BIOCHEMICAL TREATMENT OF SEWAGE USING WASTE PICKLE LIQUOR

Thesis for the Degree of M. S.

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Norman R. Sedlander

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This is to certify that the

thesis entitled

BIOCHEMICAL TREATMENT OF SEWAGE
WASTE PICKLE LIQUOR

presented by

NORMAN R. SEDLANDER

has been accepted towards fulfillment
of the requirements for

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Frank R. Theroux
Major professor

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BIOCHEMICAL TREATMENT OF SEWAGE USING WASTE PICKLE LIQUOR

By

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A THESIS

Submitted to the School of Graduate Studies of Michigan
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Gift

TABLE OF CONTENTS

ACKNOWLEDGMENT

I wish to express my appreciation first to Professor Frank R. Theroux for giving me the opportunity to work with him on a project which was most valuable and instructive in the field of sanitary engineering. Also, I want to thank the City of East Lansing for their very fine and limitless cooperation given us during the entire length of the experiment. In this category, Mr. Maurice Richmond, manager of the treatment plant, along with his assistants Henry King, Gordon Stafford and Edward Johnson deserve much credit for the assistance they gave us. My thanks, too, to Mr. Nielson of the Guggenheim Brothers for his many trips here from New York and for showing such a keen interest and giving us such unlimited help in working out current problems. Along with Mr. Nielson was Mr. Robert Theroux, son of Professor Theroux, whose job it was to start the experiment and see that everything was running smoothly from beginning to end. (Mr. Robert Theroux is a member of Moore Associates who are running similar projects in other cities throughout the mid-west for Guggenheim Brothers.)

This project was run under the auspices of the Michigan State College Engineering Experiment Station with

Dr. Clyde C. DeWitt as its director. I wish to thank him for his excellent cooperation and interest in the project.

I am grateful, also, to the Oldsmobile Drop Forge of the General Motors Division for the interest and cooperation shown by them. I want to thank, especially, Mr. B. Robbins for his timely and helpful suggestions.

I do not feel qualified to make any broad statements as to the value of this project at this time, but I hope that the limited amount of knowledge that we may have contributed will be of some value to those who find the field of sanitary engineering a challenge and a lifetime job.

INTRODUCTION

INTRODUCTION

The East Lansing Sewage Plant was designed as an activated sludge treatment plant. The Guggenheim Brothers, a counterpart of the Guggenheim Foundation, have patents dealing with treatment of wastes by chemicals to produce coagulation of suspended particles. In the activated sludge process the treatment is due to biological activities in the presence of large quantities of atmospheric oxygen, without addition of any chemicals. The general idea of this project was to study the effects of adding iron to the activated sludge process.

The unique system to be applied in this particular case was the use of iron in waste pickle liquor. In the project the waste pickle liquor was obtained from the Oldsmobile Drop Forge Division of General Motors. The pickle liquor, when first used, is a dilute solution of sulphuric acid which is used to clean iron metal before processing. The waste pickle liquor, having picked up iron particles chemically, contains iron in the form of ferrous sulphate. The factories using pickle liquor have a definite problem of disposal, so they were receptive to the idea of hauling away any amount that we wanted. At present, the Oldsmobile Drop

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Forge Plant has set up a small treatment plant for the disposal of this waste. They add lime slurry, which is a waste product from the adjacent Fisher Body Plant, to neutralize the acid before transferring it to the city sewers. Therefore, it seems that any reduction in their treatment costs would seem worthwhile.

The process of adding chemicals is not at all a new one. Many different chemicals have been used in the past such as iron salts, alum, etc. The use of waste pickle liquor, itself, seems to be of greater value because it only requires the cost of transfer from factory to treatment plant.

Based on proven theories of adding chemicals, the problem was to prove not only that a higher settling rate could be obtained, but that pickle liquor could be used as a coagulent in the treatment of sewage and not be harmful. The pickle liquor is an acid and it was not known what effect this would have in the possible shock that could be incurred on the biological status in the treatment of sewage.

SCOPE OF WORK

SCOPE OF THE PROBLEM

The problem was to determine how much sewage could be treated efficiently in a limited tank capacity, and yet produce a sufficient reduction in the biochemical oxygen demand so that it would still be safe to discharge the effluent into the Red Cedar River. (80% reduction in B. O. D. from raw sewage to final effluent is considered sufficient.)

From the diagram in the folder in the back of this paper one can see the layout of the East Lansing Sewage Plant. There are two distinct paths for treatment of sewage. Originally the plant consisted of two primary settlers, nine aeration compartments, and two final settling tanks. In 1948 an addition was made to the plant which consisted of two primary settlers, two aeration compartments (equivalent to eight as compared with the original aerators), and two final settlers (circular Dorr type). The original installation will be referred to as "No. 2" and the new addition as "No. 1" in all data, curves, and discussion.

This made an ideal situation for our experiment. It meant that we could compare the biochemical with straight activated sludge treatment. It was decided that the No. 1 installation would be operated for this experiment with the addition of the iron wastes and No. 2 installation would be operated in the usual manner for activated sludge, without addition of chemicals.

Next came the problem of placement of apparatus to inject the liquor into the sewage. Due to the layout of the plant it was decided that the place most accessible was in the feed trough to the aeration tank (see diagram of plant).

After approximately a week's "build up" with waste pickle liquor, one primary, one aeration compartment, and one final settler of No. 1 side would be drained and inactivated. This, of course, would necessitate a much higher settling rate to produce the desired B. O. D. reduction.

Finally, it was decided to start a flow through No. 1 side at one million gallons per day; run that quantity for two weeks and then increase the flow to one and one-half million (1.5) gallons per day. After operating at this capacity for two weeks, the flow would be increased to one and eight-tenths (1.8) million gallons per day for a period of two weeks. Finally, the flow would be increased to two million gallons per day for the final two-week period.

The total period came to approximately nine weeks, so temporary methods of hauling and injecting the liquor presented a problem. This will be discussed in Plant operation.

The amount of liquor to be injected was determined from charts that had been made up by the Guggenheim engineers. A one million gallon flow and a one hundred B. O. D. in the primary effluent called for two parts per million iron (Fe) and approximately two and one-half parts Fe for 1.5 M. G. D. At 1.8 M. G. D., three parts per million would be added, and finally four parts for 2 M. G. D. (2 million gallons per day flow).

This covers the scope of the problem and from what has been said it would seem to be rather a practical problem based on proven theories. Data and curves will reveal how true this statement may be.

Summarizing briefly, the scope of this experiment consists of:

I. Running two distinct flows through the original (No. 2) and the new (No. 1) sides of the plant.

II. Observation of all representative chemical tests run on both sides for comparison during experiment.

III. Consideration of practical applications from results of the experiment.

HISTORY

HISTORY

Ancient

Water purification by chemical agents is so ancient that its origin is completely obscured by the shadows of time. Records indicate that the practice was well known in China and India thousands of years ago. Ancient Chinese and Egyptians put alum in their water tubs for clarification purposes (2).

From the diligently prepared medical lore of the Sanskrit, methods of purification employing the use of sunlight, charcoal filters, and treatment with copper are set forth in great detail. Also in the Bible, water purification by adding salt is mentioned (3).

English Experience

The peculiar combination of circumstances, such as Lord Lister's momentous work with disinfectants and Koch's remarkable discovery of pathogens and their presence in water and sewage, together with the concentration of population served to arouse English public opinion to the necessity of reform in public sanitation. A report from the Royal Sewage Commission in 1865 recommended land treatment and stated that chemicals could not render sewage non-putrescible, although they could make it clear. The Second Royal Commission on Rivers Pollution in 1870 ranked in order, filtration, irrigation, and chemical processes in the removal of suspended organic matter, but pointed out that land treatment removed twice as much dissolved organic matter. Plain sedimentation was used for most treatment, but in some cases chemical methods were recommended, lime being most frequently mentioned as a coagulant.

In 1870 and "A, B, C" process using alum, blood, charcoal, and clay was boomed because of the high fertilizer content of the sludge. The effluent, while clear, was still putrescible and fertilizer value of the sludge was lost due to the high costs of drying. Because of aroused public sentiment, a chemical precipitation plant was built in London. The solids removed by this method were hauled to the sea and dumped. Although not entirely satisfactory, this method was used until World War I. It was abaondoned at this time because of the high cost and lack of chemicals. Glasgow with its free acid and iron wastes from wire mills found an alum-lime system worked well.

Many English cities had chemical treatment plants, but the partial failure of sedimentation blasted hopes of financial gain of sludge recovery. This led the Second

Royal Commission in 1908 to limit the use of chemical processes to strong sewages and those containing trade wastes. By 1910 most plants were converted to biological and settling processes.

France

The experiences were much the same as those in England.

Germany

In 1870 Germany adopted chemical methods in several plants. At Leipzig, an iron salt was employed which gave better results than at Glasgow or London because of the nature of the sewage. Unlike the French and English, the Germans took to mechanical methods such as mechanical screening and sedimentation when chemical methods were found to be unsatisfactory.

America

The first chemical precipitation plant to be used in the United States was completed in 1886 and several plants were installed in the next ten years. Worchester, Massachusetts, was the first American city to treat sewage before it was discharged into streams. This particular sewage contained iron trade wastes, making it ideal for lime treatment. The process was used from 1890 until 1925, when Imhoff tanks and trickling filters were adopted. The first alum plant was built at Somerville, New Jersey, in 1887, and that same year Alpheus Hyatt was granted a U. S. Patent for the alum process. Providence, Rhode Island, built the largest chemical coagulation plant in the United States. This plant remained in use for thirty years until 1931, at which time it was remodeled to an activated sludge system. Some of the other American cities that have used chemical precipitation at one time or another are East Orange, New Jersey, Long Branch, Mystic Valley, White Plains, New York, Canton, Ohio, Chatauqua, and the Chicago Fair of 1893. Due to the rapid development of biological methods chemical treatment never has gained much favor in this country (4).

Recent

During the recent years because of improved methods of handling and decreased costs, chemical methods have been more widely used (5). It has been found, too, that the use of chemical coagulants is imperative at many water supply and sewage disposal plants during certain annual critical periods in order to remain within prescribed limits (6).

THEORY

THE COLLOIDAL NATURE OF SEWAGE

A review of literature reveals a great number of investigations which indicate the colloidal nature of sewage. Blitz and Krohnke held that sewage particles are negatively charged, while such coagulants as ferric chloride are positivelycharged. Dunbar, Jones, and Travis ascribe the phenomena of coagulation to surface attractions. Harrison points out that color in water is due to colloidal solutions of organic matter such as humic acids, galletes, tannates, or salicylates, or in many cases due to the alkalinity and high iron content. He also states that these colloidal materials may be either positively or negatively charged (7). Seville also obtained similar results from his work (8). Upon investigation of the humic acid type of coloring matter in water, Miller found that it was due to negatively charged colloids (9). Spencer's theory is that to render particles mutually attractive is to end their colloidal state.

As soon as mutual attraction arises, agglomaration takes place and the colloidal solution becomes a full floc that steadily shrinks by packing together and precipitates because the mutual attraction of the particles

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in the floc is so great that their "gluey" or stabilizing properties vanish. He points out that particles in colloidal solutions have electrical charges either positive or negative, but mutually repellent; if they are positive, they can be precipitated with aniens, and if negative with cathions (10).

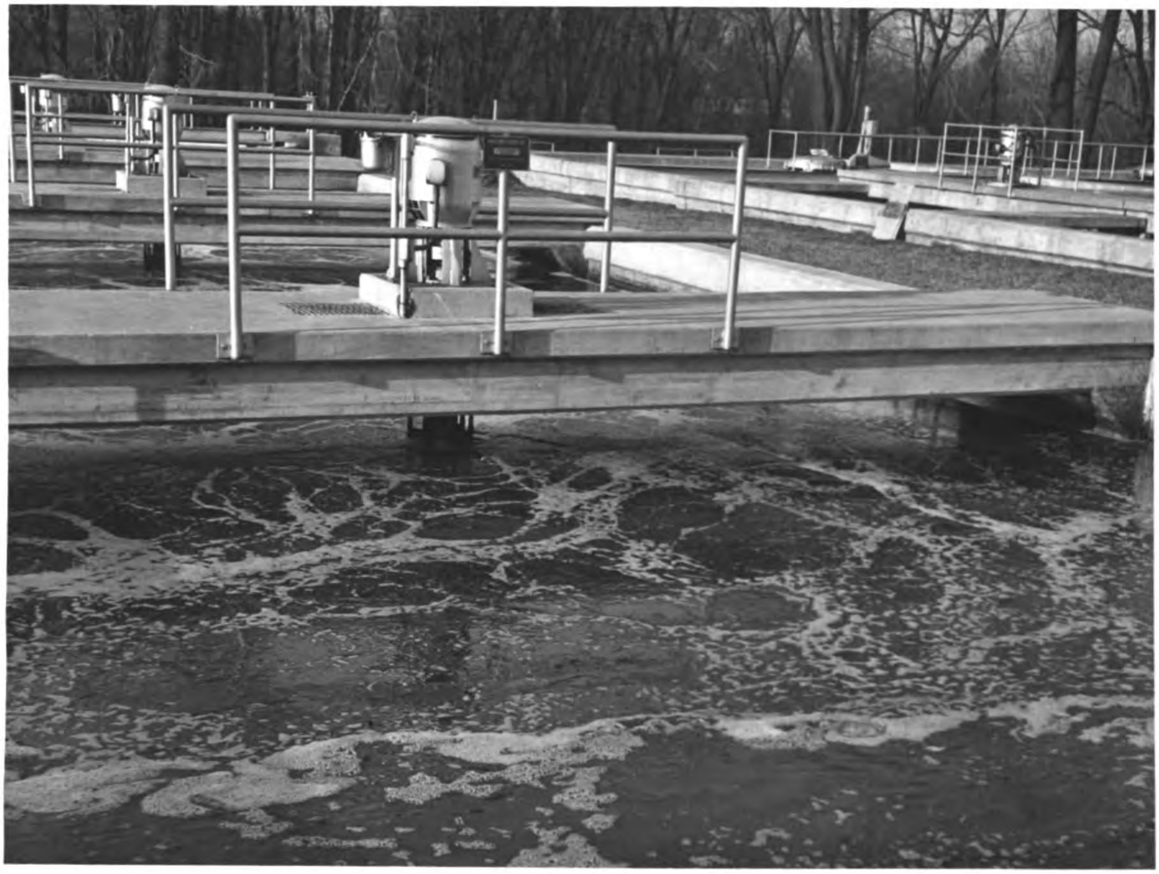
Babbitt and Deland suggest that the addition of chemicals to water form an insoluble precipitate which absorbs and entrains suspended colloidal matter (1). From summaries of previous studies of classification, Norgard concludes that coagulation with $FeCl_2$ is the reduction of the charge upon the suspended particles by colloidal ferric oxide, which has a positive charge due to absorption of ferric ions; the mutual neutralization of the charges causes coagulation (11). Eldridge points out that the object of chemical coagulation of sewage is to remove colloidal material by floculation. Upon addition to water, various ferric oxide hydrates are formed which carry a positive charge in acid and a negative charge in alkaline sewage medium (12).

From the foregoing considerations, there can be little doubt as to the colloidal nature of the clarification processes employed in the treatment of water and sewage. Therefore it can be assumed that this experiment at the East Lansing Sewage Plant fell into a particular pattern. The sewage which was almost entirely domestic, carried negative ions. The pickle liquor ($FeSO_4$) was positively charged, thus a mutual attraction producing a floc which caused a higher rate of settling of those particles in colloidal suspension.

