REPORT ON THE WATER POLLUTION INVESTIGATION OF THE YELLOW RIVER BELOW VOLNEY, IOWA

Environmental Health & Engineering Services
Iowa State Department of Health
Des Moines, Iowa
August, 1965

Iowa
State Department of Health
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DIVISION OF
Environmental Health
& Engineering Services

P. J. Houser, M.S., P.E.
DIRECTOR Chief

August 10, 1965

Mr. Robert R. Buckmaster, Chairman
Iowa Water Pollution Control Commission
300 Court Square Building
Waterloo, Iowa

Dear Mr. Buckmaster:

I am transmitting a report on an investigation of pollution of the Yellow River below Volney, Iowa.

In addition to the investigation as presented in this report, a visit was again made to the Volney area on August 5, 1965. It was found that there have been no major physical changes made by the contributor of waste, which will alter the validity of the discussion or conclusions and recommendations presented in the report.

Very truly yours,

R. J. Schliekelman, Director
Division of Water Pollution Control

RJS:ck

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OF THE YELLOW RIVER
BELOW VOLNEY, IOWA

I AUTHORITY FOR AND SCOPE OF INVESTIGATION

This investigation of water pollution of the Yellow River was initiated by this Department in accordance with the provisions of Section 135.18, Code of Iowa, 1962, and the present provisions of Section 10, House File 412, as enacted by the 61st General Assembly. In a letter dated July 9, 1964, the State Conservation Commission made a formal request that the State Health Department conduct an investigation of the alleged pollution of the Yellow River near the Town of Volney. The letter, signed by Mr. E. B. Speaker, Director, State Conservation Commission, contained further comments concerning the request for the investigation of the Yellow River. It stated that, "This stream was formerly one of our finest smallmouth bass streams and has deteriorated gradually for about the last fifteen to twenty years as a bass stream. In view of its importance as a recreational stream, we urge that every thing possible be done to alleviate pollution as a factor limiting the fish population."

The letter from the Conservation Commission was accompanied by a "Report of Pollution-Caused Fish Kill" written by Kenneth R. Kakac, State Conservation Officer. The report describes a moderate fish kill that occurred on June 21, 1964, and had a two day duration of critical effect. Two miles of the stream were affected. Dead fish, and also dying and distressed fish were noted. The report stated that cheese factory waste was the specific agent or cause of the kill. Officer Kakac also stated in his report that, "Low water in the Yellow River is a contributing factor in this kill. The only reason the fish kill was moderate is that there is a low fish population in this stretch of stream due to continued pollution through the years."

The State Conservation Commission also initiated a biological survey of the Yellow River. The survey was conducted by Gary L. Ackerman, Fisheries Biologist, on October 3, 4, and 5, 1964. Some of his findings, as compiled in his report "Yellow River Survey" are presented below.

Mr. Ackerman found that there was a notable decrease in clean water aquatic insect larvae below the village of Volney. These included the complete absence or severe decrease in total numbers of mayfly, stonefly, and caddis fly. It also was found that the midge larvae within that area were bloodworms, whereas those in upstream waters were not bloodworms. He concluded that these findings were indications of reduction in water quality, from Volney extending approximately five miles downstream.

Mr. Ackerman also conducted population studies to determine fish species composition in the stream. He found that there exists only a "fair population of smallmouth bass on the Yellow River, and that they are

notably lacking near the village of Sixteen in Section 16. The river provides excellent habitat, food availability, and cover area for reproduction, growth and survival of smallmouth bass." He recommended that, "If or when the pollutants are stopped, smallmouth bass fry should be stocked until the population becomes self-sustaining."

In addition, the Department received letters of complaint, concerning pollution of the Yellow River from two citizens of the State of Iowa in July and August, 1964.

The field portion of this investigation was conducted on two dates. One visit was made to the area on August 5, 1964, and the other visit was made on September 2, 1964. The investigation included visual observation of the physical condition of the stream and of the waste outlet. These observations were recorded and included as a part of this report. Stream samples were collected for chemical and bacteriological laboratory determinations, and these data, along with the physical observations, are discussed in Section VII of this report.

