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TECHNICAL ASSISTANCE PROJECT
AT THE
PASCAGOULA WASTEWATER TREATMENT PLANTS
PASCAGOULA, MISSISSIPPI

July, 1976

Environmental Protection Agency
Region IV
Surveillance and Analysis Division
Athens, Georgia

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INTRODUCTION

A technical assistance study of operation and maintenance problems at the Foster Street, Bayou Casotte, and East Side Wastewater Treatment Plants (WTP), Pascagoula, Mississippi was conducted July 19-24, 1976 by the Region IV Surveillance and Analysis Division, U. S. Environmental Protection Agency. Operation and maintenance technical assistance studies are designed to assist wastewater treatment plant operators in maximizing treatment efficiencies as well as assisting with special operational problems. Municipal wastewater treatment plants are selected for technical assistance studies after consultation with state pollution control authorities. Visits are made to each prospective plant prior to the study to determine if assistance is desired and if study efforts would be productive.

These plants were selected based upon the recommendation of the Mississippi Air and Water Pollution Control Commission and an EPA reconnaissance visit to the plants. The specific study objectives were to:

- Optimize treatment through control testing and recommended operation and maintenance modifications;
- Introduce and instruct plant personnel in new operational control techniques;
- Determine influent and effluent wastewater characteristics;
- Assist laboratory personnel with any possible laboratory procedure problems and
- Compare design and current loadings.

A follow-up assessment of plant operation and maintenance practices will be made at a later date. This will be accomplished by utilizing data generated by plant personnel and if necessary, making subsequent visits to the facilities. The follow-up assessment will determine if recommendations were successful in improving plant operations and if further assistance is required. In order to relate preliminary study findings and stay abreast of process changes and results, contact has been maintained with plant personnel since the study was conducted. Many of the recommendations in this report have been implemented since the study, and recent reports have shown significant improvements in removal efficiencies.

The cooperation of the Mississippi Air and Water Pollution Control Commission is greatefully acknowledged. The technical assistance team is especially appreciative of the cooperation and assistance received from personnel of the Foster Street, Bayou Casotte, and East Side Wastewater Treatment Plants.

SUMMARY

FOSTER STREET WASTEWATER TREATMENT PLANT

The Foster Street Wastewater Treatment Plant (WTP) was designed as a 4.25 mgd activated sludge system. The WTP was handling an approximate flow of 1.65 mgd. The average BOD_5 and TSS reductions during the study were 92 and 80 percent, respectively.

Below are the major problems observed during the study:

1. The grit chamber was in need of repair and was not in operation.

2. The MLSS concentration was too high (5,812 mg/l).

3. The dissolved oxygen (DO) concentrations in the aeration basins were too low; the average DO concentration was 0.14 mg/l over two days of sampling.

4. Grease and scum collected from the clarifiers were recycled back to the raw influent, which caused a build-up in the treatment system. The major source of grease in the influent was the Quaker Oats Company.

5. The activated sludge settled and compacted poorly in the final clarifiers. Excessive grease and filamentous organisms in the treatment system were suspected as a major cause.

6. Excessive solids were accumulating and denitrifying in the chlorine contact chamber. Sludge was periodically floating to the surface and flowing over the effluent weir.

7. Effective operation of the aerobic digesters was hindered by thin waste sludge and inability to effectively decant supernatant.

8. The WTP was manned 16 hours/day and often the morning shift spent time recovering from problems which occurred during the time the WTP was not staffed.

9. The effluent flow measuring equipment was out of calibration.

10. The flow splitting arrangement to the five aeration basins will not perform satisfactorily under varying plant flows.

11. Minimum operational control testing was performed.

BAYOU CASOTTE WASTEWATER TREATMENT PLANT

The Bayou Casotte WTP serving southeast Pascagoula, Mississippi was designed as a 1.6 mgd conventional activated sludge system. Reportedly the WTP receives an average daily flow of 1.5 mgd with peaks of 3-4 mgd. During the study WTP influent flow averaged 1.36 mgd with a peak flow of 2.7 mgd. Average BOD_5 and TSS reductions during the study period were 74 and 55 percent, respectively. The activated sludge was dark in color and settled slowly with minimal compaction, resulting in a turbid effluent.

Below are major problems observed during the study:

1. The organic loading to the aeration basins exceeded recommended levels.
2. At the BOD loadings during the study, oxygen supplied to the aeration basins was marginal; this allowed no excess aeration capacity for equipment breakdown or increased loads.
3. Solid deposits were found on the bottom and in the corners of the aeration basins.
4. The clarifier weir was not level.
5. The waste sludge line from the east digester and supernatant line from the west digester were clogged.
6. The maintenance of the aerobic digesters was hampered due to poor structural conditions.
7. The return sludge flow rate was excessive.
8. Grit removal equipment was inoperable.
9. The plant was operated by one uncertified operator.
10. There was no in-plant control testing.
11. The effluent flow measuring equipment was inoperable.

EAST SIDE WASTEWATER TREATMENT PLANT

The East Side WTP was designed as a 0.4 mgd activated sludge system and was operating at about design flow. The average BOD_5 and TSS reduction during the study was 93 and 96 percent, respectively.

Below are major problems observed during the study:

1. The activated sludge settled slowly and compacted poorly; the sludge blanket was within three feet of the clarifier water surface.

2. Volatile content of the mixed liquor suspended solids was only 47 percent.

3. The mixed liquor suspended solids concentration bordered on maximum recommended limits.

4. Dissolved oxygen was depleted within five minutes after aerators were turned off.

5. Influent metal concentrations were above generally observed values for purely domestic wastes.

6. The effluent flow recorder and totalizer were inoperative.

RECOMMENDATIONS

Based on observations and data collected during the study, it is recommended that the following measures be taken to improve wastewater treatment and plant operation. Some of the items listed below have been discussed with WTP personnel and have already been implemented.

FOSTER STREET WASTEWATER TREATMENT PLANT

1. The MLSS should be reduced to about 3,000 mg/l (2,100 mg/l MLVSS), which will produce an F/M ratio of approximately 0.2, based on current plant loadings. Activated sludge settleability and effluent quality will dictate the optimum MLSS, F/M and MCRT.

2. Sludge should be wasted on a regular schedule. After the MLSS have been reduced, the optimum MLSS and MCRT will determine the appropriate wasting rate.

3. Grease and scum collected from the secondary clarifier should be removed to a sanitary landfill, if acceptable, instead of recirculated to the plant influent. An alternate, but less desirable, solution would be discharge to the aerobic digesters.

4. If recommendation 3 does not improve activated sludge settleability and compaction, then the use of a polymer should be investigated. However, polymers should not be considered a long term treatment solution. Better inplant operational control and grease control at the source and within the treatment system is the key to improved treatment.

5. The dissolved oxygen concentration in the aeration basins should be maintained in the 1.0 to 2.0 mg/l range, and monitored in each basin regularly with a DO meter and field probe. Reduction of the MLSS should help in maintaining adequate DO.

6. The return sludge flow should be gradually decreased as the MLSS is reduced. Aerobic conditions in the clarifier must be maintained, and this will dictate the minimum return sludge flow.

7. The supernatant withdrawal piping for the aerobic digesters should be modified to allow either selective withdrawal from several levels or at least withdrawal from a higher level.

8. The aerators should be checked to see that they are delivering maximum efficiency. This can be done by checking the amperage pulled and depth of submergence.

9. The chlorine contact chamber should be equipped with a drain or pump to facilitate sludge removal.

10. The two-inch drain line from the thickener (supernatant) surge tank should be increased to at least four inches.

11. The WTP should be manned 24 hours/day. Additional staffing is necessary to efficiently operate the plant.

12. The Quaker Oats discharge should be monitored regularly and the sewer ordinance strictly enforced.

13. The grit chamber should be repaired and placed back in operation.

14. An in-plant control testing schedule should be immediately initiated and trend charts established and maintained at all three wastewater treatment plants.

BAYOU CASOTTE WASTEWATER TREATMENT PLANT

1. The feasibility of diverting a portion of the flow from the Bayou Casotte WTP to the Foster Street WTP should be investigated.

2. The clarifier weir should be replaced and/or leveled.

3. The waste sludge line from the east digester and supernatant line from the west digester should be reopened.

4. The MLSS concentration should be maintained at about 2,500 mg/l and a regular sludge wasting schedule should be established. Mixed liquor settleability and aeration basin dissolved oxygen will dictate the optimum MLSS concentration.

5. The aerators should be checked to see that they are delivering maximum efficiency. This can be done by checking the amperage pulled and depth of submergence.

6. The aeration basins should be sounded to determine the extent of solids accumulation and if necessary, these solids should be pumped out.

7. The grit removal equipment should be repaired and placed back in operation.

8. The flow meter, recorder, and totalizer should be repaired, calibrated, and placed back in operation.

9. The chlorine metering equipment should be repaired and placed back in operation.

10. The WTP should be staffed 16 hours/day and routinely checked during the remaining 8 hours.

EAST SIDE WASTEWATER TREATMENT PLANT

1. The aerators should remain ON at all times.

2. The MLSS concentration should be reduced to about 3,400 mg/l. Monitoring sludge blanket depth, sludge settleability and effluent quality will help determine the optimum MLSS concentration.

FOSTER STREET WASTEWATER TREATMENT PLANT

TREATMENT FACILITY

Treatment Processes

A schematic diagram of the 4.25 mgd Foster Street Wastewater Treatment Plant (WTP) is presented in Figure 1. Design data are enumerated in Table I. According to the WTP O&M manual, the WTP was designed for tapered aeration. However, each aeration basin has four mechanical aerators, all of equal size and equal spacing. Therefore, the plant should be considered as a conventional activated sludge process. The WTP began operation in March 1975 and serves an approximate population of 15,500. Roughly 10 percent of the influent plant flow was from industrial sources, primarily the Quaker Oats dog and cat food plant.