PLANT OPERATION

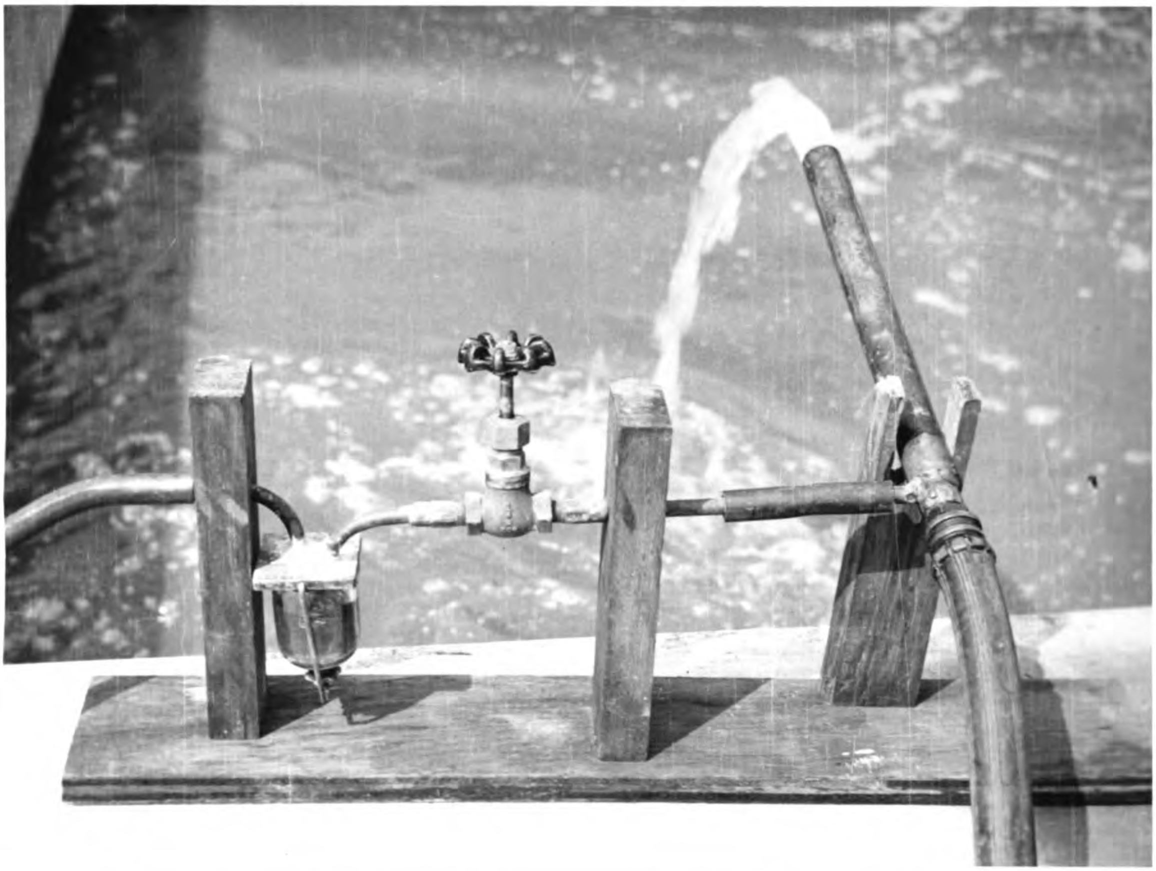
EAST LANSING SEWAGE TREATMENT PLANT

PRIMARY SETTLING TANK



MECHANICAL AERATOR

FINAL SETTLING TANK



EJECTOR FOR INJECTING
PICKLE LIQUOR

PLANT OPERATION

The first problem to be solved was to arrange for hauling of the pickle liquor from the factory to the sewage plant.

Due to the fact that acid does not affect wood, wooden barrels were used to transport the liquor from the factory to the East Lansing treatment plant. It was found that old, used fifty gallon milk (whey) barrels were very inexpensive and would serve the purpose. During the first part of the experiment the East Lansing Treatment Plant truck was large enough to haul the required amount of liquor, but as the flow was increased a larger truck was needed. A truck was then rented from the college for transport.

Next came the method of injection into the aeration tank. The first method devised was shown in diagram "A" page (31). By using a head box with a constant head, it was expected that the quantity needed could be properly controlled. It was found after a short period of operation, that particles of wood from the barrels, dirt, etc., that floated on the surface of the pickle liquor, would clog up the screen and valve below. Solids also clogged up the two control valves of the feed line and return line from the pump which was used for pumping the liquor from the barrels to the head box. Also, it was found that the scale in the liquor interfered with the operation of the pump. It would score the pump housing (brass) as well as the rubber impeller. After a period of operation the pump could not pump from the feed barrel which was about six feet below the level of the head box.

It was decided to change the structure of the apparatus as shown in method "B" page (32). The valves were removed from the feed and return line to reduce the head, and the valve was removed from the underside of the head box. The pump was slowed down by a pulley belt system. A glass tube, which was stretched out over flame (trial and error) to get a proper opening, was inserted under the head box in a rubber tube. By doing this it was found that the glass tube did not clog up nearly as much as the small valve, but would occasionally clog if a larger particle did get through the screen. The pumping head on the pump was reduced, but it was still found that the waste pickle liquor was wearing the surfaces on the pump housing and impeller. After a period of operation this became unsatisfactory. One man's time was required almost continuously to operate the injection system.

The method shown in diagram "C", page (33) was tried. The fifty gallon barrel was filled and then run out slowly by means of the valve on the bottom of the barrel. The head was large enough so that the valve was prevented from clogging. This also meant intermittent running of the pump. The area the screen occupied was also in a clean solution of pickle liquor. The scale settled to the bottom and the scum floated on top, so a clear, green liquor would normally pass through the outlet. Trouble with the pump still persisted so it was decided to make an ejector as shown in diagram "D" page (34).

This method proved most effective of all. With the help of the plant operators an ejector was made from a piece of one-inch copper-tube and a three eighths inch copper-tube with a hose connection on the end. A reducer was placed in the water main and hooked up with a three-quarter inch garden hose. A three-eighths inch rubber tube ran from the supply barrel to a sediment bulb (made from an old auto carbureter) and then to the ejector. Much to our dismay, the acid ate the metal top in two days. It was found that the pickle liquor was very corrosive on most metals -- and wearing apparel also. A cover was then made of one-fourth inch copper plate and copper-tubing inserted through holes drilled in the top. A brass needle valve was inserted on the discharge side. This worked quite well, but an occasional clogging of the needle valve resulted from particles that had managed to pass through. Generally, though, the high velocity through the needle valve kept it free and clear. To overcome the clogging of the float system in the supply barrel was devised as shown in the diagram. From then on the injection system functioned satisfactorily, The time period of injection of the pickle liquor could be extended at lower rates to get a more even distribution of iron (Fe) into the aeration tank.

The amount injected each day sometimes became a difficult problem. A rainstorm or increase in flow would demand an increase in Fe, so it became a matter of estimating such things as "wash day," rain, etc. An attempt was made to estimate the day's flow and then put in a proper amount of iron (Fe). The following day, after a check on the total flow, it was often found that either too much or too little had been added. It was then a matter of making up or deleting, whatever the case would be. By this method the proper amount of Fe was entered into the tank. It was found that a limited overdose or underdose did not affect the plant

operation noticeably. Due to recirculation of return sludge, much or the iron is maintained in the system.

As stated previously, one M. G. D. was the first flow to be run through No. 1. This was accomplished by resetting the weirs in the weir box (see schematic diagram of plant). During the period of this flow no trouble was encountered. The amount of iron required was 2 ppm.

Example: 1 M. G. D. flow
8.34# Fe/M. G. D. = 1 ppm
2 x 8.34 equals 16.68# iron required

On the average it was found that approximately 10 pounds of iron was available from a 50 gallon barrel of iron pickle liquor. Usually, then, two barrels was sufficient per day.

The flow was increased to 1.5 M. G. D. and at this flow operation was accomplished without too much difficulty. However, when the flow was increased to 1.8 M. G. D. it was found that more trips were necessary to haul the liquor. At this stage a larger truck was used carrying 10 barrels per load. Sometime later in the week it was found the liquor at the factory was very low in iron content. This made it difficult to maintain sufficient Fe for the flow. Monday was usually a good day because the factory dumped their waste pickle liquor over the weekend.

It was also found that the level in the aeration tanks was too high for efficient aeration on days of high sewage flow. The high flow of sewage decreased the detention time in the final settlers to obtain good settling results. This, of course, could be remedied in the design of new plants by the use of larger sizes.

When the flow was increased to two M. G. D. it was found that the higher resulting level in the aeration tank further interfered with efficient aeration. The aerators were run at 100% capacity, but were not fully efficient. A new design could help by being able to raise the aerators up to the proper level. The velocities were too high in the primary tank and final settler, so both primaries and final settlers were then used to obtain proper settling. Only one side of the aeration tank was kept in operation, although it was not operating at maximum efficiency. This relieved the "murky" effluent over the cascades.

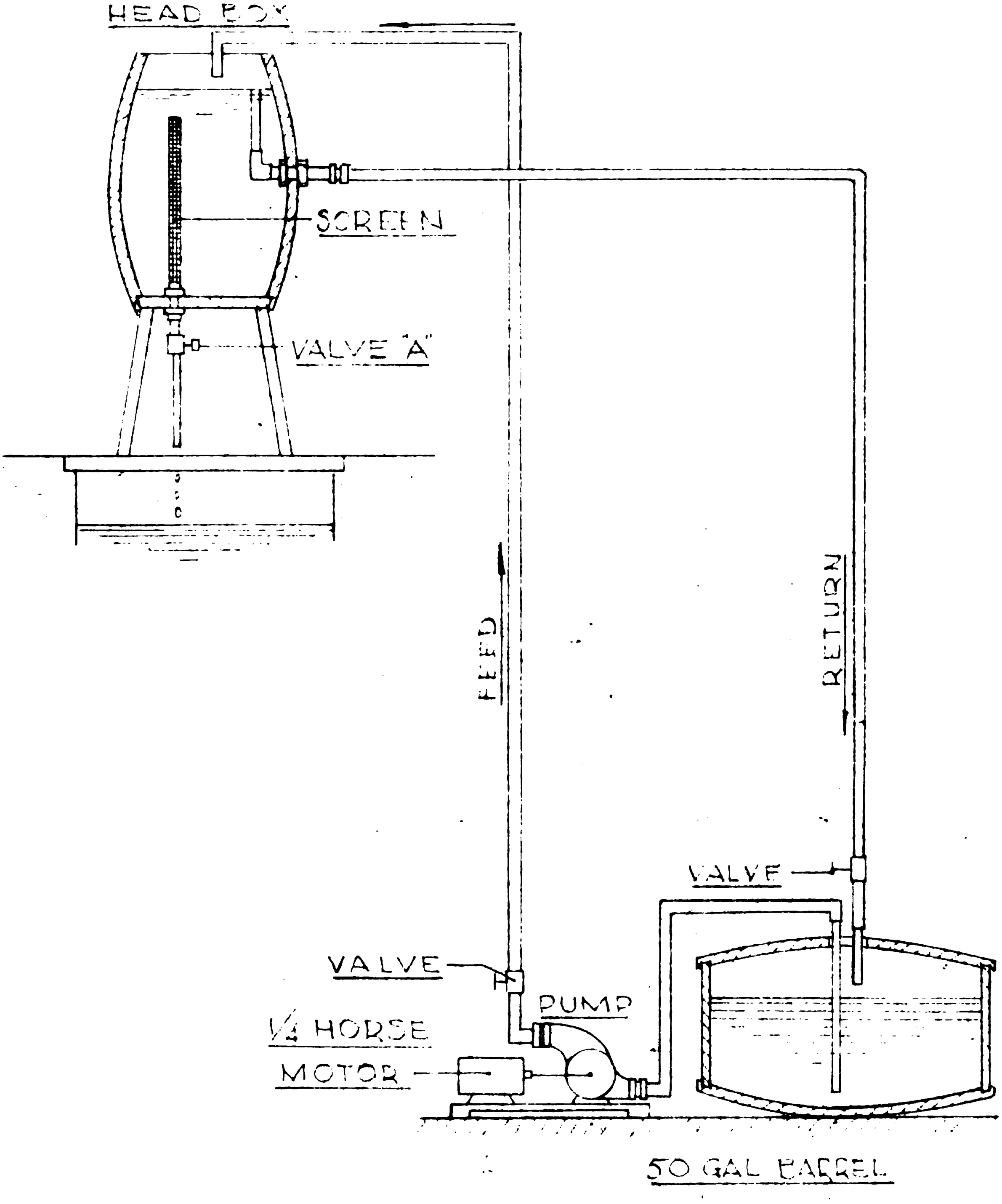
During the experiment, all regular sewage plant data was recorded. For the entire nine week period, the pH never at any time ran below 7.0.

Besides this, one separate test was run on dissolved oxygen at the entrance and discharge end of the aeration tank daily to determine the efficiency of the aerators. This test was run once in the morning and again in the afternoon. As stated before, at high flows, the aerators were not operating at a maximum. This experiment revealed that at low flow maximum aeration did not occur, but at a medium flow a maximum percent of aeration resulted.

On the data sheets, weekly averages were kept. Read down for the No. 1 side and read up on the No. 2 side to get the weekly averages. It is pointed out that at no time did the total % B. O. D. reduction go below the minimum of 80% as required.

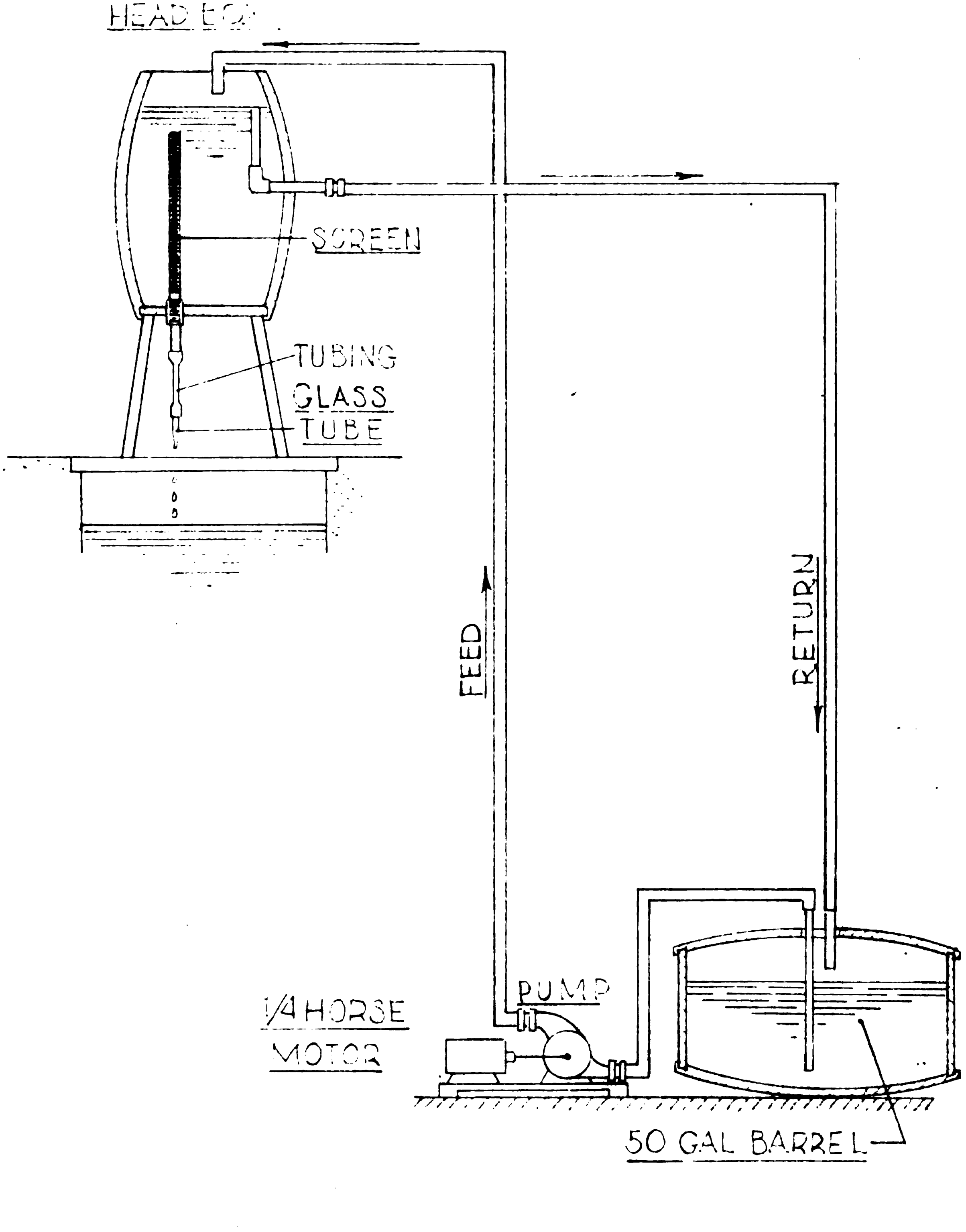
METHODS OF INJECTING
WASTE IRON PICKLE LIQUOR ($FeSO_4$)
INTO AERATION TANK

METHOD "A"