II DESCRIPTION AND USES OF RECEIVING STREAM

The Yellow River rises in the southeast corner of Winneshiek County, flows in an easterly direction, and enters the Mississippi River near the Allamakee-Clayton county line.

The stream at Volney has a drainage area of 179 square miles. At Station 9, in the southwest corner of Section 24, Range 4W, Township 96N, the drainage area is 221 square miles. There is no active flow gaging station on the stream, but the stream was probably at relatively low flow at the time of the investigation. Stream flow records of other gaged streams in northeast Iowa were reviewed. It was found that on the dates of the investigation, the other streams were at relatively low flow, but above minimum flow. Since these streams have different drainage areas, different quantities of ground water contribution, and different stream characteristics, no accurate comparison can be made with the Yellow River. However, this does show the general surface water quantities in the area at that time.

In the month prior to the August 5 stream survey, the total rainfall in the area was approximately 0.6 inch. In the period between August 10 and the September 2 survey, there were approximately 3.6 inches of rainfall. This was reflected in the record of stream flow. The records of four gaged streams in northeast Iowa showed stream flow to be approximately 20% higher on September 2 than on August 5. There was good correlation between the four streams, so that the Yellow River could be expected to have increased approximately 20% also.

Land use along the stream is principally agricultural. A great portion of the land is used for grazing, and dairy cattle were seen frequently. Stock watering then could be considered an important stream use.

The Yellow River is also considered an important fishing stream. It is valued for its game fish, most important of which is the population of smallmouth bass.

This is a naturally scenic area of Iowa. The stream is bounded at many places by high rolling and sometimes rugged hills. The hills show outcroppings of rock, and the stream bottom is rocky with many riffle areas at low flow.

III SAMPLING STATIONS

The stream sampling stations used in this investigation are described in Table I in the appendix.

IV SCOPE OF DETERMINATIONS

Analytical determinations on the samples collected consisted of both those made in the field at the collection point immediately after the sample was taken and those made in the State Hygienic Laboratory in Des Moines. The field determinations included temperature readings, pH determinations, and the stabilization of samples for dissolved oxygen determinations. In addition, the physical condition of the stream and waste outlet, as to evidence of pollution material at the time of sampling, was observed and recorded. Samples for biochemical oxygen demand and bacteriological determinations were iced in the field and transported to the State Hygienic Laboratory at Des Moines, where the determinations were made. The laboratory also determined the dissolved oxygen content from the samples stabilized in the field.

All tests in the field and laboratory were carried out in accordance with the procedures set forth in the current edition of "Standard Methods for the Examination of Water and Sewage" of the American Public Health Association, the American Water Works Association, and the Water Pollution Control Federation.

V SIGNIFICANCE AND DEFINITIONS OF THE VARIOUS PHYSICAL, CHEMICAL AND BACTERIOLOGICAL DETERMINATIONS

Temperature (^{o}C) The temperature values refer to the stream water at the point of sampling, and are reported in degrees centigrade. Temperature of water governs the solubility of oxygen in the stream and influences the rate of purification. It can also be used as an indication of waste's affect on a stream. Increased temperatures from industrial cooling waters may affect other water uses such as the suitability for fish and other aquatic life.

pH Hydrogen ion concentration, or pH, indicates the relative acidity or alkalinity of a water. A value of 7 is considered to be neutral;

whereas values above 7 are alkaline and those below 7 are acid. Certain industrial wastes may have a marked affect on the pH of receiving streams. Many stream uses, such as domestic and industrial water supplies and fish and other aquatic life, require pH values within specified limits.