Preliminary treatment consisted of a bar screen, grit chamber, and three comminutors. The grit chamber was out of service during the study. After preliminary treatment, raw wastewater and return sludge flowed into a long channel which distributed the flow into five parallel aeration basins.

Aeration basin mixed liquor was settled in two secondary clarifiers. The overflow was chlorinated and discharged into the Pascagoula River. Sludge from the clarifiers was either returned to the aeration basins or wasted to the aerobic digesters.

The sludge handling facilities included three aerobic digesters, sludge thickener and a vacuum filter. Sludge from the filter, grit, and screenings were trucked to a sanitary landfill.

Personnel

The three wastewater treatment plants were staffed by 13 men with the following classifications: 1-I, 2-II and 1-III. All laboratory, maintenance, and other support personnel were stationed at the Foster Street WTP. Of a total of six operators, four operated the Foster Street WTP, which is staffed 16 hours per day.

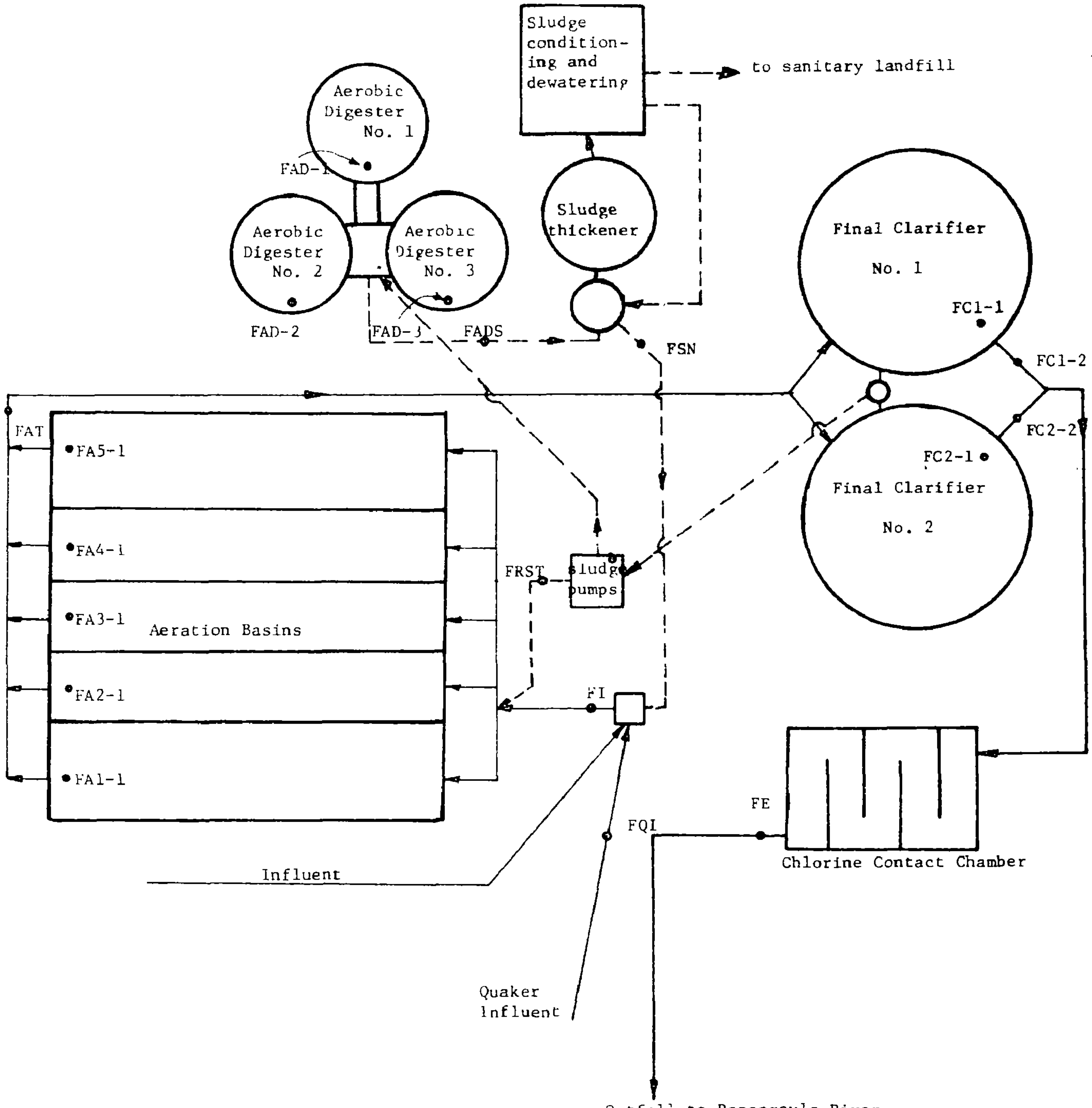


FIGURE 1
FOSTER STREET WTP
PASCAGOULA, MS

TABLE I
DESIGN DATA - FOSTER ST. WTP
PASCAGOULA, MS

FLOW MEASUREMENT

Final Effluent	6 ft. Rectangular Weir (with end contractions)
Return Sludge Flow	2.5 mgd (study period average)
Design Flow	4.25 mgd
Average Flow	1.65 mgd (study period average)

AERATION BASINS

Number	5
Basin #1	
Length	127 ft.
Width	29 ft.
Water Depth	9 ft.
Area	3,683 sq. ft.
Volume	33,147 cu. ft. (0.25 m.g.)
Basins #2, 3, 4	
Length	127 ft.
Width	23 ft.
Depth	12 ft.
Area	2,921 sq. ft.
Volume	35,052 cu. ft. (0.26 m.g.)
Basin #5	
Length	127 ft.
Width	33 ft.
Depth	10.9 ft.
Area	4,191 sq. ft.
Volume	45,682 cu. ft. (0.34 m.g.)
Aeration	4-7.5 hp mechanical aerators per basin

CLARIFIERS

Number	2
Diameter	68 ft.
Side Water Depth	8.5 ft.
Area	3,630 sq. ft.
Volume	34,279 cu. ft. (0.26 m.g.)
Weir Length	214 ft.

TABLE I
DESIGN DATA - FOSTER ST. WTP
PASCAGOULA, MS (continued)

CHLORINE CONTACT CHAMBER

Length	41 ft.
Width	60 ft.
Water Depth	6 ft.
Volume	14,760 cu. ft.(0.11 m.g.)
Detention (at design flow)	30 min.

AEROBIC DIGESTERS

Number	3
Diameter	No. 1 - 40 ft. No. 2, 3, - 38 ft.
Side Water Depth	23 ft.
Volume	No. 1 - 30,144 cu. ft.(0.225 m.g.) No. 2, 3 - 27,579 cu. ft.(0.21 m.g.)
Aeration	40 hp mechanical(1/tank)

PUMPS

Return sludge	2 (+1 standby) 550-1,100 gpm variable speed
Waste sludge	2 150-200 gpm variable speed

STUDY RESULTS AND OBSERVATIONS

A complete listing of all analytical data and general study methods are presented in Appendices A and B. Formulae used for general calculations are enumerated in Appendix C. Significant results and observations made during the study are discussed in the following sections.

Flow

Plant flow was measured by an EPA installed Stevens stage recorder on a 6-foot rectangular weir at the effluent from the chlorine contact chamber. The WTP recorder and totalizer were out of calibration. Consequently, they were not used for flow measurements during the study. The TA team installed a staff gage in the chlorine contact chamber and furnished WTP personnel with hydraulic tables so that instantaneous flows could be accurately determined to check permanently installed flow recording equipment. Return sludge flow was determined by a flume, recorder, and totalizer.

Average hourly flows from the plant during the study period are presented in Figure 2. Average flow during the study was 1.65 mgd and varied from 0.3 to 3.2 mgd. According to plant personnel, the Quaker Oats dog and cat food plant accounts for about .182 mgd of the WTP influent flow.

The return sludge flow was maintained fairly constant during the study at about 2.5 mgd, which was about 150 percent of the influent plant flow.

Waste Characteristics and Removal Efficiencies

Table II presents a chemical description of the WTP influent and effluent wastewaters with calculated treatment reductions. Analyses were made on 24-hour, flow proportional, composite samples, collected on three consecutive days and percent reductions calculated from averaged values.

The influent BOD_5 (347 mg/l) and total solids (1,257 mg/l) concentrations represent a rather strong waste. These high concentrations were the result of the Quaker Oats Company discharge, which had BOD_5 concentrations of 1,400 and 1,067 mg/l and total solids concentrations of 2,398 and 2,108 mg/l, based on grab samples taken on two different days.

Although the BOD_5 reduction was good (92%), total suspended solids removal was less impressive (80%). Very little nitrification was accomplished in the treatment system.