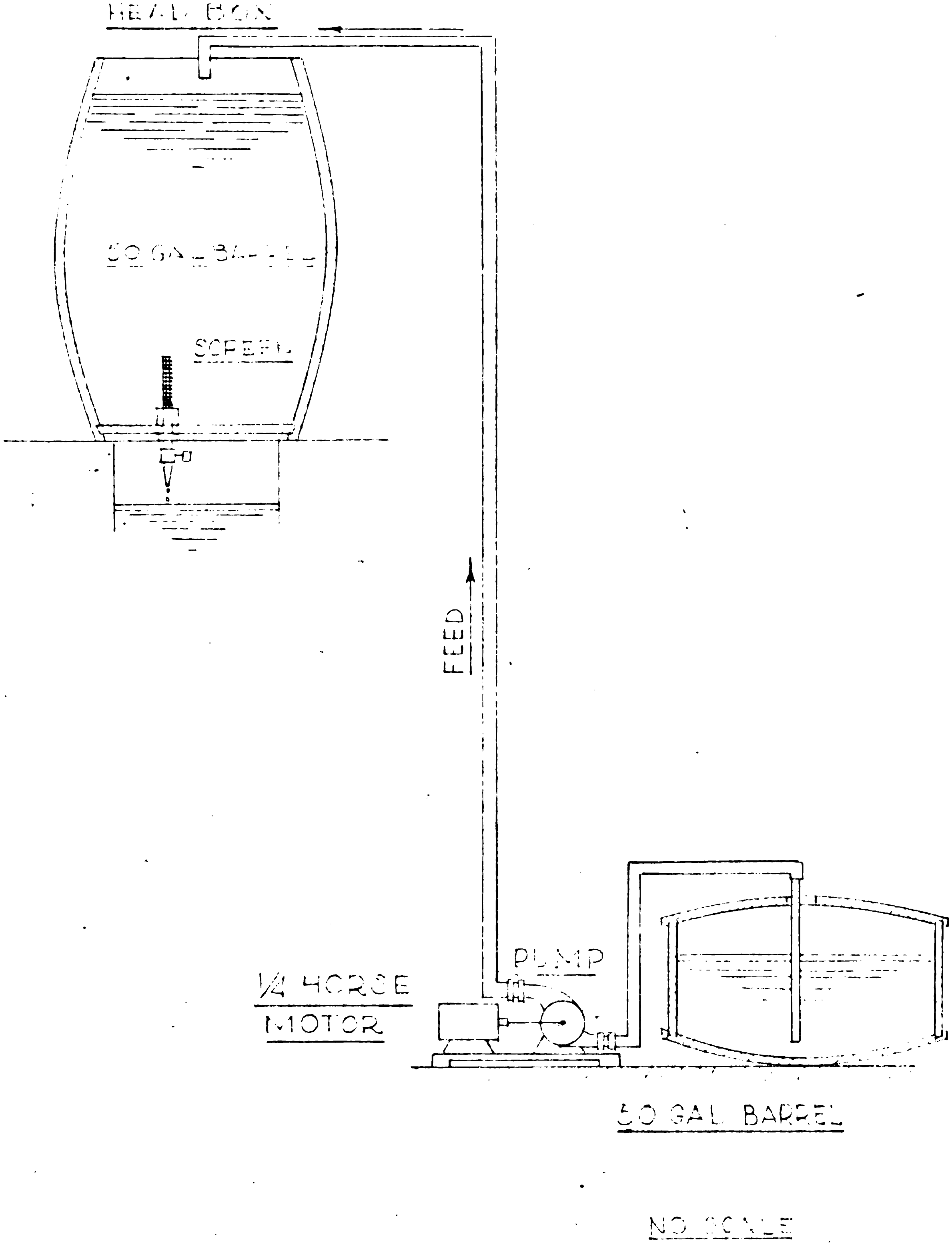
NO SCALE

METHOD "B"

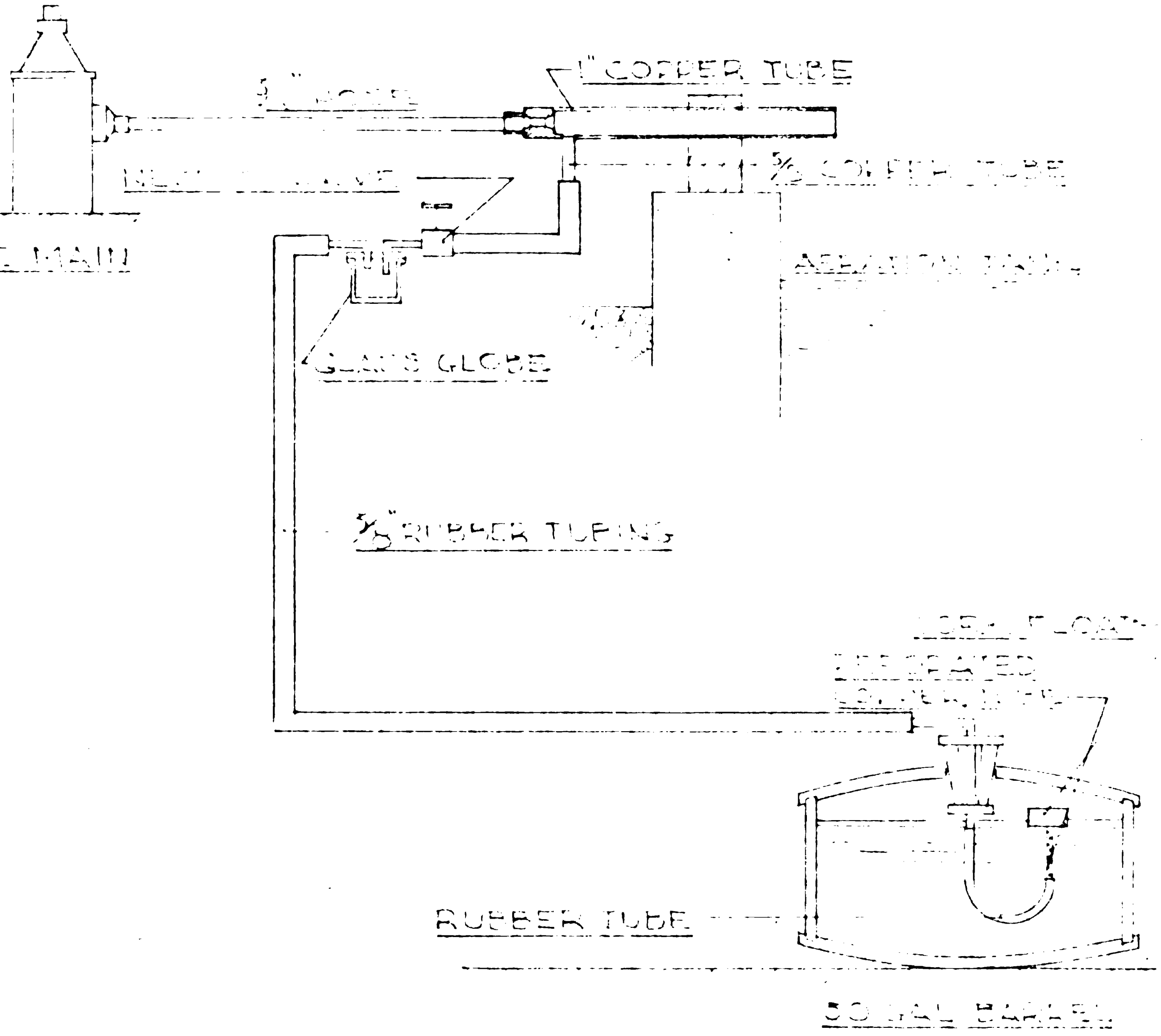


NO SCALE

METHOD "C"


HEAD BOX
50 GAL BARREL
SCREEN
FEED
PUMP
1/4 HORSE MOTOR
50 GAL BARREL
NO SCALE

METHOD 'D'


1" COPPER TUBE
5/8" HOSE
NEEDLE VALVE
5/8 COPPER TUBE
FIRE MAIN
AERATION TANK
GLASS GLOBE
5/8" RUBBER TUBING
CORK FLOAT
PERFORATED
COPPER PIPE
RUBBER TUBE
50 GAL BARREL

DATA

DATA

KEY FOR DATA SHEETS		
		UNIT OF MEASUREMENT
1	TEMPERATURE	DEGREES F
2	FLOW	MILLION GALLONS PER DAY
3	5 DAY BOD	
a	RAW SEWAGE	PARTS PER MILLION
b	PRIMARY EFFLUENT	" " "
c	FINAL EFFLUENT	" " "
4	SUSPENDED SOLIDS	
a	RAW SEWAGE	PARTS PER MILLION
b	PRIMARY EFFLUENT	" " "
c	FINAL EFFLUENT	" " "
d	MIXED LIQUOR	" " "
e	RETURN SLUDGE	" " "
5	SETTABLE SOLIDS	
a	MIXED LIQUOR	SETTLING RATE OF MIXED LIQUOR IN MILLILITERS/LITER/30 MINUTES TIME
b	RETURN SLUDGE	SETTLING RATE OF RETURN SLUDGE IN MILLILITERS/LITER/30 MINUTES TIME
6	RETENTION TIME	HOURS
a	PRI. SETT. TANK	"
b	AERATION TANK	"
c	FINAL SETT TANK	"
7	AERATORS	
a	NUMBER ON	ACTUAL NO. AERATORS IN OPERATION
b	PERCENT ON	PERCENT TIME AERATORS OPERATE / DAY
8	IRON Fe	
a	Fe	PARTS PER MILLION
9	VOLITILE SUS SOLIDS	
a	RAW SEWAGE	PARTS PER MILLION
b	PRIMARY EFFLUENT	" " "
c	FINAL EFFLUENT	" " "

NO 1 (READ DOWN)

READ DOWN

DAY & MO.	TEMP.	TOT. FLO.	FLO. No 1		5 DAY B.O.D.				SUS. SOLIDS					VOLIT. SUS.			SET. SOLIDS		VOL. R.S.		RETENTION			AERATION		Fe
	°F	M.G.D.	M.G.D.	%	RAW	PRI.	EFF.	%RED.	RAW	PRI.	EFF.	M.L.	R.S.	RAW	PRI.	EFF.	M.L.	R.S.	M.G.D.	%	PRI.	AER.	FINAL	HRS.	NO-A %ON	PPM.
6-19	57	2.715	1.505	55.0	226	136	2.8	99	121	96	87	816	1470	62	1	2	13	19	.370	25	2.7	6.9	3.9	4.27	7-85	2
20	67	2.664	1.480	55.5	233	136	2.0	99	137	72	47	726	1840	124	50	1	13	33	.392	27	2.8	6.9	4.0	4.34	8-75	2
21	66	2.744	1.525	55.4	160	116	1.2	99	193	87	55	660	2130	119	32	7	14	34	.392	26	2.7	6.7	3.9	4.21	8-80	2
22	79	2.880	1.599	55.5	147	54	2.4	98	—	—	—	968	2780	—	—	—	16	49	.381	19	2.5	6.5	3.7	4.03	8-85	2
23	81	3.532	1.959	55.5	157	104	1.0	99	—	—	—	828	2700	—	—	—	15	38	.381	20	2.1	5.5	3.0	3.28	8-85	2
24	70	2.796	1.537	55.0	265	60	34	99	—	—	—	1020	4930	—	—	—	12	70	.370	24	2.7	6.7	3.8	4.18	8-85	2
25	78	2.643	1.469	55.4	107	60	2.4	98	—	—	—	332	2490	—	—	—	10	27	.381	26	2.8	7.0	4.1	4.38	8-85	2
AVG.	71.1	2.853	1.582	55.3	185	95.1	2.2	98.7	150.3	85	63	850	2623	102	28	3.3	13.3	58.6	.381	24	2.6	6.6	3.8	4.09	7.9-84	2

WEEKLY

DAY & MO.	TEMP.	TOT. FLO.	FLO. No. 2		5 DAY B.O.D.				SUS SOLIDS					VOLIT. SUS.			SET. SOLIDS		VOL. R.S.		RETENTION			AERATION		
	°F	M.G.D.	M.G.D.	%	RAW	PRI.	EFF.	%RED.	RAW	PRI.	EFF.	M.L.	R.S.	RAW	PRI.	EFF.	M.L.	R.S.	M.G.D.	%	PRI.	AER.	FINAL	HRS.	NO-A %ON	
AVG.	71.1	2.853	1.271	44.7	206	110.7	2.27	98.7	150.3	64	1.2	915.4	2324.5	102	41	1.2	15.9	77.0	280.7	22.6	1.86	7.3	3.4	8.92	9-70.7	
25	SAME AS ABOVE	SAME AS ABOVE	1.174	44.6	—	—	—	—	—	—	—	584	2990	—	—	—	12	41	309	28	2.0	7.5	3.6	9.57	9-75	
24			1.259	45.0	—	—	—	—	—	—	—	896	2200	—	—	—	10	77	297	25	1.9	7.2	3.4	8.94	9-75	
23			1.573	44.5	—	—	—	—	—	—	—	800	3120	—	—	—	12	77	297	23	1.5	6.0	2.7	7.15	9-75	
22			1.281	44.5	—	—	—	—	—	—	—	756	1100	—	—	—	17	74	297	19	1.8	7.0	3.3	8.77	9-75	
21			1.215	44.6	160	68	1.6	99	193	67	1.0	1408	3200	119	58	2.0	20	86	268	22	1.9	7.4	3.5	9.23	9-75	
20			1.184	44.5	233	136	2.0	99	137	79	0.5	920	4000	124	39	0.5	20	90	292	23	2.0	7.9	3.6	9.50	9-60	
6-19			1.210	45.0	226	128	3.2	98	121	47	2.0	1044	3860	62	27	1.0	20	94	215	18	1.9	6.0	3.5	9.28	9-60	

READ UP

NO 2 (READ UP)

REMARKS: NOTE: Ph AVERAGED ABOVE 7.0 IN ALL TESTS THAT WERE PERFORMED ON RAW INFLUENT, PR. EFF'LNT, MIXED LICQUOR, RETURN SLUDGE & FINAL EFF'LNT.

