed. Wind variations are very common, odor coming in from the river or canal sometimes disappears rapidly and the whole area may be cleared in several minutes. Land contour is of importance in conditions of low wind velocity. At the bends of the river or as in Auburn where the land elevation rises rapidly, odor may be found in large but restricted areas. Given favorable conditions for distribution the area of noticeable odor must be governed by the volume available for that distribution.

General coverage (c) City wide coverage by river odor was recorded six times in July and the same number in August. In addition to these there were several occasions in the early morning hours when the coverage may have been very extensive. During 1943 wide distribution was not generally of high intensity, usually about /3 although on 21st and 22nd July /4 intensities were reached.

Another favorable factor was the short duration, seldom more than a few hours. There have been no high intensity, long duration coverages of odor so common in certain other years, notably 1940 and 1941. The types of odor present during these extensive distributions are not confined to any one type although hydrogen sulphide was important, pig pen, musty, and sulphite were also observed. In this connection it may be of interest to record that hydrogen sulphide was more prominent and more frequent in July than in August.

Table #6
General Coverage Data

| Date | Intensity / | Type | Time Period |
|---------|-------------|---------------------|--------------------|
| 15 July | 5 | Pig Pen | afternoon, evening |
| 21 July | 4 | H.S. | early morning |
| 22 July | 4 (3) | H.S. | evening |
| 26 July | 3 | H.S.-Musty | evening (brief) |
| 29 July | 3 | H.S.-Musty | early morning |
| 30 July | 2 (3) | H.S.-Musty sulphite | morning, afternoon |
| 1 Aug. | 2 | H.S. Musty | morning |
| 4 Aug. | 3 (4) | Sulphite complex | intermittent |
| 5 Aug. | 3 | Musty-Pig pen | morning |
| 10 Aug. | 3 | Musty-sulphite | morning |
| 25 Aug. | 2 (3) | Pig Pen | evening |
| 26 Aug. | 2 | Sulphite | evening |

Individual Reaction to the River Odors While these reactions are almost as varied as the persons involved and while most of the odors are objectionable, if intense enough, certain of them are outstanding. Hydrogen sulphide-pig pen, hydrogen sulphide-musty, and pig-pen musty are combinations which are very unpleasant to humans and unfortunately frequently present in the river odor. Other and more complicated variations of these ^{PRINCIPAL} ~~numerous~~ odors may be experienced as well as those of a nearly single type.

River Odor and Water Levels

the period of inspection has prevented observation on conditions which the writer feels are important factors in the odor problem. At no time has it been possible to study the effect produced by exposure of large areas of shore and river bed to light and air. Favorable conditions to study the results of low water volume and the resultant high concentration of pollution have not existed.

My studied conclusions as to this year's odor situation are that it is the result obtained when (a) water levels are high and concentration of pollution low, (b) the odor dispersed is essentially that of substances with low solubility in water, from chiefly quiescent water surfaces and (c) the concentrations of hydrogen sulphide in the water require turbulent conditions to release it from solution.

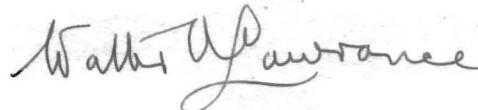
Summary

- (1) The Androscoggin River odor conditions in the Lewiston-Auburn Area were better than those existing in 1942 or 1941.
- (2) While the odor may be of a simple type it was generally that of a mixture of types, in the two cities.
- (3) The odor described as musty was observed 87 times; hydrogen sulphide, 42; and pig pen, 37; and Sulphite, 6.
- (4) River odor was present almost continuously at the Gote House, North Bridge, South Bridge, Gulf Island Dam, and the Androscoggin pond. Low intensities were frequent at the city locations.
- (5) The dominant odor in the Androscoggin "pond" area is pig pen. At the foot of the Deer Rips and Gulf Island Dams it is hydrogen sulphide, while in the Lewiston-Auburn area it is complex.
- (6) Twelve general distributions of odor were observed and reported. They were less intense and of shorter duration than in some previous years.
- (7) The Daily Reports do not cover adequately the occurrence of odor in the early morning hours.

In conclusion the writer wishes to thank all those concerned for allowing him complete freedom to report whatever facts were found and to comment upon them in any manner he thought fit.

The Central Maine Power Co. through Mr. Hudgett has rendered considerable assistance in permitting observations and analyses to be made on their properties. Acknowledgement is also made of the contribution of Dr. L. Fisher of Bates College in furnishing Wind and Weather data for the decade 1933-1942.

Respectfully submitted,



Lewiston, Maine
22 October 1943