FIGURE 2
PLANT FLOW - FOSTER STREET WTP
PASCAGOULA, MS

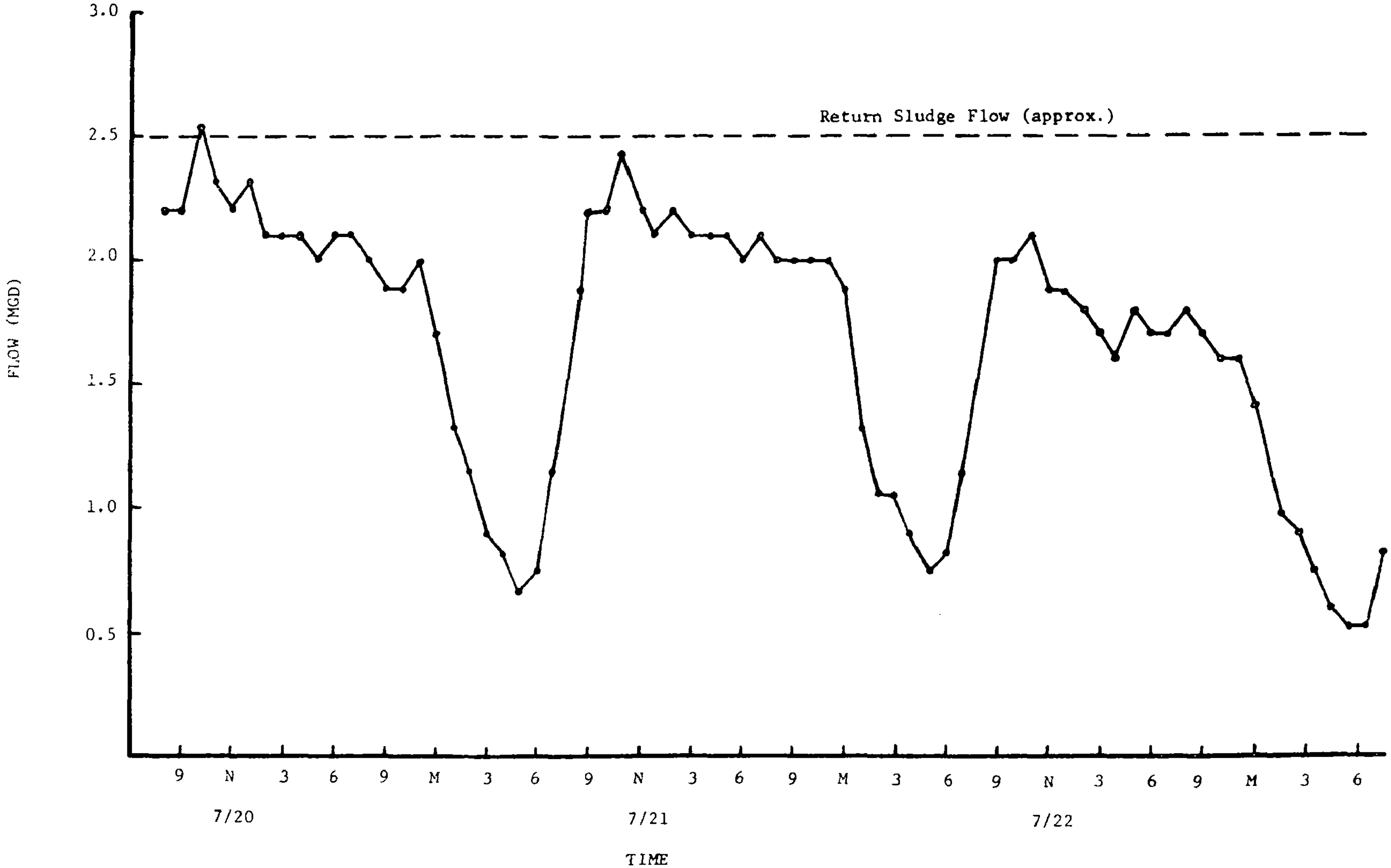


TABLE II
WASTE CHARACTERISTICS AND REMOVAL EFFICIENCIES
FOSTER ST. WTP

Parameter	Influent	Effluent	% Reduction
BOD_5 (mg/l)	347	26	92
COD (mg/l)	583	92	84
Total Solids (mg/l)	1,257	980	22
TVS (mg/l)	408	168	59
TSS (mg/l)	205	40	80
TVSS (mg/l)	165	25	85
Settleable Solids (ml/l)	6.7	<0.13	>98
TKN (mg/l)	46	33	28
NH_3-N (mg/l)	34	32	6
NO_2-NO_3-N (mg/l)	<0.01	0.03	--
Total Phosphorus (mg/l)	9.2	13	--
Chloride (mg/l)	273	278	--
Oil and Grease (mg/l)*	52.2	<5.0	>90
Cl_2 Residual (mg/l)*	--	2.9	--
Pb (µg/l)	<80	<80	--
Cr (µg/l)	<80	<80	--
Cu (µg/l)	93	18	81
Cd (µg/l)	<20	<20	--
Zn (µg/l)	285	49	83

* Averaged results of grab samples taken on three different days.

The analytical results of two grab samples collected from the Quaker Oats wastewater discharge (sample station QI) are presented in Appendix A. Based on an approximate flow of 182,000 gpd, suggested by a City official, the Quaker Oats discharge contributed about 1,870 pounds/day of BOD_5 and 158 pounds/day of grease to the WTP. The city sewer ordinance restricts the Quaker Oats BOD_5 and grease discharge to 1,589 and 70 pounds/day at a maximum flow of 300,000 gpd.

Aeration Basins

Grab samples were collected daily from each of the five aeration basins and in the discharge channel after the effluent from all basins had mixed. These samples were analyzed for total suspended solids (TSS), volatile suspended solids (VSS), percent solids by centrifuge, and settleability as determined by the settlometer. Presented in Table III are various activated sludge operational parameters calculated during the study period and the corresponding recommended values for the conventional activated sludge process.

TABLE III
ACTIVATED SLUDGE OPERATIONAL PARAMETERS
FOSTER ST. WTP

	Measured	Recommended (2) (5) (7)*
MLSS (mg/l)	5,812	1,500-3,000
MLVSS (mg/l)	3,846	--
Hydraulic Detention Time (hrs.)	7.96	4-8
Mean Cell Residence Time (days)	26**	5-15
Sludge Age (days)	23.6	3.5-7.0
Lbs. BOD/day/lb MLVSS (F/M)	0.11	0.2-0.4
Lbs. COD/day/lb MLVSS	0.18	0.5-1.0
Lbs. BOD/day/1000 cu. ft. of aeration basin	26	20-40
Return sludge rate (% of average plant flow)	150 (2.5 mgd)	25-50

* References 1-12 appear on page 56.

** Based on wasting schedule setup after the TA study.

Dissolved oxygen (DO) was measured throughout the aeration basins and the results are presented in Appendix D. The DO concentrations ranged from zero to 0.8 mg/l; the average DO concentration over a two-day period was 0.14 mg/l. These concentrations are much too low and result in a number of conditions causing poor settleability and/or treatment efficiencies. Attempts should be made to maintain DO concentrations in the 1.0-2.0 mg/l range in the aeration basins.

Prior to the TA study, sludge was not wasted to the aerobic digesters on a regular schedule. However, since the TA study, a regular wasting schedule has been instituted. The long MCRT and low food/microorganism (F/M) ratio was due to the high MLSS concentration. These operational parameters should approach recommended ranges as regular sludge wasting continues and the MLSS concentration is reduced. Close monitoring of the sludge settleability and MLSS must be maintained so that the MLSS is not reduced too much.

Assuming an F/M ratio of about 0.2, the MLSS should be reduced to about 3,000 mg/l (MLVSS = 2,100 mg/l); sludge settleability and effluent quality will determine the optimum F/M and MCRT.

The method of introducing raw wastewater and return sludge was undesirable and resulted in several bad effects. The influent raw waste and return sludge entered at one end of a long distribution channel directly in front of the opening to the #1 aeration basin. Foam and scum were much denser in the first two basins (#1 and #2) than in the final three (#3, #4, and #5) basins. The supernatant in the settlometer test was cloudy for aeration basins #1, #2, and #3 and relatively clear for basins #4 and #5.

The flow split to each aeration basin was controlled by the elevation and length of the effluent weir in each basin. Each weir had a length proportional to the volume of the respective basin so that theoretically the detention time was the same in each basin. This is not an effective method of splitting the flow. Head losses to each basin vary due to roughness in the entrance channel and abrupt changes in the direction of flow. These losses change with the rate of plant flow so that the relative amount of waste to each basin varies at a given weir elevation. Normally in this type flow configuration the first basins get a disproportionally high portion of the total waste flow. Even though no flow measurements were made, there was evidence of an uneven flow split observed in the amount of grease and foam on each basin.

A more effective method of flow distribution could be accomplished by installing adjustable weirs or orifices in the entrance to each basin (see sketch in Figure 3). This would increase the water surface elevation in the entrance flume by 6 inches to a foot, producing a head loss into the basins. This procedure would permit regulation and measurement of the flow to each basin. The additional backwater in the entrance flume may cause some deposition of solids and the weirs will have to be cleaned periodically. Weirs could be cut in sheet metal gates (preferably aluminum) to be installed in the existing basin openings. This would permit lifting of the gates periodically to flush the entrance flume.

An alternative method to the use of weirs would be a rectangular orifice formed by installing a sheet metal gate in the rectangular basin opening and adjusting the gate so that it is not completely sealed. This would permit flow through the opening under the gate. Bolts with nuts welded to the bottom of the gate could be used to adjust the size of the opening. This method may cause fewer problems with deposition of solids in the entrance flume but would not provide the degree of accuracy in flow measurement and splitting provided by the weirs.