Dissolved Oxygen (DO) Oxygen in dissolved form is essential to the natural purification of streams and the maintenance of aquatic life. This oxygen is drawn upon to support biochemical oxidation of organic wastes and is replaced by absorption from the atmosphere and photosynthetic action of some water vegetation, including algae. A deficiency of dissolved oxygen below the saturation level indicates the presence of polluting organic substances which are depleting oxygen from the stream water. The degree of this deficiency is a measure of the deoxygenating effect of the pollution matter and hence an index of the degree of pollution in a particular stream zone. If there is a sufficient quantity of oxygen present in the water, the organic material will be oxidized without creating any objectionable odor nuisance or destruction of aquatic life. However, if there is not a sufficient amount of oxygen present, anaerobic decomposition takes place. The organic material present in the water then undergoes putrefaction, with an accompanying foul odor and dark appearance of the water, which is indicative of a heavily polluted stream.

Five Day Biochemical Oxygen Demand at 20°C (BOD) This determination indicates the amount of dissolved oxygen which may be expected to be utilized in five days at 20°C to support the biochemical oxidation of the organic matter.

Oxygen Balance The arithmetic difference between DO and BOD is termed oxygen balance. If the DO of a water exceeds the BOD, a condition of positive oxygen balance exists. If BOD exceeds DO, a negative oxygen balance exists. A water in condition of negative oxygen balance depends on reoxygenation to maintain adequate oxygen content, since by definition, the oxygen demand of the water exceeds the oxygen available. In the absence of sufficient reoxygenation, the dissolved oxygen can be completely depleted from the water with resultant putrefaction and destruction of aquatic life. Since natural reoxygenation of a stream depends on absorption from the atmosphere and photosynthetic action of water vegetation, oxygen demand sometimes cannot be met. For instance, a sufficiently high BOD will exceed the oxygen replacing capabilities of a water under the most ideal conditions. Also, ice cover will effectively block atmospheric absorption and sunlight necessary for photosynthesis, to the extent that a relatively small negative oxygen balance can result in complete oxygen depletion.

Coliform Bacteria (MPN) The result of this determination is expressed as the most probable number (MPN) of coliform group bacteria per 100 milliliters of sample. This examination is perhaps the most delicate and specific test for pollution by sewage, as it shows the approximate density of a group of bacteria which is always present in large numbers in sewage, and relatively few in number in other stream pollutants. Coliform bacteria are normal inhabitants of the intestines of warm-blooded animals and are discharged

in large numbers in human feces, which constitute the principal source of these bacteria in sewage. These bacteria may also be found in varying amounts in certain organic industrial wastes and in the soil.

Fungus Growths Fungus growths refer to the communities of organisms which are frequently found in streams below points of discharge of certain organic wastes. Although such growths are referred to as fungi, they frequently include certain kinds of bacteria and protozoans in addition to the fungi, with the predominant organisms being Sphaerotilus natans, a bacterium. Frequently the growths are referred to as "slime infestations" or "sewage fungus".

The discharge of sewage or certain industrial wastes into a stream provides nutritional material in the form of nitrogen, carbon, and phosphates for the development of the fungus growths. Under optimum conditions, profuse growths develop attached to the bottom muds and stones, to snag piles, submerged plants, and other stream obstructions. As the growths develop to long lengths, they become detached and float downstream becoming entangled in any obstruction in the stream. Newly developed forms may be white; whereas older forms tend towards a dirty grey color.

VI CONTRIBUTOR OF WASTES

During the course of this investigation, it was determined that the principal source of pollution of the Yellow River is the Volney Cheese Co., Inc. This industry is located in the community of Volney, in southcentral Allamakee County. In the absence of the owners and manager, Mrs. Leonard Thompson was interviewed concerning the cheese factory operations. It was learned that the industry is engaged in the manufacture of cheddar cheese. Milk is received in both bulk and cans. Water-carried waste from the factory flows to an open ditch east of the building. The waste then flows in the ditch in a southerly direction, beneath a road, thence approximately 150 feet to the Yellow River.