NO 1 (READ DOWN)

DAY & MO.	TEMP	TOT. FLO	FLO. No 1		5 DAY B.O.D.				SUS. SOLIDS.					VOLIT. SUS.			SET. SOLIDS		VOL.R.S.		RETENTION			AERATION		Fe
	°F.	M.G.D.	M.G.D.	%	RAW	PRI.	EFF.	%RED	RAW	PRI.	EFF.	M.L.	R.S.	RAW	PRI.	EFF.	M.L.	R.S.	M.G.D.	%	PRI.	AER..	FINAL	HRS.	NO-A %ON	PPM.
6-26	66	2.666	1.482	55.5	260	128	2.4	99	110	21	10	840	2450	84	17	0	12	26	.381	26	2.8	7.0	4.1	4.33	8.85	2
27	66	3.033	1.392	46.0	117	92	1.4	99	—	—	—	996	2580	—	—	—	14	21	.285	21	1.5	3.7	2.1	4.61	4.95	2
28	66	3.141	1.446	46.0	160	124	7.6	95	170	50	4.1	988	2330	107	44	22	14	20	.285	20	1.5	3.7	2.1	4.44	4.95	2
29	65	2.708	1.249	46.0	167	124	5.6	97	102	76	2.0	888	2550	79	74	2	14	24	285	24	1.7	4.4	2.4	5.15	4.95	2
30	65	2.513	1.156	46.2	127	92	1.6	99	—	—	—	1324	3810	—	—	—	16	25	.269	25	1.8	4.7	2.6	5.55	4.95	2
7-1	65	2.261	1.040	46.0	127	82	1.6	99	—	—	—	1128	3130	—	—	—	17	28	.292	28	1.9	5.2	2.8	6.15	4.95	2
2	75	2.076	0.953	46.0	—	—	—	—	—	—	—	1288	3950	—	—	—	21	30	.292	30	2.1	5.2	3.0	6.75	4.95	2
AVG.	63	2.625	1.245	47.8	153.7	107	3.4	97	127	49	2.4	1069	2971	90	.45	8	15.4	24.8	.298	24.8	2.5	4.84	2.74	5.28	4.6.93	2

READ DOWN

WEEKLY

AVG.	69	2.628	1.388	52.2	178.5	104.5	1.8	98.5	127.3	55	7.3	842	2851	90	41.7	3.17	14.6	74	.288	21	1.86	6.7	3.1	8.14	9.79.3	
2	SAME AS ABOVE	SAME AS ABOVE	1.123	54.0	—	—	—	—	—	—	—	948	3030	—	—	—	19	85	.282	25	2.1	8.0	3.8	10.0	9.65	
7-1			1.221	54.0	127	90	2.0	98	—	—	—	1028	3380	—	—	—	17	92	.282	23	1.9	7.4	3.5	9.2	9.75	
30			1.357	53.8	—	—	—	—	—	—	—	1124	3620	—	—	—	18	88	.282	20	1.7	6.6	3.0	8.3	9.85	
29			1.495	54.0	167	144	0.8	99	102	67	1.0	800	2940	79	58	10	12	84	.295	20	1.6	6.1	2.8	7.5	9.85	
28			1.695	54.0	160	76	2.8	98	170	70	18.0	564	2800	107	47	8.6	12	55	.295	16	1.3	5.5	2.4	6.64	9.85	
27			1.641	54.0	—	—	—	—	—	—	—	848	2990	—	—	—	14	65	.268	16	1.4	5.9	2.6	6.85	9.95	
6-26			1.184	44.5	260	108	1.6	99	110	27	3.0	584	2200	84	20	0.5	12	28	.309	28	2.0	7.3	3.6	9.5	9.65	
DAY & MO	°F	M.G.D.	M.G.D.	%	RAW	PRI.	EFF.	%RED	RAW	PRI.	EFF.	M.L.	R.S.	RAW	PRI.	EFF.	M.L.	R.S.	M.G.D.	%	PRI	AER	FINAL	HRS	NO-A %ON	
	TEMP.	TOT. FLO.	FLO No. 2		5 DAY B.O.D.				SUS. SOLIDS					VOLIT. SUS.			SET. SOLIDS		VOL R.S.		RETENTION			AERATION		

READ UP

NO 2 (READ UP)

REMARKS: RESET WEIRS No1 & No2 TO MAINTAIN APPROX. 1.0 M.G.D. THROUGH NO1 6-28-50

NO 1 (READ DOWN)

DAY & MO.	TEMP. °F	TOT. FLO. M.G.D.	FLO. No1 MGD.	FLO. No1 %	5 DAY B.O.D. RAW	5 DAY B.O.D. PRI.	5 DAY B.O.D. EFF.	5 DAY B.O.D. %RED.	SUS. SOLIDS RAW	SUS. SOLIDS PRI.	SUS. SOLIDS EFF.	SUS. SOLIDS M.L.	SUS. SOLIDS R.S.	VOLIT. SUS. RAW	VOLIT. SUS. PRI.	VOLIT. SUS. EFF.	SET. SOLIDS M.L.	SET. SOLIDS R.S.	VOL. R.S. MGD	VOL. R.S. %	RETENTION PRI.	RETENTION AER.	RETENTION FINAL	AERATION HRS.	AERATION NO-A %ON	Fe PPM
7-3	62	2.314	1.062	46	—	—	—	—	—	—	—	896	2600	—	—	—	17	78	.248	23	1.8	5.0	2.5	6.05	4.95	2
4	73	2.268	1.045	46	187	116	4.0	98	101	55	4	680	4090	87	48	3	18	89	.248	24	1.9	5.0	2.8	6.25	4.95	2
5	66	2.498	1.149	46	220	136	5.2	98	123	71	18	1036	3040	96	46	13	16	82	.248	22	1.8	4.7	2.6	5.60	4.80	2
6	65	2.636	1.210	46	200	132	5.6	97	101	67	12	1104	3620	78	56	9	17	90	.334	20	1.6	3.7	2.4	5.30	4.80	2
7	70	2.560	1.180	46	130	142	3.2	97	—	—	—	1072	2390	—	—	—	17	58	.296	30	1.6	4.5	2.5	5.95	4.97	2
8	76	2.493	1.140	45.8	100	86	6.0	94	64	30	2	1184	2150	—	—	—	18	54	.252	20	1.8	4.7	2.6	5.60	4.97	2
9	78	2.416	1.110	46	147	74	5.2	97	68	34	3	1128	2710	—	—	—	20	87	.252	21	1.7	4.7	2.6	5.75	4.97	2
AVG.	70	1.741	1.128	45.9	164	143	4.7	96.8	91.4	51.4	7.8	1014	2543	87	50	8.7	17.5	77	.270	23	1.74	4.5	2.6	5.70	4.91	2

READ DOWN

WEEKLY

DAY & MO.	TEMP. °F	TOT. FLO. M.G.D.	FLO. No. 2 M.G.D.	FLO. No. 2 %	5 DAY B.O.D. RAW	5 DAY B.O.D. PRI	5 DAY B.O.D. EFF.	5 DAY B.O.D. %RED	SUS. SOLIDS RAW	SUS. SOLIDS PRI.	SUS. SOLIDS EFF.	SUS. SOLIDS M.L.	SUS. SOLIDS R.S.	VOLIT. SUS. RAW	VOLIT. SUS. PRI.	VOLIT. SUS. EFF.	SET. SOLIDS M.L.	SET. SOLIDS R.S.	VOL. R.S. MGD	VOL. R.S. %	RETENTION PRI	RETENTION AER	RETENTION FINAL	AERATION HRS.	AERATION No-A %ON
AVG.	70	2.741	1.327	44.1	162.3	112.3	3.3	95.3	91.4	53.2	5	828.6	2951	87	53.3	2.3	20.1	89.6	.277	21.6	1.81	6.9	3.2	8.49	9-65
9	78	SAME AS ABOVE	1.306		100	92	3.6	98	63	42	7	740	2520	—	—	—	23	83	282	21	1.8	7.0	3.3	8.61	9-65
8	76		1.353		130	98	6.4	96	64	30	2	728	2430	—	—	—	24	91	.282	21	1.8	6.9	3.2	8.30	9.65
7	70		1.380		200	124	2.8	98	—	—	—	904	2910	—	—	—	21	89	.282	21	1.7	6.7	3.1	8.15	9.65
6	65		1.426		103	80.2	10.0	90	—	—	—	944	3160	—	—	—	21	97	282	17	1.7	6.6	3.0	7.89	9.65
5	66		1.349		200	124	2.8	99	101	55	1	800	3870	78	29	1	17	88	.210	23	1.9	6.1	3.2	8.34	9.65
4	73		1.223		220	136	2.8	98	123	88	9	856	3120	96	77	1	18	83	.310	25	1.9	7.4	3.0	9.18	9.65
7-3	62		1.252		183	132	3.6	98	101	51	6	828	2650	87	54	5	17	85	.292	23	1.9	7.2	3.5	8.96	9.65

READ UP

NO 2 (READ UP)

REMARKS:

NO1 (READ DOWN)

DAY	TEMP.	TOT. FLO.	FLO. NO. 1		5 DAY B.O.D.				SUS. SOLIDS.					VOLIT. SUS.			SET. SOLIDS		VOL. R.S.		RETENTION			AERATION		Fe
MO.	°F	M.G.D.	M.G.D.	%	RAW	PRI.	EFF.	%RED.	RAW	PRI.	EFF.	M.L.	R.S.	RAW	PRI.	EFF.	M.L.	R.S.	M.G.D.	%	PRI.	AER.	FINAL	HRS.	NO-A %ON	PPM.
7-10	72	2.651	1.540	58	240	144	7.6	97	168	73	32	1008	3470	127	52	31	19	92	.336	22	1.3	3.4	1.9	4.16	4-97	2
11	73	2.692	1.560	58	187	110	7.2	96	109	24	4	1128	3410	—	—	—	20	90	.336	22	1.3	3.2	1.9	4.11	4-97	2
12	82	2.938	1.700	58	200	116	8.8	96	122	71	12	1052	3770	122	63	12	18	89	.336	20	1.2	3.1	1.7	3.78	4-97	2
13	61	2.559	1.480	58	200	93	7.6	95	329	113	27	1064	3710	174	96	25	15	92	.500	34	1.4	3.3	2.0	4.22	4-100	2
14	68	2.428	1.410	58	137	100	10.6	92	80	83	3	636	1600	—	—	—	9	15	.357	26	1.4	3.6	2.0	4.54	4-100	2
15	72	2.448	1.420	58	80	88	3.6	95	48	16	1	420	1460	—	—	—	8	20	.357	25	1.4	3.6	2.0	4.52	4-100	2
16	73	2.910	1.690	58	170	94	10.6	93	77	54		428	640	—	—	—	7	13	.357	23	1.2	3.2	1.7	3.79	4-100	2
AVG.	72	2.661	1.543	58	173.4	106	8.0	94	133.3	62	13.3	819.4	2580	140.3	57	22.3	13.7	50.3	.368	24.6	1.31	3.3	1.9	4.17	4-98.7	2

READ DOWN

WEEKLY

DAY MO.	TEMP.	TOT. FLO.	FLO. No. 2		5 DAY B.O.D.				SUS SOLIDS					VOLIT. SUS.			SET SOLIDS		VOL R.S.		RETENTION			AERATION		
	°F	M.G.D.	M.G.D.	%	RAW	PRI.	EFF.	%RED.	RAW	PRI.	EFF.	M.L.	R.S.	RAW	PRI.	EFF.	M.L.	R.S.	M.G.D.	%	PRI.	AER.	FINAL	HRS.	NO-A %ON	
AVG.	72	2.661	1.118	42	173.4	99	4.5	97	133.3	55.1	6.5	1004	2804	140.3	63.3	7	22.7	86	.377	33.9	2.17	7.7	3.87	10.11	9-63	
16	SAME AS ABOVE	SAME AS ABOVE	1.220	42	170	88	4.2	99	77	46	9	1112	2280	—	—	—	22	65	.403	33	1.9	6.9	3.5	9.22	9-60	
15			1.028	42	80	58	7.6	97	48	32	0.5	1280	2760	—	—	—	23	83	.403	39	2.4	7.9	4.2	10.95	9-60	
14			1.018	42	137	76	4.2	99	80	38	10	1085	2900	—	—	—	23	83	.403	39	2.4	7.9	4.2	11.08	9-60	
13			1.079	42	200	100	2.8	99	329	113	11	828	3840	174	75	11	22	94	.468	44	2.2	7.3	4.0	10.41	9-65	
12			1.238	42	200	120	2.8	97	122	30	2	1028	2630	122	30	2	25	83	.341	28	2.0	7.2	3.5	9.10	9-65	
11			1.132	42	187	104	6.8	90	109	42	5	868	2000	—	—	—	24	90	.309	27	2.1	7.9	3.8	9.93	9-65	
7-10			1.111	42	240	144	2.8	97	168	85	9	624	2320	127	85	8	20	93	.309	27	2.2	7.9	3.9	10.1	9-65	

READ UP

NO 2 (READ UP)

REMARKS: RESET WEIRS No1 & NO2 TO MAINTAIN APPROX. 1.5 M.G.D THROUGH No1 7-10-50

NO 1 (READ DOWN)

DAY & MO.	TEMP. °F	TOT. FLO M.G.D.	FLO No 1 M.G.D.	FLO No 1 %	5 DAY B.O.D. RAW	5 DAY B.O.D. PRI.	5 DAY B.O.D. EFF.	5 DAY B.O.D. % RED.	SUS. SOLIDS. RAW	SUS. SOLIDS. PRI.	SUS. SOLIDS. EFF.	SUS. SOLIDS. M.L.	SUS. SOLIDS. R.S.	VOLIT. SUS. RAW	VOLIT. SUS. PRI.	VOLIT. SUS. EFF.	SET. SOLIDS M.L.	SET. SOLIDS R.S.	VOL. R.S. M.G.D.	VOL. R.S. %	RETENTION PRI.	RETENTION AER.	RETENTION FINAL	AERATION HRS.	AERATION NO-A % ON	Fe P.P.M.
7-17	69	2.980	1.730	58	—	—	—	—	186	103	28	584	2310	74	32	14	3	12	.290	17	1.2	3.1	1.7	3.70	4-100	2
18	65	2.676	1.550	58	170	92	6.8	96	103	70	17	492	3030	48	70	1	3	13	.381	24	1.3	3.5	1.9	4.14	4-100	2
19	62	3.603	2.090	58	153	116	6.8	96	335	99	25	648	2370	169	58	32	5	27	.381	18	1.0	2.6	1.4	3.06	4-100	2
20	59	2.811	1.630	58	107	58	4.8	96	102	87	24	716	5000	—	—	—	5	30	.480	29	1.3	3.0	1.8	3.93	4-100	2
21	61	2.718	1.570	58	237	134	4.4	98	167	113	25	764	5760	—	—	—	7	14	.480	30	1.3	3.1	1.9	4.08	4-100	2
22	72	2.529	1.460	57.7	113	108	4.4	96	87	71	11	532	1840	—	—	—	7	22	.476	32	1.4	3.3	2.0	4.40	4-100	2
23	79	2.859	1.558	54.6	103	72	8.0	92	240	43	9	688	2070	—	—	—	7	13	.476	29	1.2	3.0	1.8	4.12	4-100	2
AVG.	69	2.885	1.655	57.5	147	101.6	5.1	95.7	116.5	87	18.9	632	3197	97	53.3	19	5.3	19.6	.423	25.6	1.24	3.1	1.8	3.99	4-100	2

READ DOWN

WEEKLY

NO 2 (READ UP)