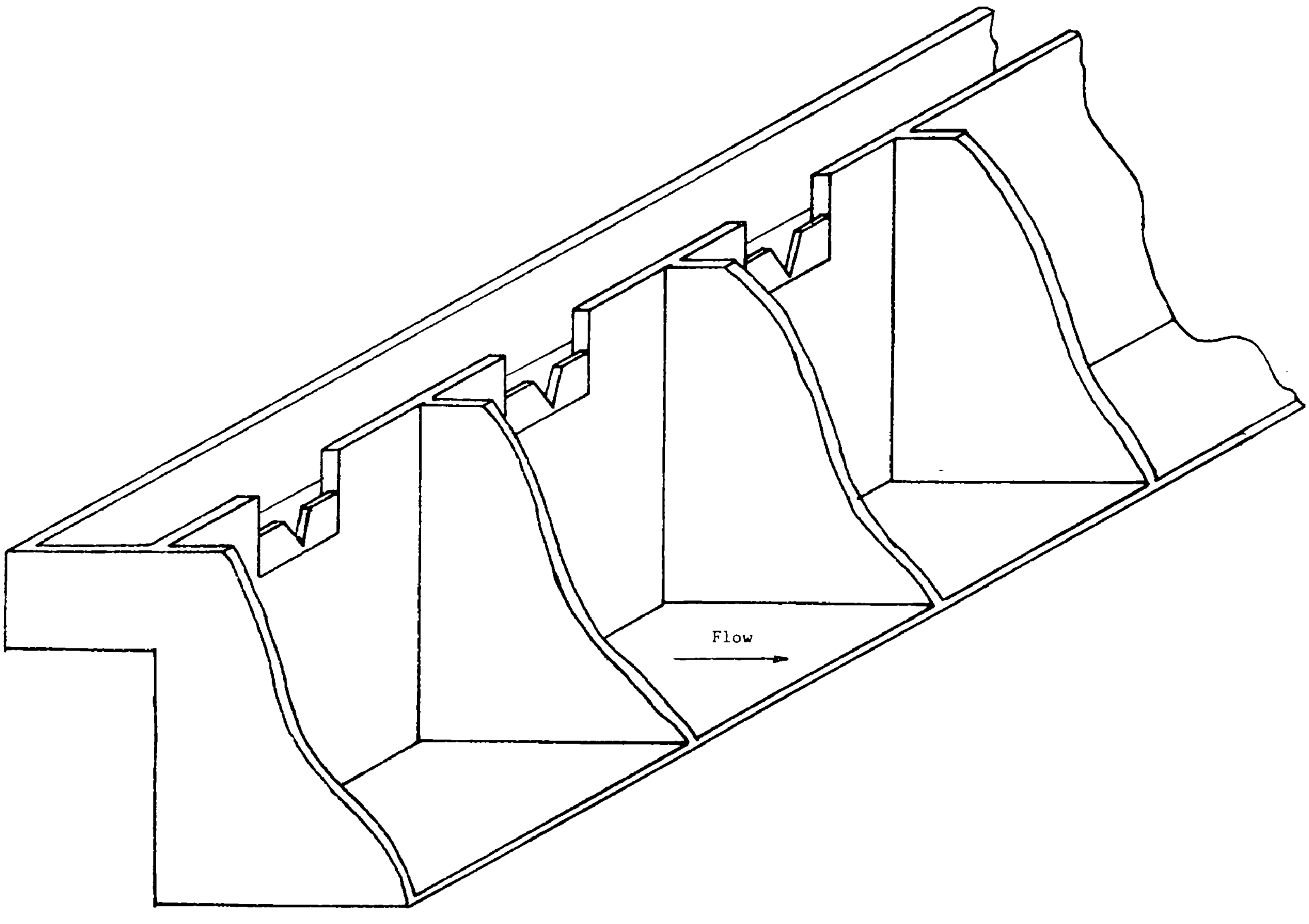
A microscopic examination of mixed liquor and return sludge demonstrated a dense sludge which supported in high densities the entire spectrum of protozoan organisms from a young sludge to an old sludge. Also observed was a dense concentration of very small filamentous organisms. The presence of all major protozoans indicate an activated sludge that would give characteristics of a young sludge if the solids level was decreased. The filamentous growth was of high enough concentration to cause floating of the newly formed biological sludge, resulting in an effluent with a high volatile solid content.

Another indicator of sludge quality is the oxygen uptake rate of the return sludge. The oxygen uptake rate is a measure of the difference in sludge activity before and after introduction of the raw waste. The ratio of these two variables or "load ratio" is calculated as follows:

$$\text{Load ratio} = \frac{\text{DO/min of fed sludge}}{\text{DO/min of unfed sludge}}$$

The procedure is presented in Appendix E.

FIGURE 3
MODIFIED INFLUENT FLOW DISTRIBUTION



The return sludge was septic and could be quickly aerated to a DO concentration of only 3.0 mg/l which was depleted in one minute. After satisfying the septic sludge demand, an unfed uptake of 1.5 and a fed rate of 2.1 was measured.

A calculated ratio for these two rates was 1.4. A conventional activated sludge process generally operates within a load range of 2 to 4. This ratio of 1.4 is indicative of a sludge of low activity with an acceptable feed. The rapid depletion of oxygen was the result of septic conditions.

Clarifiers

Both circular clarifiers have a center feed, rim take-off flow configuration with a short center baffle to distribute incoming flow. Activated sludge settleability as determined by the settlometer test is presented in Figure 4. Settleability in each aeration basin did not vary appreciably from that of the combined aeration basin effluents. The activated sludge settled and concentrated poorly, probably due to the buildup of grease in the treatment system.

The depth of the sludge blanket (DOB) below the water surface varied between 2 and 3.5 feet. This would be expected due to the poor settleability of the sludge. Many factors including flow and temperature can cause solids to carry over the weirs when the sludge blanket is this close to the water surface. This is a dangerous zone of operation and usually results in excessively high solids in the effluent.

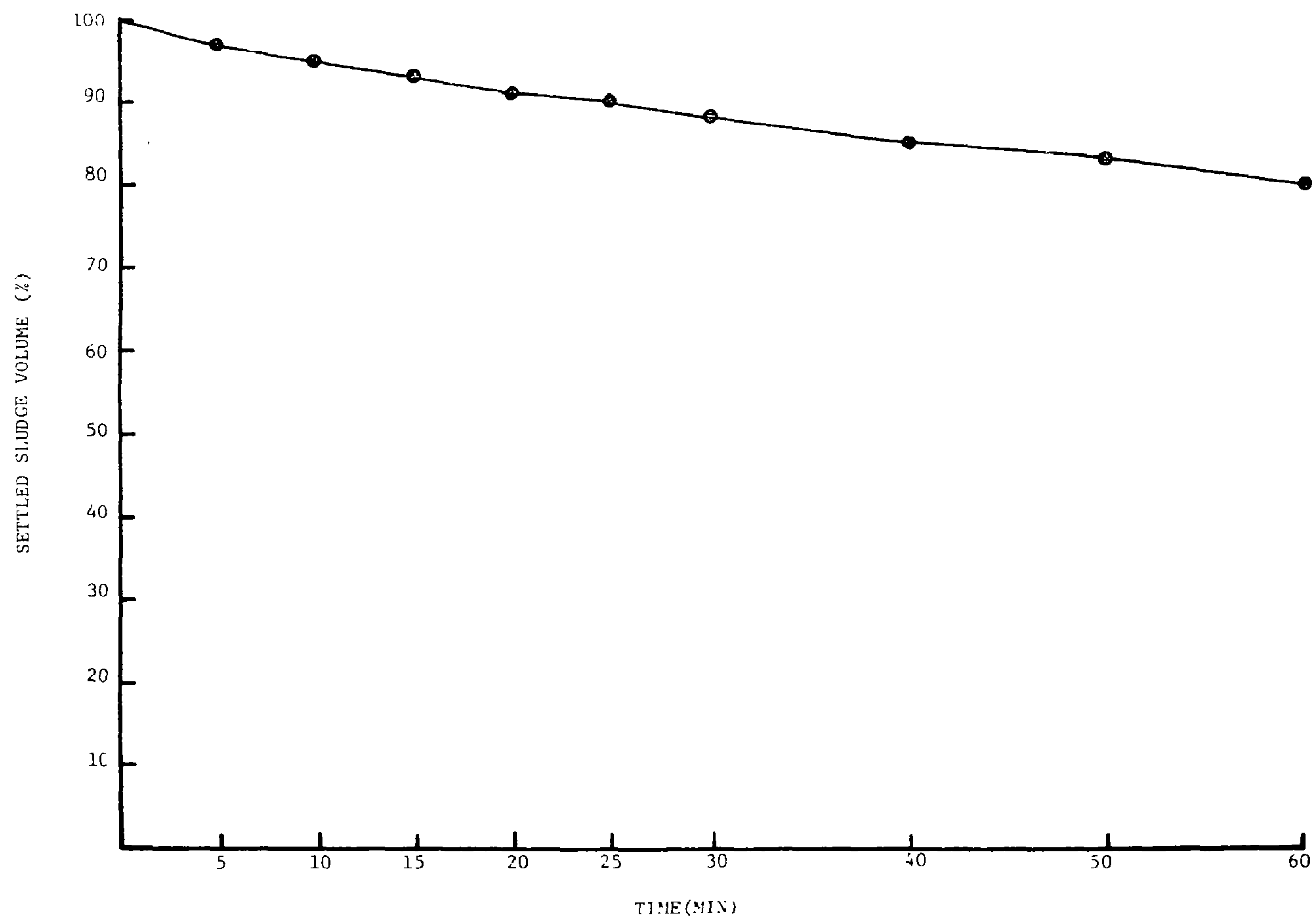
The measured and recommended operating parameters for secondary clarifiers following the conventional activated sludge process are presented in Table IV.

TABLE IV
SECONDARY CLARIFIER OPERATIONAL PARAMETERS
FOSTER ST. WTP

	Measured	Recommended (3)(4)
Hydraulic Loading (gpd/sq. ft.)	227	400-800
Solids Loading (lbs/day/sq. ft.)	28	20-30
Hydraulic Detention (hrs.)		2-2.5
Clarifier #1	3.0†(1.2)*	
Clarifier #2	3.0†(1.5)*	
Weir Overflow Rate (gpd/lin. ft.)	3,855	15,000

† = calculated as volume/flow
* = measured by dye study

FIGURE 4
SETTLOMETER TEST
FOSTER STREET WTP



The results of the clarifier dye tracer study are presented in Figure 5. The area under the two curves (Figure 5) are an indication of the flow split to the two clarifiers which was 53 and 47 percent to the #1 and #2 clarifiers, respectively. The hydraulic detention time was determined as the centroid of the respective curves (Figure 5) and are presented in Table IV.