The waste consists of cooling water and process wastes from the various plant operations. The latter would include milk spills, piping drips, floor washings, equipment clean-up, can drippings and wash water, etc. Whey is segregated in the plant and stored in an overhead tank east of the factory building. Much of the whey is hauled away to farms in the area and the rest is released to the stream. The whey tank is located near the bank of the open drainage ditch. A considerable amount of whey was leaking from the tank on both visits to the site, and the escaping whey was flowing down the bank into the drainage ditch.

Except for sanitary sewage, the waste from the industry receives no treatment prior to entering the drainage ditch. Mrs. Thompson stated that waste from the sanitary facilities flows through a septic tank.

VII DISCUSSION OF PHYSICAL, CHEMICAL AND BACTERIOLOGICAL DATA

The following is a discussion of the findings of this investigation at the various sampling stations on the Yellow River. Results of laboratory determinations are tabulated in Tables II and III in the appendix of this report.

Since the investigation was conducted on two different dates, the results of the individual surveys will be presented separately. The August 5 survey will be discussed first.

Station A This station was established as a control so that the stream water quality above the source of pollution could be compared to that below. The station is located at the first county road crossing above Volney. On this date, there were no visible signs of pollution. The water was fairly clear, there was no odor, no floating scum, and no solids deposition on the stream bottom. The BOD was 3 ppm which is quite low. The dissolved oxygen concentration was 8.5 ppm, which is 100% saturation of the water. This relation of BOD and DO provides a positive oxygen balance of 5 ppm. MPN of coliform bacteria was also quite low at 1,500 per 100 ml.

Station CFO This station represents the sample of cheese factory waste taken from the open ditch a short distance above confluence with the Yellow River. The BOD of the sample was 10,500 ppm, which represents an extremely high strength waste. The sample had zero dissolved oxygen and a pH of 6.0. MPN of coliform bacteria was 430,000. The waste was a milky white color and was quite turbid. Where the waste entered the stream, there was very definite discoloration of the stream water. There was some solids deposition in the ditch, which had the appearance of decomposing sludge. There was also a very definite odor of milk along the ditch. Sewage fungus could be seen growing on obstructions in the ditch.

Station 2 At this station, 150 feet below the waste inlet to the stream, the white coloration had spread to cover over half of the stream width. Due to mixing of the waste with the stream water, the color was somewhat diluted at this point, but still strikingly apparent. The waste strength was also diluted by the stream water, but was still quite high at greater than 65 ppm BOD. The DO at this point was only 4.9 ppm, which leaves an extremely negative oxygen balance. The MPN of coliform bacteria was greater than 1,100,000, which figure is quite high and indicative of polluted water. Compared to the figure 8.3 at the control Station A, the pH had dropped considerably to 7.2. This is simply another indication that the waste is affecting the stream. The waste with pH 6.0, which is not uncommon for a milk processing waste, combining with the 8.3 pH stream water, left a combined pH of 7.2.

There was little odor at this station and much evidence of algae. There was also considerable sludge deposition and growth of sewage fungus.

Station 3 At this station, 250 feet below the waste inlet, the stream water was still milky colored. There was deposition of decomposing sludge with gas bubbles rising to the surface. There was odor, sewage fungus growth, and algae. There was also an oily scum floating on the surface that had not been noted upstream. A few dead fish were seen at this point and others were seen in distress and swimming on their sides. The DO at this station was 5.3 ppm, but the BOD was greater than 30 ppm, leaving a negative oxygen balance. The MPN was still quite high at greater than 1,100,000 and pH was up to 7.6.

Station 4 Station 4 and Station 3 are both 250 feet below the waste inlet. The sample for Station 3 was taken on the left side of the stream in the colored water. Since the waste had apparently not spread to the right side at this point, a sample was taken there for comparison purposes and was designated Station 4. Although the waste was not visible on the right side, laboratory results did show contamination. BOD was 12 ppm, and DO was 7.0 ppm, leaving a negative oxygen balance. MPN was 2,300.