DAY & MO.	TEMP. °F	TOT. FLO. M.G.D.	FLO No. 2 M.G.D.	FLO No. 2 %	5 DAY B.O.D. RAW	5 DAY B.O.D. PRI.	5 DAY B.O.D. EFF.	5 DAY B.O.D. % RED.	SUS. SOLIDS RAW	SUS. SOLIDS PRI.	SUS. SOLIDS EFF.	SUS. SOLIDS M.L.	SUS. SOLIDS R.S.	VOLIT SUS. RAW	VOLIT SUS. PRI.	VOLIT SUS. EFF.	SET. SOLIDS M.L.	SET. SOLIDS R.S.	VOL R.S. M.G.D.	VOL R.S. %	RETENTION PRI.	RETENTION AER.	RETENTION FINAL	AERATION HRS.	AERATION NO-A % ON	
AVG.	69	2.885	1.230	42.5	147	78.4	3.4	96.5	176.5	81.5	5.7	1087	2813	97	61.3	2.5	13.9	42.4	.404	33.4	2.0	6.9	3.56	9.27	9-60	
23	SAME AS ABOVE	SAME AS ABOVE	1.301	45.4	103	70	8.2	92	240	—	—	1004	1920	—	—	—	15	19	.423	34	2.0	6.9	3.6	8.65	9-60	
22			1.069	42.3	113	91	8.2	93	87	51	5	896	1630	—	—	—	12	20	.423	40	2.3	7.6	4.0	10.5	9-60	
21			1.148	42	237	136	1.6	99	167	87	3	1040	2860	—	—	—	12	22	.423	37	2.1	7.2	3.7	9.8	9-60	
20			1.181	42	107	56	3.0	97	102	80	28	1164	4130	—	—	—	12	85	.373	32	2.0	7.2	3.6	9.51	9-60	
19			1.513	42	153	108	0.8	99	335	109	2	1308	2780	169	92	2	15	30	.391	26	1.6	5.8	2.8	7.43	9-60	
18			1.126	42	170	88	1.4	99	103	57	0.5	1280	2810	48	50	0.5	16	35	.391	33	2.1	7.5	3.8	10.0	9-60	
7-17			1.250	42	—	—	—	—	186	106	10	916	3500	74	42	5	15	86	.403	32	1.9	6.8	3.4	9.0	9-60	

READ UP

REMARKS:

NO 1 (READ DOWN)

AY	TEMP.	TOT. FLO.	FLO NO.1		5 DAY B.O.D.				SUS. SOLIDS					VOLIT. SUS.			SET. SOLIDS		VOL. R.S.		RETENTION			AERATION		Fe
MO.	°F	M.G.D.	M.G.D.	%	RAW	PRI.	EFF.	% RED.	RAW	PRI.	EFF.	M.L.	R.S.	RAW	PRI.	EFF.	M.L.	R.S.	M.G.D	%	PRI.	AER.	FINAL	HRS.	NO-A % ON	P.P.M.
-24	70	2.640	1.169	46	250	122	8.4	97	491	118	1.8	880	2290	246	55	8	5	15	.479	31	1.3	3.2	1.9	5.02	4-100	2
25	67	2.556	1.480	58.2	200	68	7.2	96	129	33	1.5	592	2000	76	33	1.5	7	11	.479	32	1.4	3.3	2.0	4.34	4-100	2
26	74	2.484	1.940	57.8	157	110	4.6	97	59	49	2	944	2220	—	—	—	8	16	.479	33	1.4	3.3	2.0	4.45	4-100	2
27	75	2.645	1.533	58	133	100	7.2	95	100	49	1	716	1950	80	28	1	8	20	.479	31	1.3	3.2	1.9	4.18	4-100	2
28	72	2.517	1.458	58	47	86	5.0	94	111	73	4.5	612	2350	—	—	—	10	19	.541	30	1.1	2.8	3.3	4.40	4-100	2
29	78	2.327	1.352	58	103	68	8.9	88	36	28	0.5	516	1490	—	—	—	8	16	.545	33	1.2	2.9	3.6	4.75	4-100	2
30	75	2.843	2.050	72.2	207	76	12.4	94	562	52	21	572	1950	159	78	10	8	24	.545	27	1.0	2.5	2.9	3.13	4-100	3
AVG.	73	2.573	1.498	58.3	157	90	7.4	94.4	213	63.1	4.6	690.3	2036	140	48.5	5.1	7.71	17.3	.507	.31	1.24	3.1	2.5	4.40	4-100	2.1

READ DOWN

WEEKLY

AVG.	73	2.573	1.085	41.7	157	95	6.1	95.6	213	49	5.3	1059	2409	140	34	5.9	12.7	23.9	.349	37.3	2.64	7.4	4.76	8.89	7.7-67	
30			.793	27.8	207	92	4.9	98	562	50	26	1258	2540	159	42	20	15	30	.247	31	3.0	7.2	5.4	9.45	6-70	
29	SAME AS ABOVE	SAME AS ABOVE	.975	42	103	82	6.4	94	36	5	10	1140	2250	—	—	—	16	25	.277	40	3.4	7.8	6.2	7.70	6-80	
28			1.059	42	47	86	4.0	92	111	30	0.5	1000	2820	—	—	—	14	35	.341	46	3.2	6.9	5.8	7.10	6-80	
27			1.112	42	133	128	8.0	94	100	71	0.5	744	2020	80	31	0.5	9	20	.374	35	2.2	7.5	3.9	10.10	9-60	
26			1.044	42.2	157	102	6.2	96	59	31	3.0	1252	2870	—	—	—	13	17	.391	37	2.3	7.8	4.1	10.70	9-60	
25			1.176	41.8	200	84	4.8	98	129	49	0.5	1016	2110	76	16	0	11	17	.423	39	2.2	7.5	4.0	9.56	9-60	
-24			1.471	54	250	100	8.4	97	491	108	6.0	1052	2250	246	41	3.0	11	22	.391	35	2.2	7.5	3.9	7.63	9-60	
AY	°F	M.G.D.	M.G.D.	%	RAW	PRI.	EFF.	% RED.	RAW	PRI.	EFF.	M.L.	R.S.	RAW	PRI.	EFF.	M.L.	R.S.	MGD	%	PRI.	AER.	FINAL	HRS.	NO-A % ON	
MO.	TEMP.	TOT. FLO.	FLO No.2		5 DAY B.O.D.				SUS. SOLIDS					VOLIT. SUS.			SET. SOLIDS		VOL. R.S.		RETENTION			AERATION		

READ UP

NO 2 (READ UP)

REMARKS:

NO1 (READ DOWN)

DAY & MO.	TEMP. °F	TOT. FLO MGD	FLO. No1 MGD.	FLO. No1 %	5 DAY B.O.D. RAW	5 DAY B.O.D. PRI.	5 DAY B.O.D. EFF.	5 DAY B.O.D. %RED	SUS. SOLIDS RAW	SUS. SOLIDS PRI.	SUS. SOLIDS EFF.	SUS. SOLIDS M.L.	SUS. SOLIDS R.S.	VOLIT. SUS RAW	VOLIT. SUS PRI.	VOLIT. SUS EFF.	SET. SOLIDS M.L.	SET. SOLIDS R.S.	VOL.R.S. MGD	VOL.R.S. %	RETENTION PRI.	RETENTION AER.	RETENTION FINAL	AERATION HRS.	AERATION NO-A % ON	Fe PPM
7-31	74	3.543	2.550	72	103	80	5.0	95	253	70	17	1472	3910	—	—	—	5	11	.545	21	0.8	2.1	2.3	2.52	4-100	3
8-1	74	2.797	2.010	72	47	20	5.8	88	114	40	2.1	1332	6440	57	32	9	3	12	.545	27	1.0	2.5	2.9	3.19	4-100	3
2	68	2.531	1.820	72	80	34	8.0	90	41	23	1.5	1124	3800	—	—	—	4	9	.545	30	1.1	2.7	3.2	3.53	4-100	3
3	58	2.470	1.780	72	160	104	8.0	95	94	92	11	964	3180	53	48	6	4	10	.545	38	1.1	2.8	3.3	3.61	4-100	3
4	64	2.375	1.710	72	70	98	5.6	92	93	57	9	844	4020	—	—	—	5	20	.545	32	1.2	2.8	3.4	3.71	4-100	3
5	62	2.375	1.710	72	113	108	9.6	92	73	75	7	656	2450	—	—	—	6	12	.545	32	1.2	2.8	3.4	3.71	4-100	3
6	68	2.150	1.550	72	80	84	8.8	89	150	75	15	642	2200	91	23	0	8	6	.550	35	1.2	3.1	3.8	4.14	4-100	3
AVG	67	2.606	1.876	72	93.3	75.4	7.3	91.6	117	62	9	1005	3714	67	34.3	5	5	11.4	.546	31	1.1	2.7	3.2	3.35	4-100	3

READ DOWN

WEEKLY

AVG.	67	2.606	.731	28	78.6	47.6	33	90.3	117	34.6	6.6	1599	4057	67	21.3	5.3	8.3	13.3	.264	39	3.37	7.6	3.0	10.5	6-70	
6	SAME AS ABOVE	SAME AS ABOVE	0.393	28	80	52	10.8	86	150	11	2	1264	3150	91	11	2	6	6	.277	46	4.0	8.5	3.6	7.56	6-70	
5			0.787	28	113	80	2.6	99	73	28	3	1388	3110	—	—	—	7	12	.277	41	3.7	7.9	3.3	9.55	6-70	
4			0.711	28	70	48	9.2	87	94	35	17	1440	2960	—	—	—	7	14	.277	41	3.7	7.9	3.3	10.6	6-70	
3			0.690	28	160	36	6.4	96	94	67	6	1568	4270	—	—	—	7	16	.265	38	3.5	7.8	3.0	10.9	6-70	
2			0.665	28	80	34	8.8	89	41	17	2.5	1816	4200	53	33	6	7	17	.265	37	3.3	7.7	3.0	11.3	6-70	
8-1			0.665	28	47	16	7.6	85	114	20	8	2048	7200	57	20	8	12	48	.268	34	3.0	7.1	2.7	11.3	6-70	
7-3			0.600	28	—	—	—	—	253	64	8	1672	3510	—	—	—	12	22	.358	36	2.4	6.0	2.2	12.5	6-70	
DAY &	°F	MGD.	MGD.	%	RAW	PRI.	EFF.	%RED.	RAW	PRI.	EFF.	M.L.	R.S.	RAW	PRI.	EFE	M.L.	R.S.	MGD	%	PRI	AER	FINAL	HRS	NO-A % ON	
MO.	TEMP.	TOT. FLO.	FLO No. 2		5 DAY B.O.D.				SUS SOLIDS					VOLIT. SUS.			SET. SOLIDS		VOL R.S.		RETENTION			AERATION		

READ UP

NO 2 (READ UP)

REMARKS: RESET W.E. F.S. No1 & No2 TO MAINTAIN APPROX. 18 MGD THROUGH No1 8-1-50

NO 1 (READ DOWN)

DAY & MO.	TEMP.	TOT. FLO.	FLO NO1		5 DAY B.O.D.				SUS. SOLIDS.					VOLIT. SUS.			SET. SOLIDS		VOL.R.S.		RETENTION			AERATION		Fe
	°F	M.G.D.	M.G.D.	%	RAW	PRI	EFF.	%RED.	RAW	PRI.	EFF.	M.L.	R.S.	RAW	PRI	EFF.	M.L.	R.S.	MGD	%	PRI	AER	FINAL	HRS	NO-A % ON	P.P.M.
8-7	71	2.100	1.510	72	163	154	2.0	99	83	52	2.0	552	1620	—	—	—	6	22	.550	36	1.2	2.7	3.3	4.26	4-100	3
8	70	2.036	1.572	75	146	116	7.2	95	90	111	0.7	724	2100	64	71	3	6	14	.550	35	1.1	2.6	3.1	4.08	4-100	3
9	76	2.213	1.770	76	183	80	8.6	95	205	44	6.5	792	1730	99	81	7	9	14	.550	31	1.2	2.9	3.5	3.63	4-100	3
10	80	2.379	1.903	81	147	120	10.8	93	166	117	21	832	2590	—	—	—	9	18	.550	29	1.3	3.1	3.8	3.37	4-100	3
11	59	2.106	1.682	80	70	46	5.6	92	34	43	0.7	776	2520	—	—	—	11	33	.550	33	1.1	2.7	3.3	3.81	4-100	3
12	57	1.950	1.560	80	120	104	14.8	88	91	47	1.0	744	2750	—	—	—	11	66	.550	35	1.3	3.1	3.9	4.12	4-100	3
13	64	1.934	1.540	80	100	84	14.8	85	71	110	5	628	3310	50	59	5	12	77	.550	30	1.3	3.3	3.7	4.15	4-100	3
AVG	68	2.111	1.640	78.4	133	101	9.1	92.4	114.3	74.9	5.3	721	2230	71	70.3	5	9.1	34.9	.550	32.7	1.2	2.9	3.5	3.92	4-100	3

WEEKLY

DAY & MO.	TEMP.	TOT. FLO.	FLO No. 2		5 DAY B.O.D.				SUS. SOLIDS					VOLIT. SUS.			SET. SOLIDS		VOL. R.S.		RETENTION			AERATION	
	°F	M.G.D.	M.G.D.	%	RAW	PRI.	EFF.	%RED.	RAW	PRI.	EFF.	M.L.	R.S.	RAW	PRI.	EFF.	M.L.	R.S.	MGD	%	PRI	AER	FINAL	HRS.	NO-A % ON
AVG.	68	2.111	.462	21.6	133	71.3	8.1	94.6	114.3	50	2.0	1273	3016	65	41	2.6	9.6	31.6	.183	38.6	5.2	7.4	4.6	9.65	3.9-73
13	SAME AS ABOVE	SAME AS ABOVE	.385	20	100	84	3.2	97	71	51	—	1104	2930	50	42	—	12	39	.136	35	—	—	—	9.72	3-75
12			.390	20	120	61	3.2	97	31	42	2.5	1336	4380	—	—	—	15	68	.136	35	6.3	7.1	5.6	9.60	3-75
11			.424	20	70	46	10.4	86	34	40	1	1233	3620	—	—	—	12	47	.136	32	5.7	6.7	5.1	8.83	3-75
10			.476	19	147	70	13.2	92	166	82	1	1148	1340	90	42	7	8	13	.136	29	5.0	6.1	4.5	7.85	3-75
9			.443	24	183	40	10.4	94	205	38	4.5	1236	2720	—	—	—	8	16	.240	54	5.4	5.6	4.8	8.43	3-75
8			.524	25	147	88	2.4	99	90	41	2	1512	2920	54	40	1	7	16	.257	45	4.6	9.8	4.0	14.4	6-70
8-7			.590	28	163	110	4.2	97	83	56	1	1328	2600	—	—	—	7	22	.237	40	4.0	9.2	5.6	12.7	6-70

NO 2 (READ UP)

REMARKS: DUE TO DROP IN TOTAL FLOW WEIRS WERE RESET TO MAINTAIN APPROX. 1.3 M.G.D. THROUGH NO1 8-8-50

NO 1 (READ DOWN)

DAY & MO.	TEMP.	TOT. FLO.	FLO. No.1		5 DAY B.O.D.				SUS. SOLIDS.					VOLIT. SUS.			SET. SOLIDS		VOL. R.S.		RETENTION			AERATION		Fe
	°F	M.G.D.	M.G.D.	%	RAW	PRI.	EFF.	% RED.	RAW	PRI.	EFF.	M.L.	R.S.	RAW	PRI.	EFF.	M.L.	R.S.	M.G.D.	%	PRI	AER.	FINAL	HRS.	NO-A % ON	P.P.M.
8-14	68	2.467		100	—	—	—	—	—	—	—	812	1990	—	—	—	12	30	.545	22	1.6	2.1	2.4	2.09	4-100	3.5
15	68	2.077		100	93	96	12	68	138	70	5	720	2700	75	50	0	14	73	.545	26	1.9	2.4	2.8	3.09	4-100	3.5
16	72	1.975		100	175	108	8	95	158	32	8	832	2900	136	14	6	15	88	.580	29	2.0	2.5	3.0	3.25	4-100	3.5
17	81	1.987	SAME	100	130	90	8	94	123	18	2	948	2180	—	—	—	20	65	.580	33	2.0	2.5	2.9	3.23	4-100	4
18	64	1.716		100	93	74	12	87	64	26	10	844	2650	—	—	—	20	90	.580	32	2.4	2.5	3.4	3.73	4-100	4
19	70	1.805		100	93	80	13.6	86	44	18	2	648	1852	—	—	—	17	85	.580	33	2.3	2.8	3.3	3.56	4-100	5
20	56	1.734		100	153	148	5.6	93	150	40	4	976	3650	—	—	—	17	89	.580	32	2.3	2.7	3.4	3.70	4-100	4
AVG	70	1.966		100	134	102	10	91	130	34	5.1	826	2559	106	32	2.5	16.4	76.6	.570	29.4	2.1	2.5	3.1	3.31	4-100	3.64