The return sludge flow was kept constant at about 2.5 mgd, which was approximately 150 percent of the influent plant flow. This rate of return sludge was exceptionally high, but necessary, in order to contain the sludge blanket in the clarifiers and to maintain aerobic conditions. As sludge settleability improves, the return sludge flow should be reduced to a rate which maintains good clarifier operation. Septic conditions, excessive sludge blanket, black color, sludge floating to the surface, and bubbles are indicators that the return sludge flow has been reduced too much.

The solids loading (Table IV) approached the maximum recommended loading, even though the WTP was operating at less than half the design flow. This was due to the extremely high MLSS concentration.

Grease removed from the final clarifiers can be pumped to the digesters or flow to the head of the plant. During the study, grease flowed to the head of the plant, which was the least desirable alternative of handling excessive grease. Preferably, grease removed from the final clarifiers should be disposed at the sanitary landfill rather than re-introduced to the liquid flow.

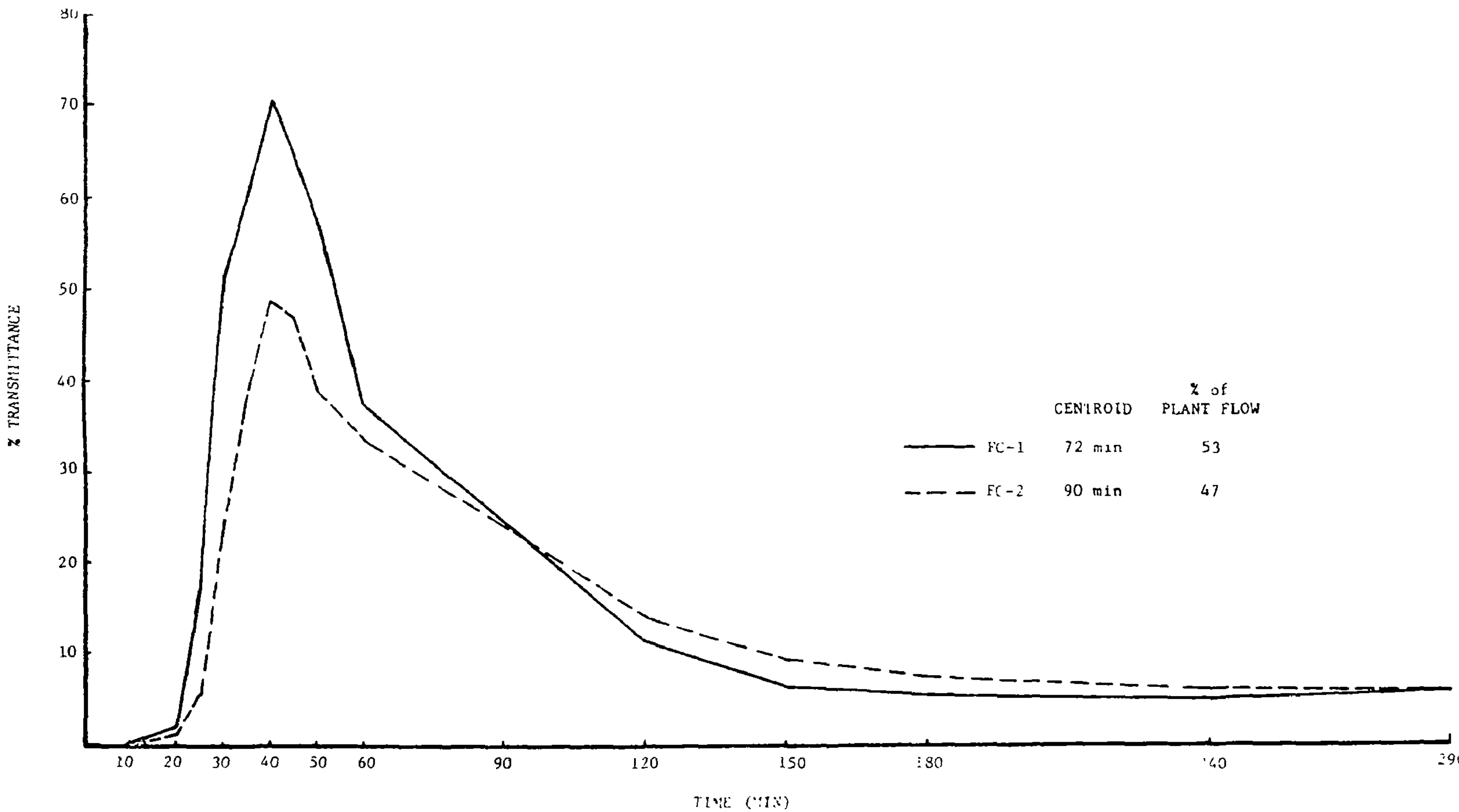
Effective sludge wasting to the aerobic digesters will be difficult due to the poor activated sludge settleability and compaction in the final clarifiers. The use of polymers may improve sludge settleability and compaction resulting in improved effluent quality and sludge control in the treatment system. However, the influent grease concentration should be controlled at the source and recycling grease in the treatment system should be stopped immediately.

Chlorine Contact Chamber

The hydraulic detention time in the chlorine contact chamber (CCC) at existing flows (1.65 mgd), was about 96 minutes. The average chlorine residual during the study period was 2.5 mg/l and ranged between 1.3 and 3.5 mg/l. Chlorine was fed at the rate of about 140 pounds/day.

Sludge had accumulated in the CCC as evidenced by periodic boiling up of black solids. Plant design does not include any means of draining the CCC and no portable pump was available for sludge removal. A drain or pump should be provided to facilitate draining and sludge removal.

FIGURE 5
CLARIFIER DYE STUDY
FOSTER STREET TP



Aerobic Digesters

Sludge is treated in three aerobic digesters, a gravity sludge thickener and a vacuum filter. Sludge from the aerobic digester may be thickened in a sludge thickener prior to the vacuum filter if desired. Effective operation of the aerobic digesters was hampered by certain design flaws. According to plant personnel, the supernatant draw-off line is located too low to decant clarified liquid; consequently, the supernatant piping cannot be used. In order to decant from the digesters a small portable pump must be used, which requires about 25-30 hours to pump clarified supernatant. Extending the supernatant draw-off pipe vertically in either a fixed or movable position (Appendix F) by using a swivel joint would allow use of existing piping and valves to more effectively decant clarified digester supernatant.

The O&M manual for the Foster Street WTP states that, "The three digesters are so designed and valved that the sludge may be transferred from tank 1 to tank 2 to tank 3 under normal operation". According to WTP personnel, however, existing piping does not allow this flexibility.

Reduction of the high solids in the aeration basins will require increased wasting to the aerobic digesters. Poor sludge compactability in the final clarifiers will complicate the wasting/digestion process. Aerobic digesters should not be shut off for more than 1-4 hours to decant and/or pump solids to the vacuum filter. In order to accomplish this, the supernatant piping arrangement must be modified.

Supernatant from the sludge thickener flows into the supernatant surge tank. This tank was designed with an exceptionally small (about 2 inch) drain line which continually plugs. This small line should be replaced with a larger line at least 4 inches in diameter.

Laboratory

The laboratory for all three plants is located at the Foster Street WTP. It is manned by two laboratory technicians who conduct all chemical analyses for the three plants plus conduct chlorine residual tests and a fecal coliform sampling program for the City of Pascagoula Water Department. The laboratory was adequate in size for the analyses performed.

During the study the following observations and suggestions were made:

1. Sodium thiosulfate which was obtained from a private laboratory and used in the BOD_5 and DO determinations was not standardized by laboratory personnel. The procedure and importance of standardizing was discussed. After returning to the EPA laboratory, a bottle of 0.0375 N potassium biniodate and standardized 0.0375 sodium thiosulfate was sent to the laboratory personnel as a check for their sodium thiosulfate. It was suggested that a portable DO meter with a field and laboratory probe would save time and effort.

2. DO was determined in the effluent, after chlorination, without using the correct dechlorination procedure. The proper procedure was discussed.

3. Routine tests conducted by the lab personnel for all three plants included BOD_5 (influent and effluent before chlorination), TSS (influent, effluent, mixed liquor, return sludge and sludge before dewatering), Cl_2 residual, fecal coliform, pH (influent and effluent), DO (influent, effluent, and aeration basins), settleable solids (influent and effluent), and 30-minute settling test (SVI). It was suggested that they replace the SVI test with the settlometer test and include the centrifuge test. The procedure and the importance of these two tests were discussed. Because of an inoperative muffle furnace, no volatile solids tests were being conducted. The importance of these results in loading calculations and operation of aeration basins was also discussed.

4. Trend charts were not being used. The procedure and importance of these were discussed.

It was suggested that an in-plant control testing program be initiated immediately, including the following chemical and physical parameters: settlometer, clarifier sludge blanket depth, and aeration basin TSS, VSS, and DO. It was further suggested that dissolved oxygen measurements be made throughout the aeration basins at various depths and trend charts be established and maintained. Useful parameters for plotting include MLSS, sludge settleability, significant influent and effluent waste characteristics, flow (plant, return sludge, waste sludge), depth of clarifier sludge blanket, MCRT, and F/M ratios. Experience will dictate which of these parameters are necessary for successful plant operation. These suggested parameters should serve only as a guide and are intended to establish trends so that gradual changes in plant conditions can be noticed prior to a deterioration in effluent quality. It is advisable that plant changes be made one at a time and maintained for approximately two weeks to allow the plant to reach equilibrium.

BAYOU CASOTTE WASTEWATER TREATMENT PLANT

TREATMENT FACILITY

Treatment Processes

A schematic diagram of the 1.6 mgd Bayou Casotte WTP is presented in Figure 6. Design data are enumerated in Table V. The plant began operation in 1965 and serves a population of approximately 11,000. No industrial wastes are received at the WTP.