Station 5 At the bridge, 400 feet below the waste outlet, the cloudy white appearance had spread across the entire width of the stream. There were patches of oily scum floating at this station as at Station 3. A blanket of sludge covered the bottom. BOD of the water was again greater than 30 ppm and DO was 6.2 ppm. MPN was again greater than 1,100,000.

Station 6 None of the visible signs of pollution were seen at this station. However, BOD was 25 ppm and DO was down to 4.1 ppm leaving a negative oxygen balance. MPN remained at its high level of greater than 1,100,000.

Station 7 BOD showed good decrease to 11 ppm at this station. DO was 5.9 ppm leaving a negative oxygen balance. MPN also showed sharp decrease to 240,000.

Station 8 At this station, the oxygen demand of the stream water had been nearly satisfied. BOD was down to 3 ppm. However, this had resulted in lowering of the dissolved oxygen content to 2.5 ppm, which is the lowest concentration noted on the stream. MPN of coliform bacteria was down to 43,000.

The following paragraphs discuss the findings of the September 2, 1964, visit to the Yellow River.

Station A On this date, conditions at the control station were much the same as on August 5. MPN was higher at 9,300, but this figure is not uncommon for unpolluted Iowa streams. BOD was 8 ppm and DO was 13.1 ppm. The water was supersaturated with dissolved oxygen, probably because of algal activity. There were no visible signs of pollution.

Station CFO The sample of cheese factory waste was again of the same milky color and odor. The drainage ditch was lined with decomposing sludge and sewage fungus. The strength of the waste, as measured by BOD, was not as high as found on August 5. The quantity of milk or byproduct being wasted varies during the day depending upon the operations being carried out in the plant. BOD was 1,600 ppm, MPN was greater than 110,000,000 and there was zero DO.

Station 1 On this date, a sample was taken in the river, 10 feet below the waste inlet ditch. At this point, the stream was colored a milky white. There was some fungus growing on obstructions. The BOD was 240 ppm and the DO was 7.2 ppm. MPN was extremely high at greater than 110,000,000.

Station 3 At this station, 250 feet below the inlet ditch, the milky color was still evident but to lesser degree. There was a great abundance of sewage fungus, and some algae. There was decomposing sludge blanketing the stream bottom, gas bubbles rising to the surface, and some slight odor. There was also a white scum floating on the water. BOD at this station was 35 ppm and DO was 9.5 ppm, leaving a negative oxygen balance. Again, MPN was extremely high at 4,600,000.

Station 5 At this station, 400 feet below the inlet ditch, the milky color and other pollutional effects were less apparent than on August 5. One of the reasons is that the increased stream flow on this date diluted the waste such as to lower the concentration of organic matter in the water. As was mentioned in Section II of this report, stream flow was some 20% higher on September 2 than on August 5. This increased flow was readily apparent to the eye. Another reason for the lessened pollutional effect was that the strength, or BOD, of the raw waste at the time of sampling on September 2 was considerably lower than reported on August 5. This also results in lower concentration of waste in stream water. By the same token, increased strength of waste and lower stream flows on some other day would result in a greater degree of pollutional effect.

On September 2, although lower than on August 5, BOD was still high at 16 ppm. DO was 9.5 ppm resulting again in negative oxygen balance. MPN was 930,000. The water was slightly turbid, and as viewed looking down from the bridge, isolated white streaks could be seen in the stream. There was some bottom sludge and gas bubbles breaking the surface in deep still areas of the stream. There were also clumps of sludge, which had broken loose from the bottom and floated to the surface of the water. Considerable algae growth was noted at the station and there was some dirty white scum caught in still areas.

Station 6 The water at this station, three-fourths mile below the waste ditch, was slightly turbid but had no white color. There was black sludge in still areas of the stream, and there was sewage fungus growing on rocks in the riffle areas. BOD at this point was 17 ppm, and DO was 7.5 leaving a negative oxygen balance. MPN was 430,000.