WEEKLY

AVG.																									
8-14	TOTAL FLOW THROUGH NO1																								
DAY &	°F	M.G.D.	M.G.D.	%	RAW	PRI.	EFF.	% RED.	RAW	PRI.	EFF.	M.L.	R.S.	RAW	PRI.	EFF.	M.L.	R.S.	M.G.D.	%	PRI.	AER.	FINAL	HRS	NO-A % ON
MO.	TEMP	TOT. FLO.	FLO. No. 2																						

NO 2 (READ UP)

REMARKS: 100% FLOW THROUGH NO. 1 8-14-50

READ DOWN

READ UP

No 1					DISSOLVED OXYGEN PPM.				No 2	
DATE	RAW	PRI. EFF	FIN. EFF	M.L.	R.S.	RAW	PRI. EFF	FIN. EFF	M.L.	R.S.
6-19	0.8	0.4	0.8	0.6	0.4	1.0	0	1.2	2.4	0
20	—	—	3.4	3.2	—	—	—	—	—	—
21	TR	TR	3.2	2.0	—	0.5	0.4	1.2	1.2	[illegible]
22	—	—	—	2.0	—	—	—	—	—	—
23	2.2	3.6	5.0	3.0	—	2.2	—	—	—	—
24	1.6	0.2	3.6	3.2	1.4	1.6	—	—	—	—
25	2.2	1.8	1.8	1.8	—	2.2	—	—	—	—
AVG	1.7	1.5	2.9	1.9	0.3	1.7	0.2	1.2	1.8	0.1
6-26	1.6	0	1.6	1.6	0.6	1.6	0.4	4.3	4.8	2.6
27	—	—	1.5	1.0	—	—	—	—	—	—
28	TR	0.2	1.0	1.0	—	TR	0.0	5.2	4.5	2.4
29	—	—	—	—	—	—	—	—	—	—
30	0.8	—	—	—	—	0.5	0.8	2.8	3.8	—
7-1	—	—	—	—	—	—	—	—	—	—
2	—	—	3.0	1.6	—	—	—	—	—	—
AVG.	1.2	0.1	1.8	1.3	0.6	1.2	0.4	4.3	4.1	2.5
7-3	1.5	0	4.2	2.4	—	1.6	0	1.0	2.5	0.5
4	—	—	3.2	4.4	—	—	—	—	—	—
5	0.4	TR	0.6	1.8	0.8	0.4	TR	1.6	2.0	1.2
6	—	—	0	0.9	—	—	—	—	—	—
7	—	—	—	1.6	—	—	—	—	—	—
8	—	—	—	1.2	—	—	—	—	—	—
9	—	—	—	3.2	—	—	—	—	—	—
AVG.	1.0	TR	2.1	1.9	0.8	1.0	TR	1.3	2.4	0.9
7-10	1.4	0	0.8	1.0	0.8	1.4	TR	3.0	3.0	1.4
11	—	—		0.8	—	—	—	—	—	—
12	1.0	0.4	0.2	1.0	—	1.0	TR	1.8	2.4	—
13	—	—	0	0.2	—	—	—	—	—	—
14	1.6	0	1.6	2.0	1.0	1.6	0	4.0	2.8	1.4
15	—	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—	—	—	—
AVG.	1.3	0.2	0.9	1.0	0.9	1.3	TR	2.9	2.7	1.4
7-17	3.4	3.2	1.2	2.8	2.6	3.4	1.8	1.2	1.6	[illegible]
18	—	—	—	—	—	—	—	—	—	—
19	1.8	0.2	1.0	1.4	2.0	1.8	0.3	2.6	2.4	1.2
20	—	—	—	1.5	—	—	—	—	—	—
21	2.6	2.2	1.6	1.6	1.0	2.8	2.4	5.6	5.0	2.8
22	—	—	—	—	—	—	—	—	—	—
23	—	—	—	—	—	—	—	—	—	—
AVG.	2.6	1.9	1.3	1.8	1.9	2.6	1.5	3.1	3.0	1.9

NO 1			DISSOLVED OXYGEN PPM					NO 2		
DATE	RAW	PRI. EFF.	FIN. EFF.	M.L.	R.S.	RAW	PRI. EFF.	FIN. EFF.	M.L.	R.S.
7-24	1.6	1.0	0.8	1.0	1.0	1.6	1.4	2.2	2.4	2.0
25	—	—	0.2	1.3	—	—	—	—	—	—
26	1.2	1.0	1.0	1.2	0.8	1.2	TR	2.0	1.8	1.0
27	—	—	—	—	—	—	—	—	—	—
28	1.6	TR	0.2	0.8	0.8	1.6	TR	2.0	1.4	0.6
29	—	—	—	—	—	—	—	—	—	—
30	—	—	—	—	—	—	—	—	—	—
AVG.	1.5	0.7	0.4	1.4	0.9	1.5	0.5	2.1	1.9	1.2
7-31	2.2	2.0	1.5	1.1	0.4	2.2	2.0	1.2	2.2	0.4
8-1	—	—	—	—	—	—	—	—	—	—
2	2.8	2.6	2.0	1.6	2.8	2.8	0.2	3.2	1.8	2.2
3	—	—	—	—	—	—	—	—	—	—
4	2.0	1.0	2.7	1.8	1.8	2.0	1.2	1.8	2.0	1.8
5	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—
	2.3	1.9	2.1	1.5	1.7	2.3	1.1	2.1	2.0	1.5
8-7	1.6	0.4	2.6	1.6	1.3	1.5	TR	3.4	5.0	2.2
8	—	—	—	—	—	—	—	—	—	—
9	0.4	TR	1.5	1.2	0.8	0.4	TR	1.8	1.8	0.4
10	—	—	—	—	—	—	—	—	—	—
11	1.4	1.0	1.0	1.0	0.8	1.4	0	1.4	1.6	1.[illegible]
12	—	—	—	—	—	—	—	—	—	—
13	—	—	—	—	—	—	—	—	—	—
AVG.	1.1	0.5	1.7	1.3	1.0	1.1	TR	2.2	2.8	1.3
8-14	—	—	—	—	—	—	—	—	—	—
15	—	—	0.3	—	—	—	—	—	—	—
16	—	—	0.1	—	—	—	—	—	—	—
17	—	—	TR	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—
19	—	—	0.5	—	—	—	—	—	—	—
20	—	—	0.3	—	—	—	—	—	—	—
	0	0	0.3	0	0	0	0	0	0	0

GRAPHS

FIGURE 1

COMPARISON OF
HOURS OF RETENTION
TO REMOVE 1000# B. O. D.

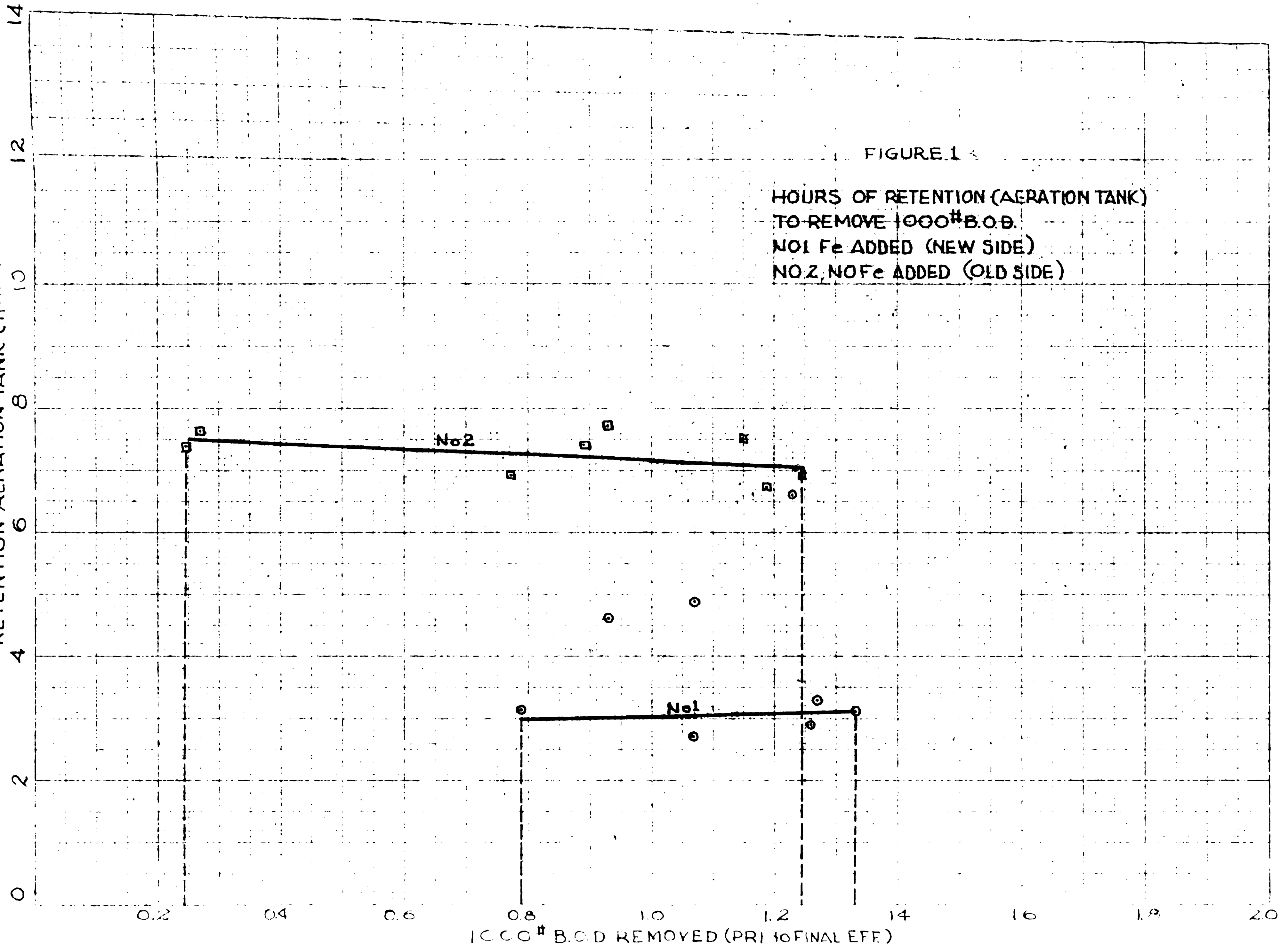


FIGURE 1

HOURS OF RETENTION (AERATION TANK)
TO REMOVE 1000# B.O.D.
NO1 Fe ADDED (NEW SIDE)
NO 2, NO Fe ADDED (OLD SIDE)

FIGURE 2

COMPARISON OF
HOURS RETENTION WITH MIXED LIQUOR
SETTLING RATE FOR A 30 MINUTE
SETTLING RATE

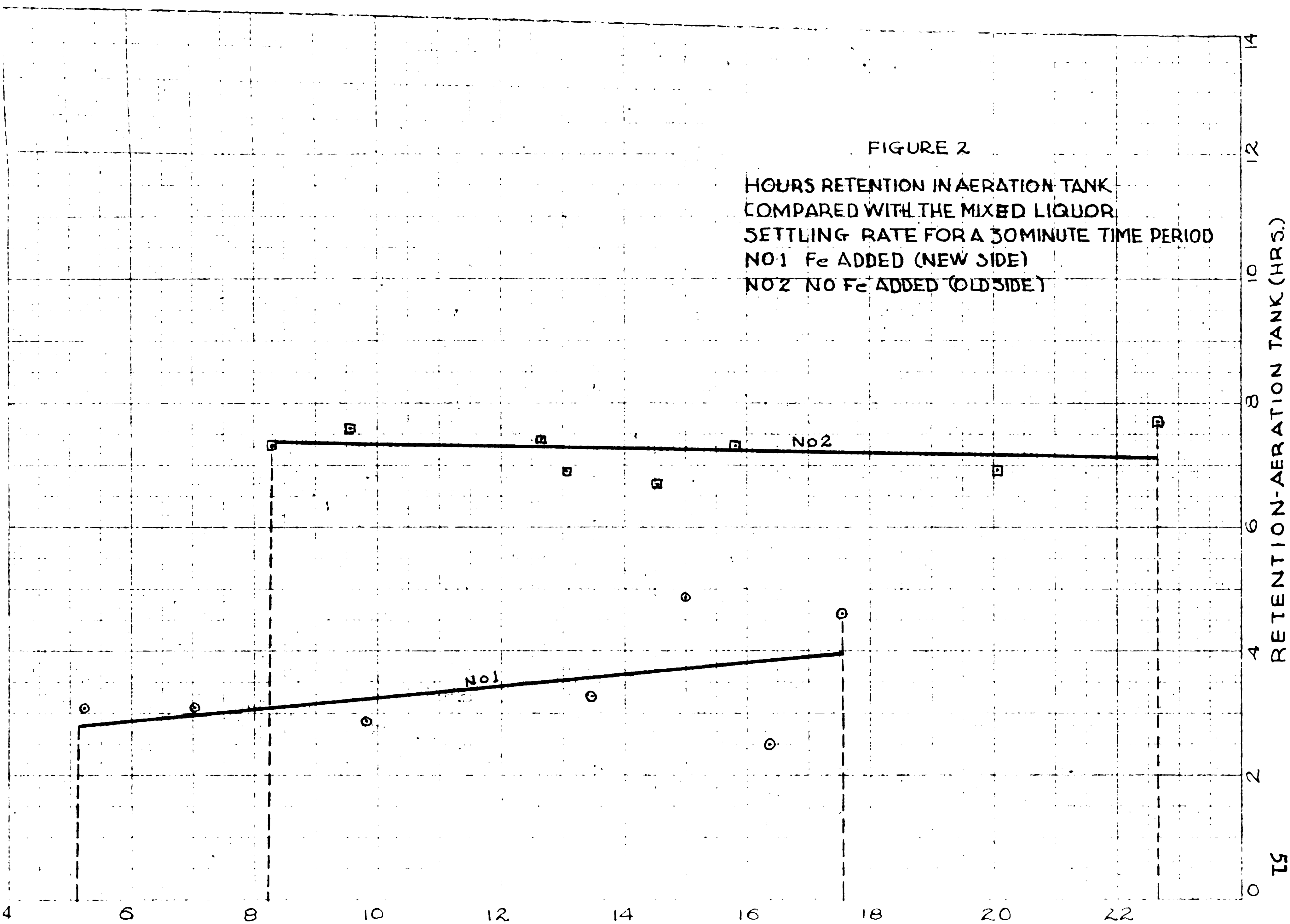


FIGURE 2

HOURS RETENTION IN AERATION TANK
COMPARED WITH THE MIXED LIQUOR
SETTLING RATE FOR A 30 MINUTE TIME PERIOD
NO1 Fe ADDED (NEW SIDE)
NO2 NO Fe ADDED (OLD SIDE)

FIGURE 3

COMPARISON OF
HOURS RETENTION FOR PERCENT
B. O. D. REMOVAL (Pri. to FINAL Eff.)