The WTP is operated in the conventional activated sludge (A/S) mode. Return sludge is pumped from the clarifier back to the aeration basins. Waste sludge is pumped to the aerobic digesters, after which it is discharged onto sludge drying beds.

The grit removal system was not operational. The final effluent is chlorinated and discharged into Bayou Chico.

Personnel

The WTP is staffed by one non-certified operator eight hours per day.

STUDY RESULTS AND OBSERVATIONS

A complete listing of all analytical data and general study methods are presented in Appendices A and B. Formulae used for general calculations are enumerated in Appendix C. Significant results and observations made during the study are discussed in the following sections.

Flow

Flow rate prior to the study was determined by measuring the head with a yard stick over a 2 foot rectangular contracted weir. A recorder and totalizer were not calibrated properly. During the study, flows were determined with an EPA installed Stevens stage recorder and staff gage. Since there was no flow measuring device on the return sludge, an approximated flow was calculated utilizing simplified mixing formulae.

The average hourly WTP flow during the study is illustrated in Figure 7. The flow range was from 0.603 to 2.73 mgd, the average having been 1.36 mgd. A staff gage was installed by EPA personnel to facilitate daily operation and data reporting.

Return sludge flow for one return pump operating at maximum capacity is 400 gpm (0.576 mgd). On July 20, 1976 the return sludge rate was calculated at 0.468 mgd or 36 percent of the average daily flow.(10) During July 21-22, 1976, two pumps were in operation for 8 hours each day. Return sludge flows were calculated for the indicated days as follows:

July 20, 1976	July 21, 1976	July 22, 1976
0.468 mgd	0.812 mgd	0.695 mgd

FIGURE 6
BAYOU CASOTTE WASTEWATER TREATMENT PLANT
PASCAGOULA, MS

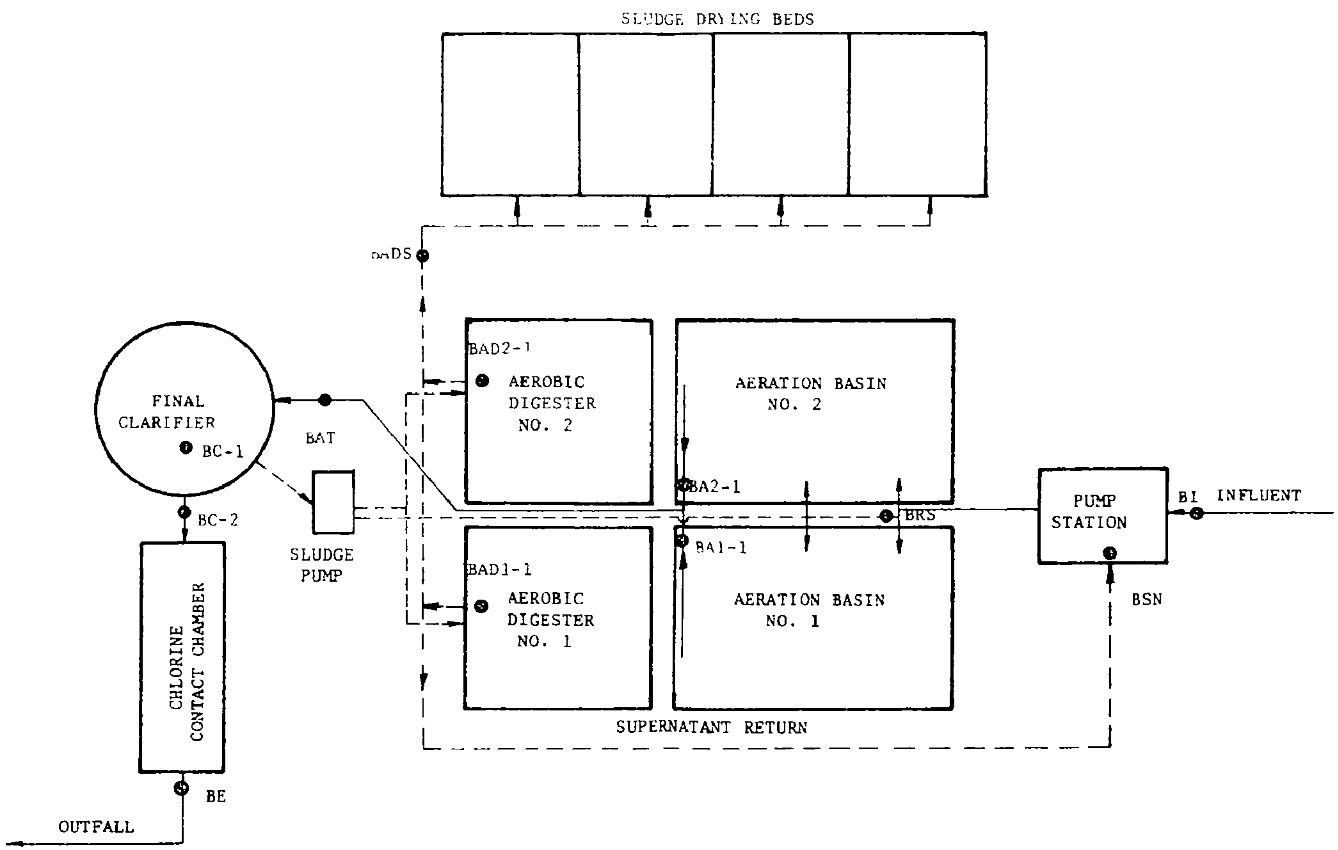


TABLE V
DESIGN DATA - BAYOU CASOTTE WTP
PASCAGOULA, MS

<u>Flow Measurement</u>

Type	2 ft. rectangular weir
Design flow	1.6 mgd

<u>Aeration Basin</u>

Number	2
Dimensions	
Surface	
Length	80 ft.
Width	52 ft.
Bottom	
Length	56 ft.
Width	28 ft.
Water Depth	12.0 ft.
Surface Area/basin	4,160 sq. ft.
Volume/basin	32,640 cu. ft. (244,150 gals.)
Aeration	2-15 h.p. aerators/basin

<u>Clarifier (Final)</u>

Number	1 (circular)
Diameter	52 ft. (ID)
Depth (SWD)	7.4 ft.
Center	9.58 ft.
Hopper Depth	2.2 ft.
Surface Area	2,123 sq. ft.
Volume	17,300 cu. ft. (129,000 gals.)
Weir Length	163 ft.

<u>Chlorine Contact Chamber</u>

Dimensions	
Surface (WL)	
Length	62 ft.
Width	22.5 ft.
Bottom	
Length	50 ft.
Width	10.5 ft.
Water Depth	6 ft.
Surface Area	1,395 sq. ft.
Volume	5,544 cu. ft. (41,470 gals.)

TABLE V (Cont.)

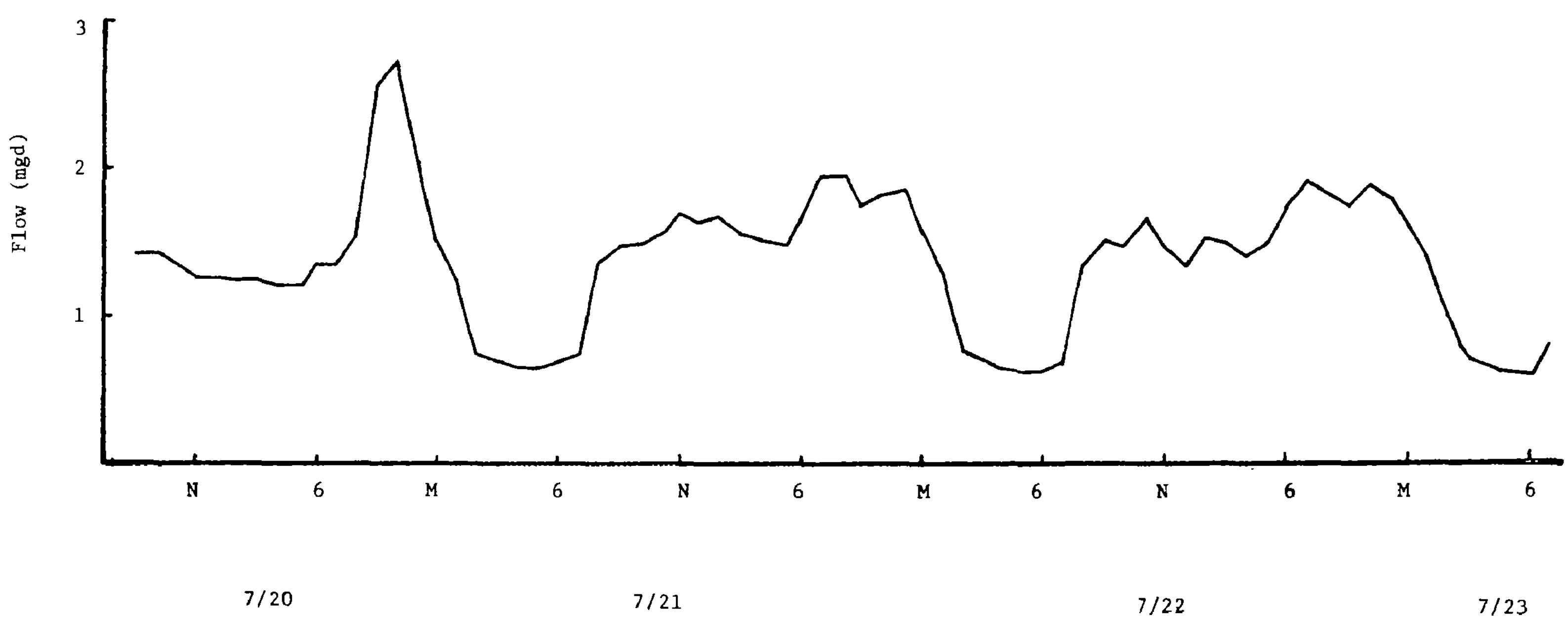
Aerobic Digesters

Number	2
Dimensions	
Surface (W.L)	
Length	52 ft.
Width	52 ft.
Bottom	
Length	28 ft.
Width	28 ft.
Water Depth	12 ft.
Surface Area/basin	2,704 sq. ft.
Volume/basin	19,200 cu. ft. ((143,620 gals.)
Aeration/basin	1-15 h.p. aerator

Sludge Drying Beds

Number	7
Length	59.2 ft.
Width	20 ft.
Area	8,284 sq. ft.