Station 7 At this station, two miles below CFO, a jump was noted in both BOD and MPN. BOD was reported as 35 ppm and MPN as 1,100,000. These higher values are apparently due to the fact that the stream at this point was carrying higher strength waste discharged from the cheese factory earlier in the day, which had not been dispersed as it flowed downstream. This is not uncommon for a stream to carry "slugs" of waste proportional in strength to the variations in waste strength entering the stream. Dissolved oxygen concentration was 8.5 ppm, and there were none of the visible signs of pollution.

Station 8 At this station, approximately three miles below CFO, BOD was down to 8 ppm and DO was 9.2 ppm. This is the first station below the source of pollution to exhibit a positive oxygen balance. MPN was down to 7,500 and there were no visible signs of pollution.

Lloyd Johanningmeier, whose farm and home are located at Station 8, stated that conditions in the stream had been worse earlier in the summer. He said that there had been severe odor from the river and that the river bottom had been badly slime covered. The stream had been a good place to swim, but after development of the pollution conditions earlier in the summer, swimming had been entirely discontinued. He also stated that there had been a serious fish kill some weeks before this investigation. He felt that all the fish had been killed out near his property.

Station 9 There was again positive oxygen balance at this station. BOD was 8 ppm and DO was 13.2 ppm. MPN was 4,300. There were no visible signs of pollution.

VIII DEFINITIONS OF WATER POLLUTION

In accordance with the Iowa Stream and Lake Pollution Law, House File 412, as enacted by the 61st General Assembly, pollution is defined as follows:

". . . pollution means the contamination of any waters of the state so as to create a nuisance or render such waters unclean, noxious or impure so as to be actually harmful, detrimental or injurious to public health, safety or welfare, to domestic, commercial, industrial, agricultural, or recreational use or to livestock, wild animals, birds, fish or other aquatic life."

Sections 657.1 and 657.2, Code of Iowa, define a nuisance as follows:

Section 657.1 - "Whatever is injurious to health, indecent, or offensive to the senses, or an obstruction to the free use of property, so as essentially to interfere with the comfortable enjoyment of life and property, is a nuisance, . . ."

Section 657.2 - ". . . 4. The corrupting or rendering unwholesome or impure the water of any river, stream, or pond, . . . , to the injury or prejudice of others."

IX SUMMARY AND CONCLUSIONS

During the course of this investigation, the following conditions pertaining to the aforementioned definitions were found to exist.

1. The wastes discharged from the Volney Cheese Co., Inc. cheese factory contain solids which are subject to settling. Such solids form deposits of sludge on the stream bottom. These deposits of waste solids undergo anaerobic decomposition, and under such circumstances, obnoxious odors result which constitute a nuisance. Furthermore, since these solids contain numerous bacteria, a potential health hazard exists to persons coming into contact with these sludge deposits.

2. The milk processing wastes contain unstable organic material, both soluble and insoluble, which when stabilized in the stream, utilizes the oxygen that is dissolved in the stream water.

It is generally agreed that if fish life is to be normally maintained, there must be three or more ppm of dissolved oxygen in the stream at all times. During the course of this investigation, it was determined that these concentrations for the most part did exist. However, it was clearly demonstrated that the waste load on the stream did cause oxygen depletion. Furthermore, it was demonstrated that the waste load was of such organic strength that certain environmental conditions could cause serious oxygen deficiency in the stream.

3. The organic material in the waste also contains the nutrients necessary for the growth and maintenance of certain objectionable bacteria, protozoans, and fungi, referred to as sewage fungus. This fungus was found to exist in the stream. It is an unsightly condition and adversely affects fishing and other recreational use of the stream.

4. The milk processing wastes being discharged into the Yellow River from the cheese factory were found to contain numerous bacteria, some of which may be pathogenic (disease producing). Therefore, a potential health hazard exists to persons coming into intimate contact with the stream water below the point of discharge. Dairy animals wading in the stream may pick up bacteria on their bodies and udders, and such bacteria may be transferred to the milk during the milking process. Milk, therefore, from cattle having access to the stream below the point of discharge, constitutes a potential health hazard.