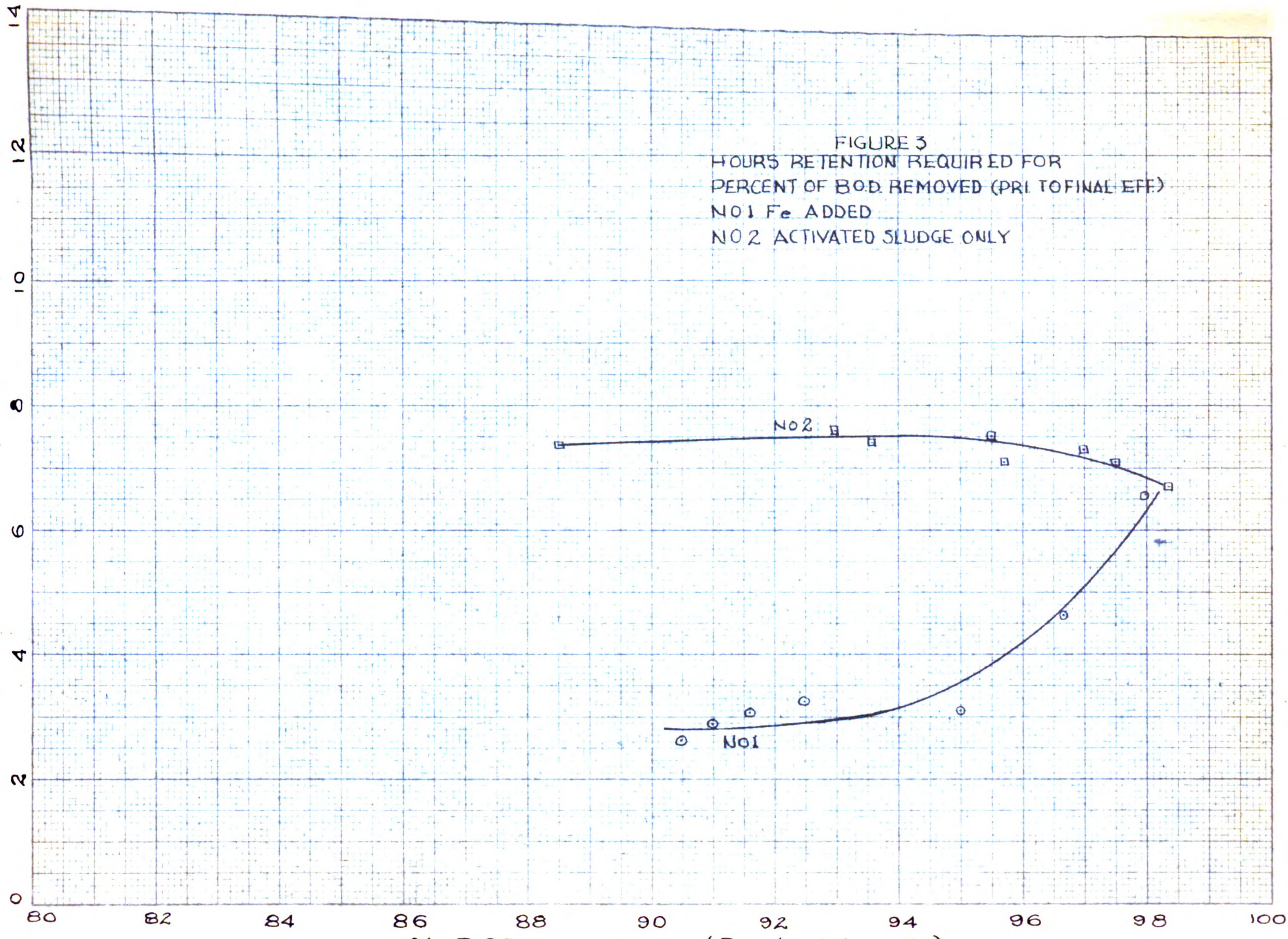


FIGURE 3

HOURS RETENTION REQUIRED FOR PERCENT OF B.O.D. REMOVED (PRI. TO FINAL EFF.)

NO1 Fe ADDED

NO2 ACTIVATED SLUDGE ONLY

FIGURE 4

KILOWATT HOURS OUTPUT PER
1000# of B. O. D. Removed
(Pri. to FINAL Eff.)

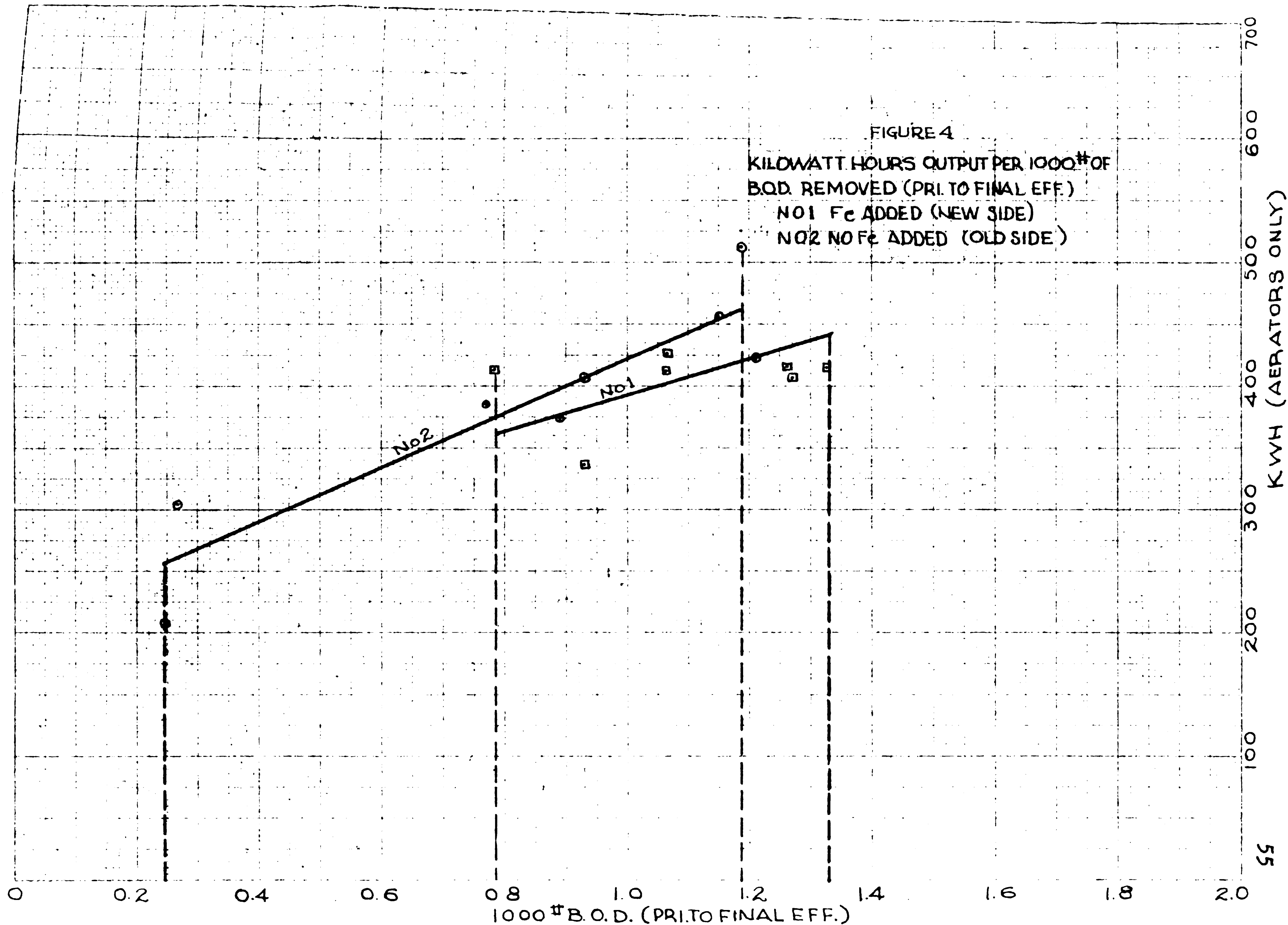
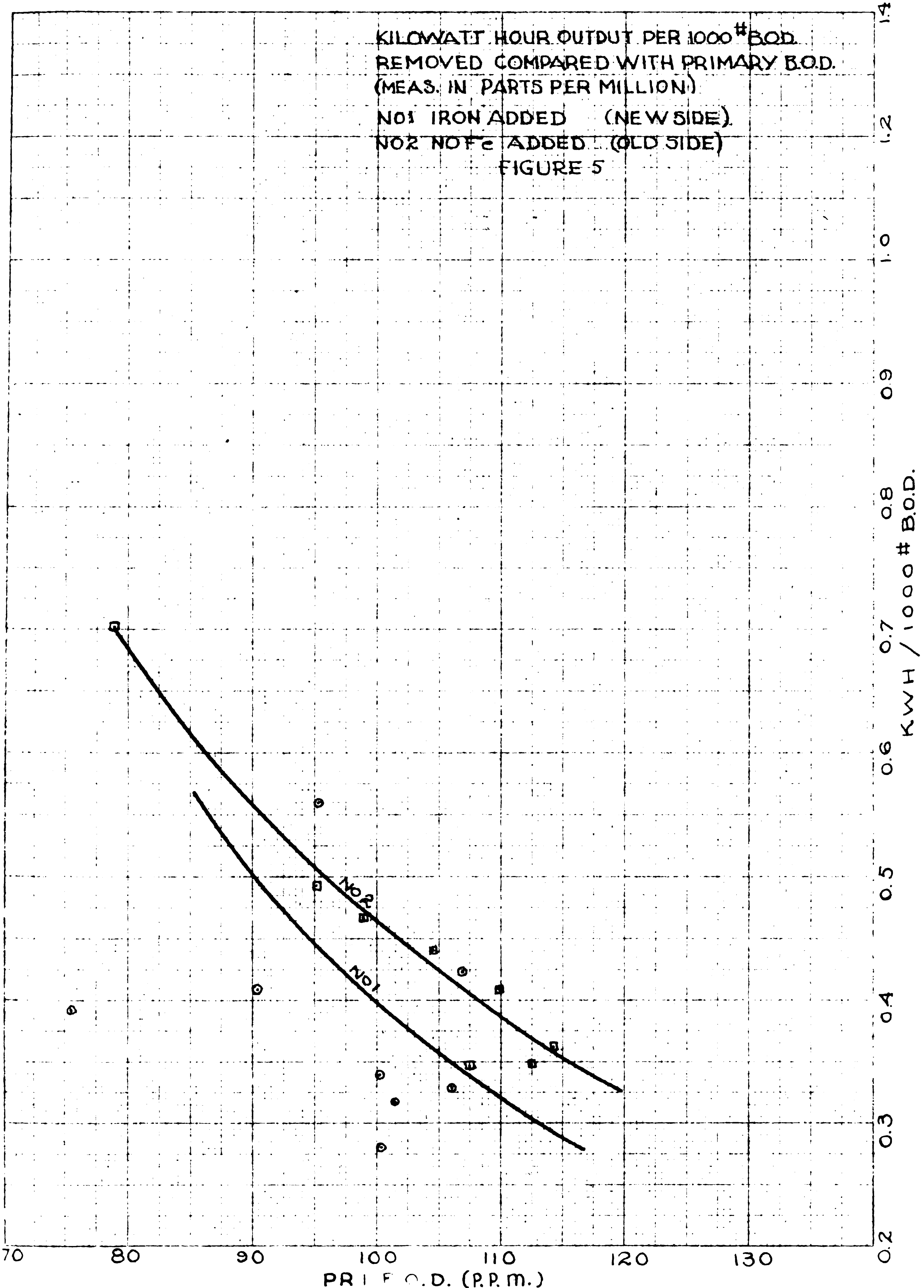


FIGURE 4

KILOWATT HOURS OUTPUT PER 1000# OF B.O.D. REMOVED (PRI. TO FINAL EFF.)
NO1 Fe ADDED (NEW SIDE)
NO2 NO Fe ADDED (OLD SIDE)

FIGURE 5

KILOWATT HOURS OUTPUT PER
1000# B. O. D. REMOVED COMPARED WITH
PRIMARY B. O. D.
(MEASURED IN PARTS PER MILLION)



KILOWATT HOUR OUTPUT PER 1000# B.O.D. REMOVED COMPARED WITH PRIMARY B.O.D. (MEAS. IN PARTS PER MILLION)

NO1 IRON ADDED (NEW SIDE)

NO2 NO Fe ADDED (OLD SIDE)

FIGURE 5

FIGURE 6

COMPARISON OF
SETTLING RATE OF MIXED LIQUOR SOLIDS
WITH SUSPENDED SOLIDS IN MIXED LIQUOR

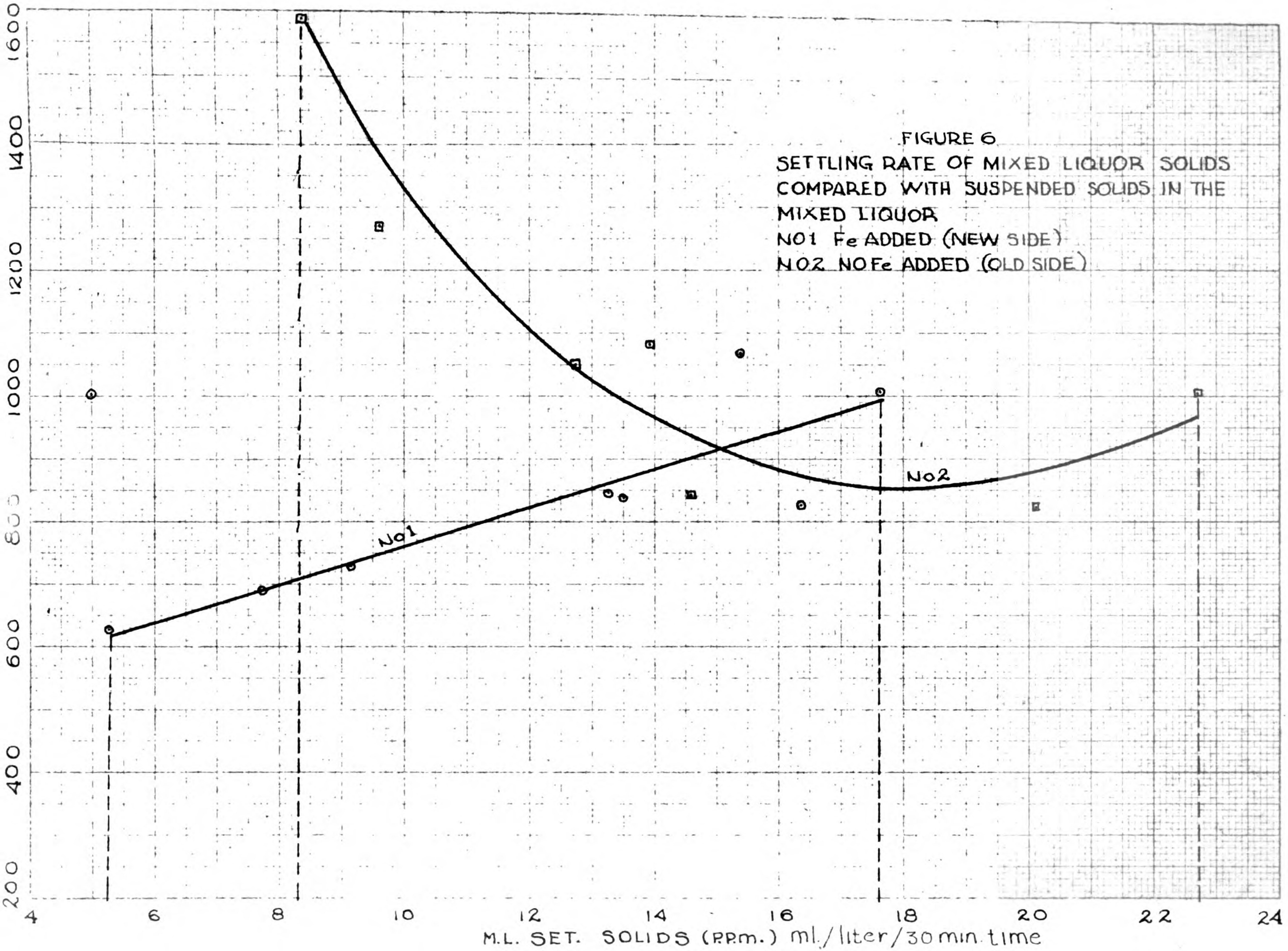


FIGURE 6

SETTLING RATE OF MIXED LIQUOR SOLIDS COMPARED WITH SUSPENDED SOLIDS IN THE MIXED LIQUOR

NO1 Fe ADDED (NEW SIDE)