FIGURE 7
PLANT FLOW
BAYOU CASOTTE WTP
PASCAGOULA, MS



The average return sludge flow rate for the study period was 0.658 mgd or 48 percent of the average daily flow.

When only one pump was operational, sludge wasting to the digesters was accomplished by closing off the return sludge valves and then opening valves to the digesters. When the second pump was repaired and in operation, flow could be maintained in the return and waste lines, thus eliminating the closing of the valves. Sludge was wasted only once during the study (July 22).

Waste Characteristics and Removal Efficiencies

Table VI presents a chemical description of the influent and effluent waste water with calculated treatment reductions. Removal efficiencies were calculated using averaged data from three consecutive 24-hour, flow proportional composite samples.

TABLE VI
WASTE CHARACTERISTICS AND REMOVAL EFFICIENCIES
BAYOU CASOTTE WTP

Parameter	Influent	Effluent	% Reduction
BOD (mg/l)	253	67	74
COD (mg/l)	432	206	52
TS (mg/l)	1,097	971	11
TVS (mg/l)	342	183	46
TSS (mg/l)	108	49	55
TVSS (mg/l)	80	40	50
TKN (mg/l)	28.7	24.1	16
NH_3-N (mg/l)	23.8	18.5	22
NO_2-NO_3-N (mg/l)	<0.01	0.03	--
Total Phosphorus (mg/l)	19.3	6.5	66
Chloride (mg/l)	247	267	--
Oil and Grease (mg/l)*	43.2	--	--
Cl_2 Residual (mg/l)*	--	5.1	--
Pb (μg/l)	<80	<80	--
Cr (μg/l)	<80	<80	--
Cu (μg/l)	120	80	33
Cd (μg/l)	<20	<20	--
Zn (μg/l)	278	182	35
Settleable Solids (ml/l)	14	<0.8	>94

*Averaged results of grab samples taken on three different days.

These influent data are indicative of a typical domestic wastewater with an organic content somewhat higher than the normal 200 mg/l BOD_5. The Bayou Casotte WTP was accomplishing poor treatment efficiency.

Aeration Basins

Grab samples were taken from the aeration basins (Stations BA1-1, BA2-1) and analyzed for total suspended solids (TSS), volatile suspended solids (VSS), percent solids by centrifuge, and settleability as determined by the settlometer. Presented in Table VII are various activated sludge operational parameters calculated during the study period and the corresponding recommended values for the conventional plug flow process.

TABLE VII
ACTIVATED SLUDGE
OPERATIONAL PARAMETERS
BAYOU CASOTTE WTP

	Measured	Recommended (5)(7)(9)
MLSS (mg/l)	2,537	1,500-3,000
MLVSS (mg/l)	1,778	
Hydraulic Detention Time (hrs.)	5.8	4-8
Mean Cell Residence Time (days)	8.8	5-15
Sludge Age (days)	8.4	3.5-10
Lbs. BOD/day/lb MLVSS (F/M)	0.39	0.2-0.4
Lbs. COD/day/lb MLVSS	0.67	0.5-1.0
Lbs. BOD/day/1,000 cu. ft. of aeration basin	44	20-40
Return Sludge Rate (% of average plant flow)	48	15-75
Oxygen requirement (lbs O_2/lb BOD removed)	1.2*	0.8-1.1
(lbs. O_2/lb BOD under aeration)	0.9*	

* Based on an effective transfer rate of 1.8 lb. O_2/h.p. - hr. (9)

The aeration basins contained a dark grey-black mixed liquor and return sludge, with foam accumulations in the corners of the aeration basins. These observations were indicative of an inadequate air supply to the aeration basin for the organic load received.

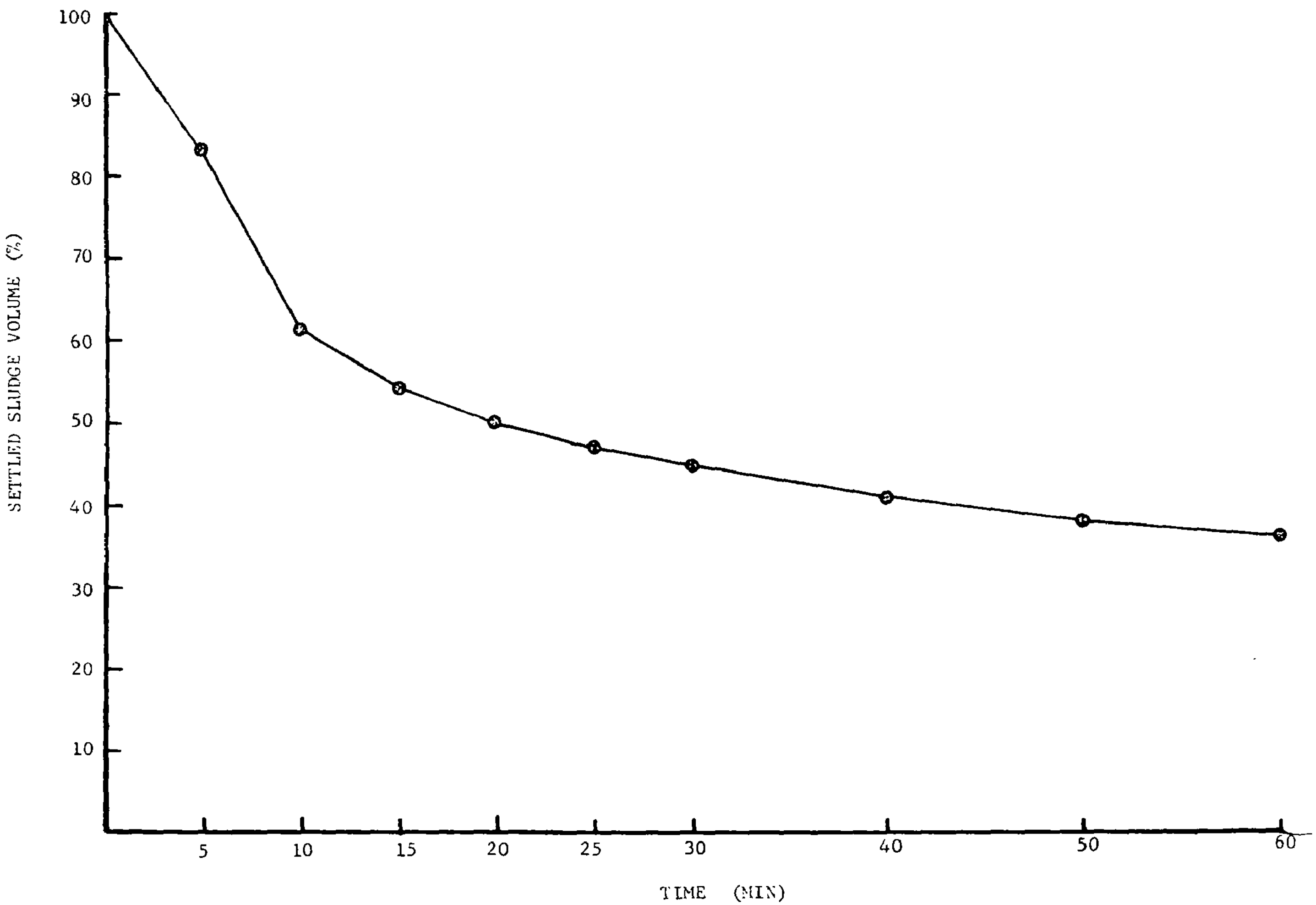
The results of the settlometer tests are presented in Appendix A and illustrated in Figure 8. Sludge settleability was slow, leaving a turbid supernatant. A microscopic examination of the suspended particles in the supernatant demonstrated small fluffy particles of bacteria cells attached to short filamentous (bacteria) agglomerates. A further examination of mixed liquor solids and return sludge revealed heavy concentrations of stalked ciliates and filamentous bacteria. These data indicate an under-oxidized sludge.

The oxygen uptake rate of the return sludge is another means of measuring sludge quality. An oxygen uptake rate or load ratio was calculated using the oxygen depletion rate before and after introduction of the raw waste.

$$\text{Load ratio} = \frac{\text{DO/min fed sludge}}{\text{DO/min unfed sludge}}$$

The oxygen uptake procedure is presented in Appendix E.

FIGURE 8
SETTLOMETER TEST
BAYOU CASOTTE WTP



The calculated load ratio for the Bayou Casotte WTP was 2.0. Generally, a conventional activated sludge plant should operate in a load range of 2-4. A load ratio of 2.0 is indicative of an acceptable feed, but conditions and sludge quality probably need to be improved. What is not shown here is the high rate at which oxygen was depleted from the aerated return sludge sample. A sludge that leaves the aeration basin having less than 0.5 mg/l of DO will become septic in the clarifier and exert an immediate demand upon the air supply system.