5. The Yellow River below the Volney Cheese Company cheese factory in Allamakee County was found to be polluted as defined in House File 412, as enacted by the 61st General Assembly, due to the discharge of untreated milk processing wastes from the Volney Cheese Company.

X RECOMMENDATIONS

Planning and construction of treatment facilities, adequate to eliminate and prevent in the future the existing pollution of the Yellow River, should be instituted immediately for all the wastes originating from the Volney Cheese Co., Inc. cheese factory.

Respectfully submitted,

D. R. Brindley
Public Health Engineer

DRB:ck

TABLE I

WATER POLLUTION INVESTIGATION
OF THE YELLOW RIVER
BELOW VOLNEY, IOWA

DESCRIPTION OF SAMPLING STATIONS

STATION NO.	DESCRIPTION
A	Yellow River Control - County road crossing in northwest corner of Section 24, Franklin Township - one mile above Volney Cheese Factory
CFO	Drainage ditch southwest of Volney Cheese Factory, 10 feet above confluence with Yellow River
1	Yellow River, 10 feet below CFO
2	150 feet below CFO
3	250 feet below CFO, near left bank
4	250 feet below CFO, near right bank
5	County road crossing, west-center of Section 18, Linton Township - 400 feet below CFO
6	Near center of Section 18, Linton Township - Three-fourths miles below CFO
7	West-center Section 16, Linton Township - Two miles below CFO
8	Road crossing, southeast corner Section 16, Linton Township - Three miles below CFO
9	150 feet above road crossing, south-center of Section 24, Fairview Township, Five miles below CFO

TABLE II

WATER POLLUTION INVESTIGATION
OF THE YELLOW RIVER
BELOW VOLNEY, IOWA

CHEMICAL AND BACTERIOLOGICAL DATA
August 5, 1964

Sta. No.	Coliform Bacteria (MPN/100 ml)	BOD (ppm)	DO (ppm)	% Saturation	Oxygen Balance (ppm)	pH	Temp (°C)	Time
A	1,500	3	8.5	100	+5	8.3	24	12:15 pm
CFO	430,000	10,500	0.0	0	-10,500	6.0	30	9:05 am
2	>1,100,000	>65	4.9	57	>-60	7.2	24	9:15 am
3	>1,100,000	>30	5.3	60	>-25	7.6	22	9:45 am
4	2,300	12	7.0	79	-5	7.9	22	9:50 am
5	>1,100,000	>30	6.2	71	>-24	7.8	23	10:10 am
6	>1,100,000	25	4.1	47	-21	7.6	23	10:30 am
7	240,000	11	5.9	67	-5	7.4	22	11:15 am
8	43,000	3	2.5	28	----	7.4	22	11:30 am

Symbol > indicates "greater than"