NO2 NO Fe ADDED (OLD SIDE)

FIGURE 7

COMPARISON OF
SETTLING RATE OF RETURN SLUDGE
WITH SUSPENDED SOLIDS IN RETURN SLUDGE

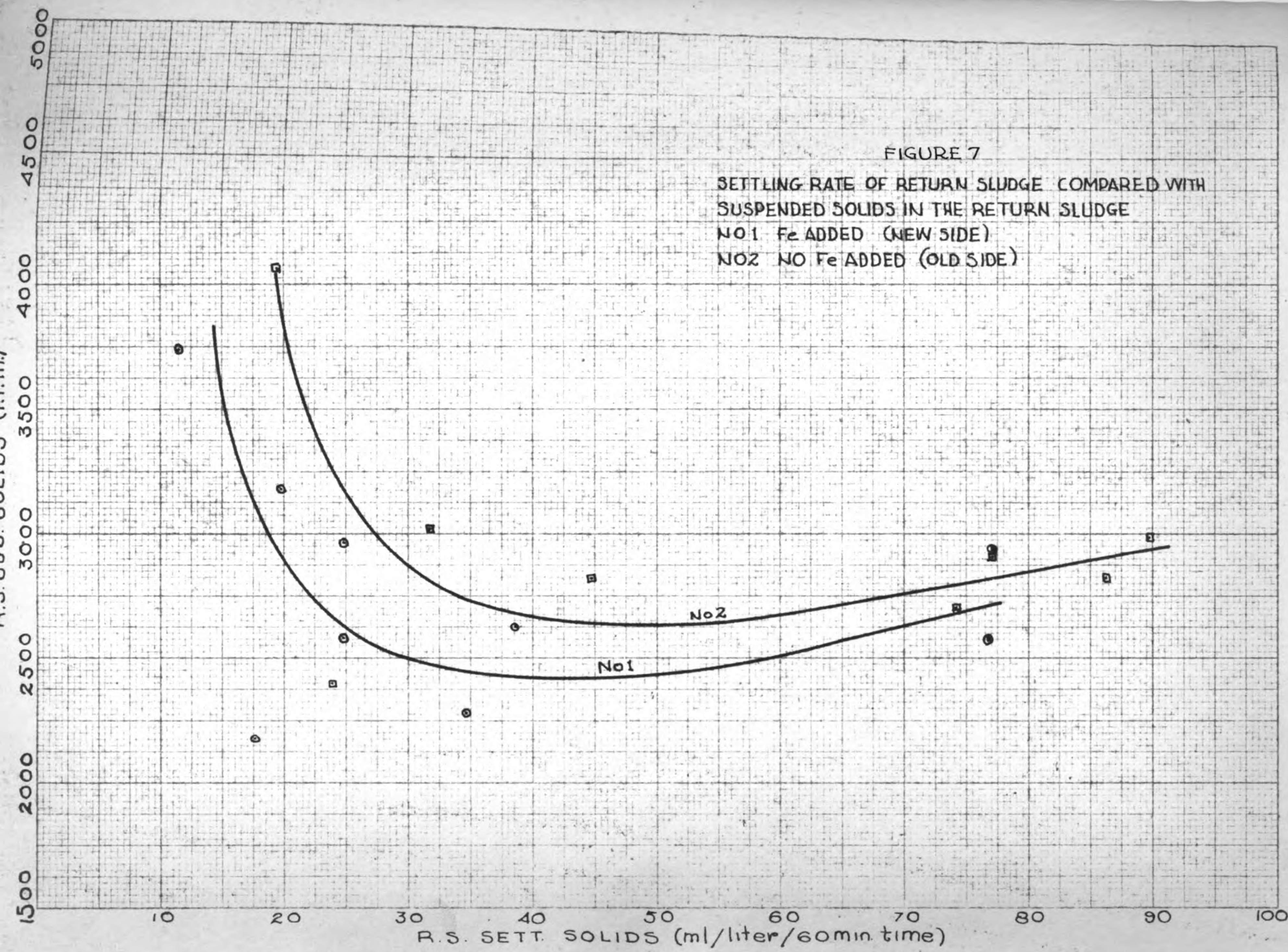


FIGURE 7

SETTLING RATE OF RETURN SLUDGE COMPARED WITH SUSPENDED SOLIDS IN THE RETURN SLUDGE

NO1 Fe ADDED (NEW SIDE)

NO2 NO Fe ADDED (OLD SIDE)

DISCUSSION

DISCUSSION OF CURVES

As was stated earlier, the problem to be investigated was the effect of use of iron in the activated sludge process. It was expected that this would result in increase in resulting plant capacity by reducing the detention time required in the aeration tanks and by the reduction of the amount of air required. The curves resulting from the date kept during the summer prove the success of the experiment.

The first comparison in Fig. 1 page 50 is that of hours of retention with one thousand pounds of B. O. D. removed from the primary effluent to the final effluent. The striking difference definitely establishes the prime purpose of our experiment.

B. O. D. removal in 1000 lbs. units =

$$\frac{(\text{Mil. Gal. per Day}) \times 8.34 \times (\text{B. O. D. Prim. Eff.} - \text{B. O. D. Final Effluent})}{1000}$$

$$\text{Hours Retention in Aeration Tank} = \frac{\text{Tank Volume in Gals.}}{\text{Sewage Flow} + \text{Return Sludge in G. P. M.}} \times 24$$

Figure 1 shows the B. O. D. removal for No. 2 side ranges from 240 pounds to 1,240 lbs. with aeration time of approximately seven hours. Figure 1 also shows the B. O. D.

removal for No. 2 side (iron waste liquor used) ranges from 800 pounds to 1,330 lbs. with an approximate three hour average retention.

Curve No. 1 of Fig. 1 is shown as a straight line. The three points "0" above and to the right occurred at the beginning of the "run" when the build up of iron was taking place. Comparison of curves 1 and 2 of figure 1 gives the most obvious picture as to what actually happened.

Other comparisons help to support the picture given in Figure No. 1. From the curves shown on Figure No. 2 page 52 it can be seen that the solids in the mixed liquor settle at a much higher rate in No. 1 side than the solids in the mixed liquor in the No. 2 side. Note also the retention periods. Here again the average retention for No. 1 side is approximately three and one-half hours.

Mixed liquor settleable solids are measured at the East Lansing plant by taking a 1,000 milliliter sample and letting it settle for a period of thirty minutes. The answer for settling then is milliliters per liter and the range for the No. 1 side is lower than that of the No. 2 side, resulting in a much greater compactness.

This would bear out theories of others as given in the section on theory. The iron with its positive charges is attracted by the colloidal sewage particles which are negatively charged. This combination of negatively and positively charged particles forms heavier particles which in turn tend to "drag down" other suspended materials along in its descent. If more time was available to experiment so as to dry different amounts of iron and different flows a point of maximum efficiency could be found. From the results obtained, it may be concluded that the iron definitely increases the settling rate.

As a comparison to the curves of Figure No. 2, a comparison was made in Figure 3, page 5h, of the retention in the aeration tank and the per cent reduction in B. O. D. from primary to final effluent. The results revealed what happened at the beginning of the "run" while the iron was being built up. Generally, after the first three points on the No. 1 curve, you can detect almost a straight line variation occurring. The difference in the retention periods remains about the occurring. The difference in the retention periods remains about the same as that on the curves of Figure 2. It is interesting to note that the per cent of reduction for No. 1 side did not go below 90%. The addition of iron then in beneficial. This also indicates that the acid did not "shock" the plant. In order to get such a good B. O. D. reduction it was necessary to have good efficiency in the biological status of the plant also. If the bacteria had been killed by the acid, the plant could not operate on an iron injection alone.

The last three curve sheets tend to bear out the fact that an equally efficient system can be operated with a much lower retention period using iron.

One might think then that the power costs on the aeration would be lower. Glancing at the data sheets, it might seem that way, too, but this is not so. When it came time to figure actual KWH output per thousand pounds of B. O. D. removed, it was found that the output was nearly the same. Noting this factor on Figure 4, page 56, one can readily wee that the KWH output is not nearly as divergent as with other factors brought up in previous curve sheets. The data sheets tend to be a little misleading. The power factor output for the motors on the No. 1 side is 4.3 KW while on the No. 2 side it is only 3.0 KW. It looked promising to see only four aerators in operation on No. 1 side against 9 aerators on the No. 2 side. After multiplying the number of aerators by their power factor and then the per cent on, the difference was not nearly as great as expected. The points are spread out over a wide range so averages had to be taken to get the straight line shown. It would be much more conclusive and a better curve could be obtained by running the experiment a much longer period of time. The points shown are weekly averages whereas most normal sewage plant averages are monthly ones.

It would take many months to get a true picture of the KWH comparison. Another means of comparison for KWH output was calculated, but here again, the spread of points is a little confusing. The curve for No. 2 side in Figure 5, page 57, is fairly consistent, so when drawing the curve for No. 1 side, it was assumed the curve to run in approximately the same direction. This cannot be verified; it is only an assumption, and it is felt that much further study would have to be made before any definite conclusions could be made.

If the above curves were fairly accurate, and the KWH output is nearly the same, the added cost of hauling the pickle liquor, storing, and feeding it into the system would tend to make the total cost the same.

On Figure 6, page 59, the mixed liquor settable solids was compared with the suspended solids in the mixed liquor to see if there was any definite relationship. Noting that the No. 1 has almost a straight line relationship, whereas the No. 2 side shows a rather different picture. The definite change of slope in No. 2 side would indicate a floc that is much more "fluffy."

The straight line variation of No. 1 side indicates that the iron has a definite effect on the settling qualities of the mixed liquor. This would indicate that the addition of iron would make the plant operation more stable and would tend to eliminate the problem of changing the amount of return sludge and wastage to a certain degree. A longer period of experimentation should be carried out to fully varify the previous statement.

After comparing the mixed liquor settable and suspended solids, a comparison of the return sludge settable and suspended solids might help confirm those comparisons made with mixed liquor suspended and settable solids, Figure 7, page 61. The No. 2 side curve tends to be fairly accurate, but because of the great divergence of points on the No. 1 side curve, it had to be estimated to a great extent. If the uppermost point on the left for curve No. 1 side had been eliminated, it would have changed the characteristics a great deal. More study and longer experimentation would tend to clarify this situation.

SUMMARY

SUMMARY

Summarizing the results of the data collected, it was found that the addition of pickle liquor did:

(1) increase the settling rate of suspended solids

(2) not affect the biological status of the activated sludge due to its acid content (pH was always above 7.0)

(3) decrease the KWH output cost slightly

Parts (1) and (2) were proved definitely. More time and study would be required on part (3). I do not think the curves dealing with the KWH output of the aerators give a clear picture of what has happened.

Looking at the results from a practical viewpoint, it would seem that the use of pickle liquor would be a profitable venture in either

(1) the building of a new sewage treatment plant with approximately half the required tank capacity of an activated sludge plant.

(2) the increasing of the capacity of an existing plant without increasing the tank capacity.

During the nine weeks which the experiment was run, only the basic theories mentioned above were proved. The limited time this experiment was run bears out the fact that further investigation over longer period of time would be to the best interests of everyone concerned. I sincerely hope that whatever construceive knowledge that has been imparted will be of some value to those who may again be confronted with the problem of further experiment, design, and construction of treatment plants.

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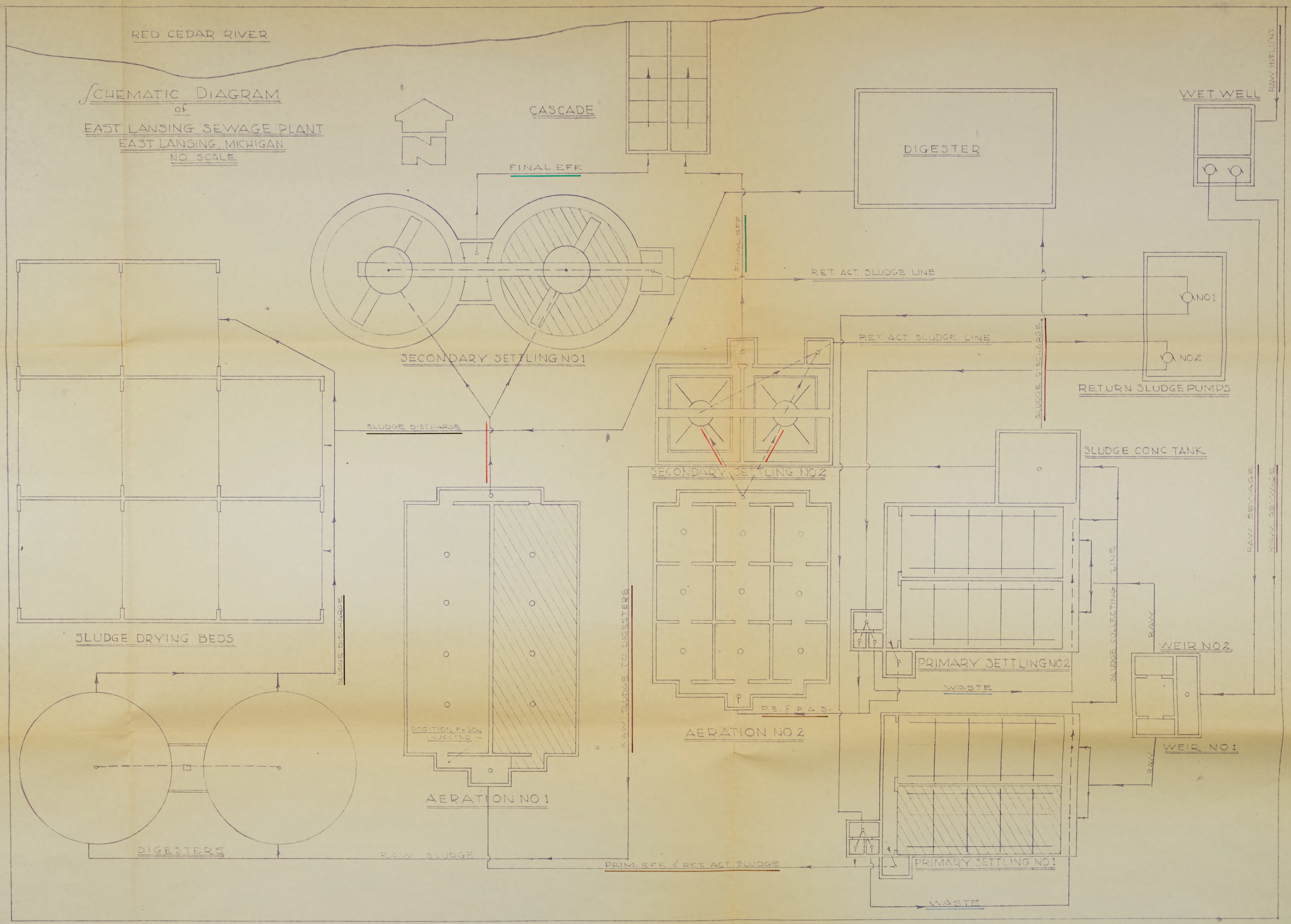

SCHEMATIC DIAGRAM of EAST LANSING SEWAGE PLANT

EAST LANSING, MICHIGAN
NO SCALE

RAW: 🟪
PRI. EFF. & RET. ACT. SLUDGE: 🟫
WASTE: 🟦
RET. ACT. SLUDGE: ▭

RAW SLUDGE TO DIGEST: 🟥
SLUDGE TO BEDS: ⬛
FINAL EFF.: 🟩
MIXED LIQUOR TO FINAL SETT.: 🟥

LEGEND

Pocket has: 1 Plan