TABLE III

WATER POLLUTION INVESTIGATION
OF THE YELLOW RIVER
BELOW VOLNEY, IOWA

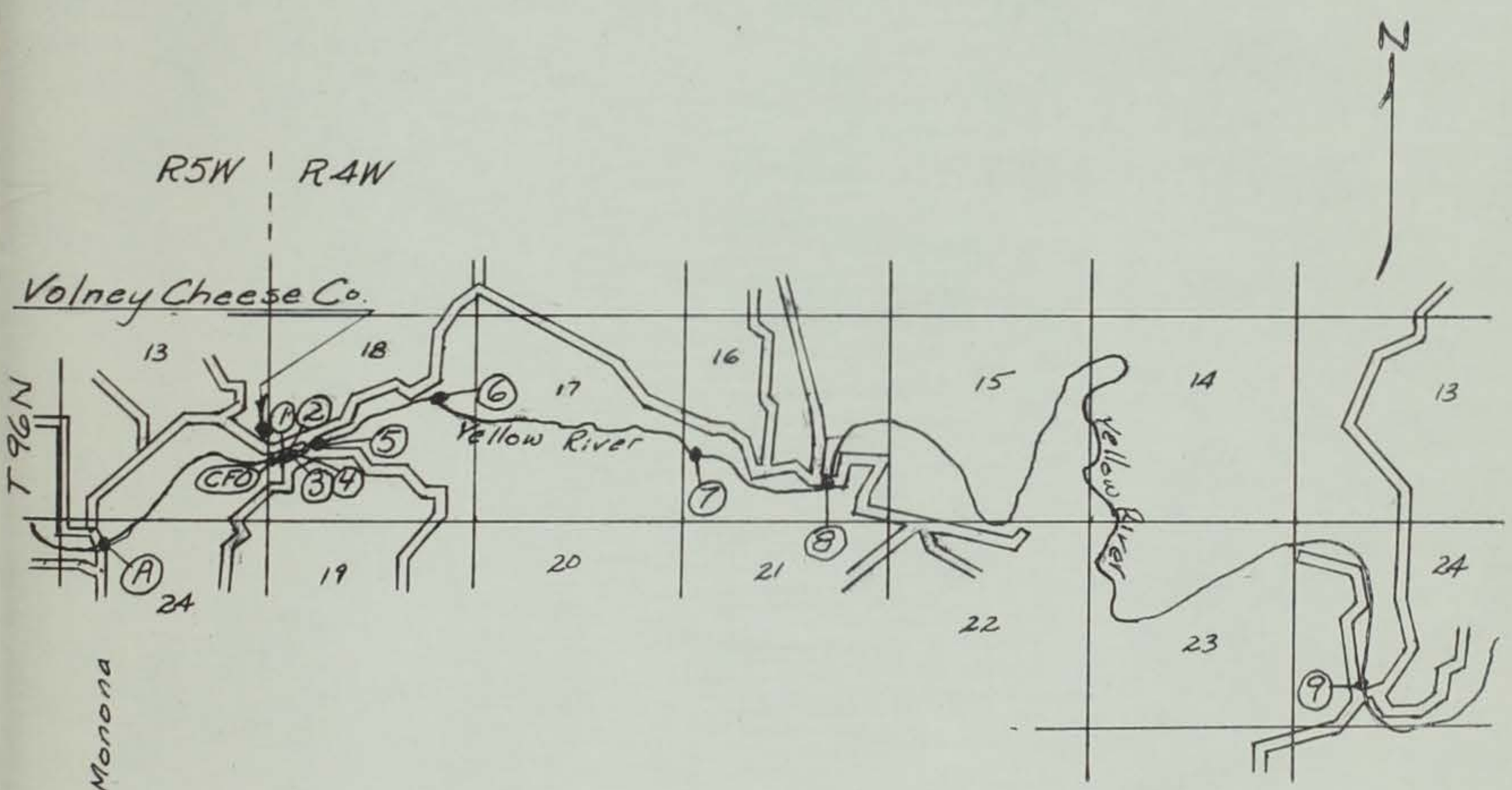
CHEMICAL AND BACTERIOLOGICAL DATA
September 2, 1964

Sta. no.	Coliform Bacteria (MPN/100 ml)	BOD (ppm)	DO (ppm)	% Saturation	Oxygen Balance (ppm)	pH	Temp (°C)	Time
A	9,300	8	13.1	151	5	--	23	3:50 pm
CFO	> 110,000,000	1600	0.0	0	-1600	6.1	26	12:25 pm
1	> 110,000,000	240	7.2	81.5	-233	7.1	22	12:30 pm
3	4,600,000	35	9.5	108	-25	7.6	22	12:40 pm
5	930,000	16	9.5	104	-6	8.1	20	1:00 pm
6	430,000	17	7.5	85	-10	7.7	22	1:20 pm
7	1,100,000	35	8.5	95	-27	7.6	21	2:00 pm
8	7,500	8	9.2	100	1	7.8	20	2:10 pm
9	4,300	8	13.2	150	5	8.4	22	2:40 pm

Symbol > indicates "greater than"

FIGURE 1

Description of Sampling Stations



Yellow River

below Volney

in

Allamakee County