Dissolved oxygen (DO) concentrations measured in the aeration basins are presented in Appendix D. Dissolved oxygen concentrations throughout the aeration basins ranged from 0 to 0.2 mg/l. To calculate the amount of oxygen supplied to the aeration basins, an oxygen transfer rate of 1.8 lbs. O_2/hp-hr was used.(9) From this calculation, 2,592 lbs/day of oxygen can be supplied by the four 15 hp aerators. Assuming an influent BOD_5 concentration of 253 mg/l (Table VI), an influent flow of 1.36 mgd, and an effluent BOD_5 concentration of 30 mg/l, the existing aeration equipment can supply about 1.0 lbs. O_2/lb. BOD_5 removed. This is within recommended values.(9)

A qualitative sounding of the aeration basins demonstrated that there were solid accumulations on the outer areas of the aeration zones. Solid deposition may be the result of poor mixing, high specific gravity solids (sand) in the influent, and/or deposition during periods of aerator malfunction. The buildup of sludge banks within the aeration basins may significantly reduce the effective volume. Also, solids accumulated on the bottom and in the corners exert an increased oxygen demand upon the system, further stressing the limited oxygen supply.

It can be concluded from the above data that the aeration basins received a heavy organic loading and the aeration capacity was marginal. Under the present organic loading, aerobic conditions cannot be maintained in the system with one aerator out of service, or an increase in the organic or hydraulic load. Past experience has shown that one of the four aerators was frequently out of service. During about 6 continuous hours/day, the plant flow exceeds 1.6 mgd (Figure 7). The obvious solution to this problem is to reduce the load on the plant and/or provide standby aerators and replacement parts for existing equipment.

Clarifiers

The circular clarifier has a center feed, rim take-off flow configuration. Measured and recommended operating parameters for secondary clarifiers following the conventional activated sludge process are presented in Table VIII.

TABLE VIII
SECONDARY CLARIFIER OPERATIONAL PARAMETERS
BAYOU CASOTTE WTP

	Measured	Recommended (5)(7)
Hydraulic Detention Time (hrs.)	1.25* (1.4)	2-3
Hydraulic Loading (gpd/sq. ft.)	641	400-800
Solids Loading (lb/day/sq. ft.)	13.4	20-30
Weir Overflow Rate (gpd/lin. ft.)	8,344	<15,000
Depth (SWD) (ft.)	7.4	12-15**

* Calculated as volume/flow
() Indicate detention time as determined from the dye study.
**Ten State Standards,(7) section 54.12 recommends that final clarifiers following activated sludge should not be less than eight feet deep.

The clarifier side water depth was less than recommended by Ten State Standards.(7) The shallow depth causes difficulty in holding the sludge blanket in the clarifier.

The clarifier weir was found to be out of level. The elevation of the weir varied 0.08 feet (.96 inch) around the clarifier and the flow around the weir was observed to vary significantly.

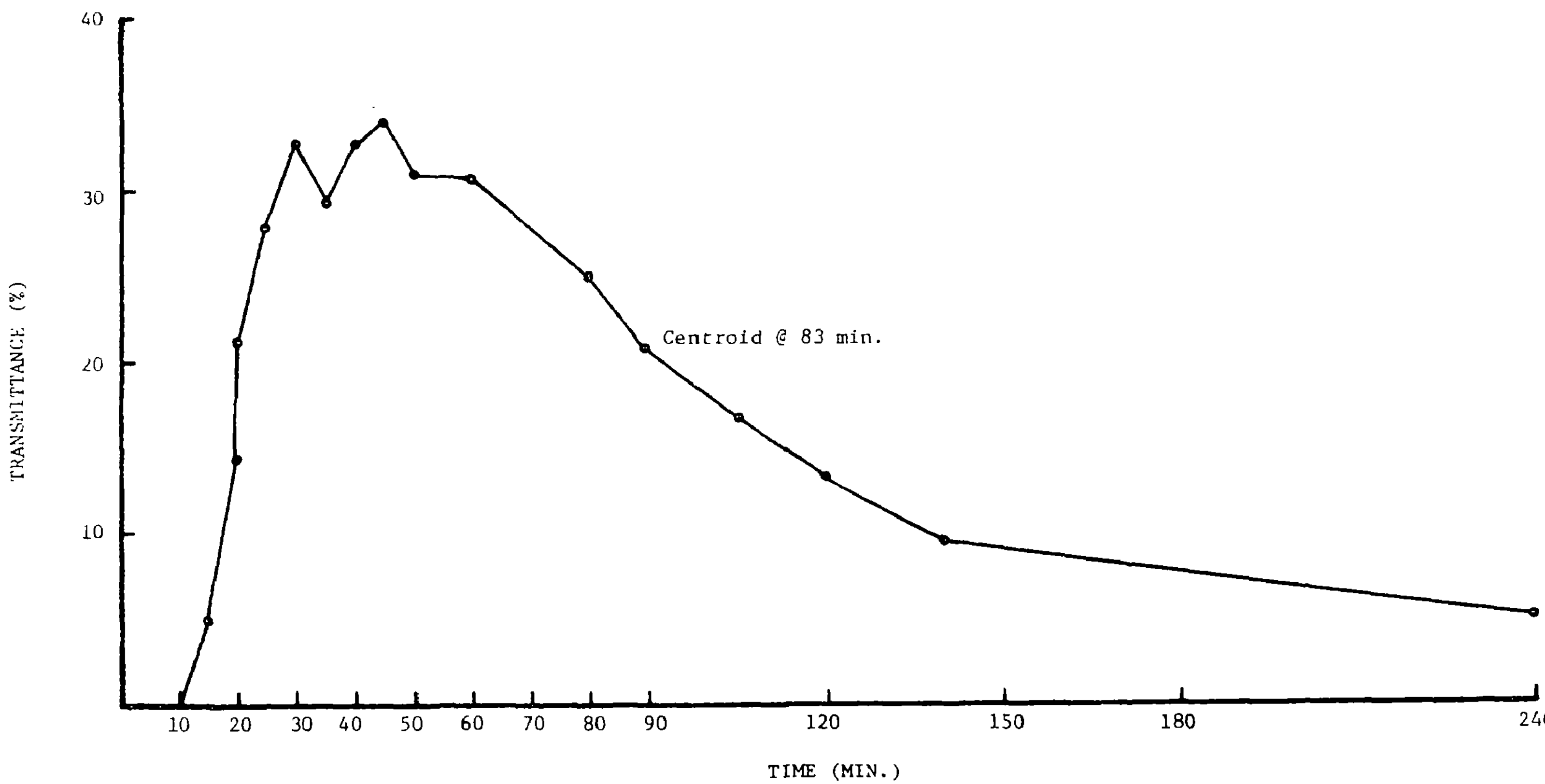
The results of the clarifier dye tracer study are presented in Figure 9. Location of the centroid of the dye concentration curve is a measure of the clarifier detention time (DT) which was 83 minutes (1.4 hours). A calculated detention time using plant flow and return sludge flow during the period of the dye tracer study was 1.25 hours. The longer DT during the dye study compared to the calculated DT was due to a 30-minute dramatic drop in flow, from about 1.6 to .59 mgd. This drop in flow rate is not shown in Figure 7, due to the short duration. The calculated detention time using average study flow and return sludge flow was 1.5 hours. In all cases, detention times were less than the recommended 2 hours.

Solids washout was documented as a recurring problem attributed to rainfall and heavy infiltration. On July 20, 1976, there was a brief solids washout between 10 and 12 a.m. Influent wastewater flow at this time was recorded at 2.7 mgd. Influent plus return sludge flow was approximately 3.2 mgd. The clarifier DT during this period was only 0.97 hours.

Sludge blanket depth, measured 2 hours following the washout, was 3.7 feet. Only one return sludge pump was being operated at full capacity. Sludge blanket depths of 4-5 feet were measured on the remaining days of the study. These depths were observed when both return sludge pumps were pumping, one full capacity, the other 1/3 capacity.

It can be summarized from the above data and observations that the clarifier is hydraulically overloaded during many hours of the day, and especially when both return sludge pumps are operating.

FIGURE 9
CLARIFIER DYE STUDY
BAYOU CASSOTTE WTP



The clarifier was designed with a detention time of 2 hours. Calculations show that this design (2 hours DT) corresponds to a flow of 1 mgd, allowing 50 percent return flow rather than 1.6 maximum influent flow. To avoid solids washout and efficiently operate this clarifier, it will be necessary to divert a portion of the plant flow to the Foster Street WTP. Return sludge pumping should be limited to one pump at 1/2 to 3/4 capacity running continuously with the other pump as standby and during times of sludge wasting.

Chlorine Contact Chamber

The 0.41 mg chlorine contact chamber (CCC) has a theoretical detention time at design flow of 40 minutes. At the average influent flow during the study, the calculated detention time was 44 minutes.

Chlorine usage, according to WTP personnel, was manually adjusted at 45 lbs. of Cl_2 per day to the effluent. Using the cylinder weight scale, the following daily chlorine rates were determined:

July 20, 1976	July 21, 1976	July 22, 1976
65 lbs.	88 lbs.	67 lbs.

The effluent chlorine residual ranged from 1.4 to 8.4 mg/l. This heavy usage of chlorine was unnecessary to disinfect the wastewater effluent. It is generally recommended that a 0.5 mg/l residual with a CCC detention time of 30 minutes is adequate for WTP effluent disinfection.

Aerobic Digesters

The Bayou Casotte WTP digesters have serious structural defects. There are large visible cracks in the walls which, according to operating personnel, extend to the bottom of the digesters. Due to a plugged withdrawal line, digested sludge could not be wasted from the east digester (BAD1) directly to the drying beds. Supernatant cannot be pumped from the west digester (BAD2) to the WTP headworks because of a plugged line. Supernatant from the west digester had to be pumped via a portable pump to the east digester supernant line and then to the WTP headworks.

Sludge withdrawal from the east digester had been accomplished by pumping (portable pump) sludge to the west digester and then to the drying beds. The pump suction line only extends about 3 feet below the surface, so the heavily concentrated sludge on the bottom was not removed. The inadequacy of this pumping procedure can be readily demonstrated by the solids levels and the DO concentrations of the two basins. The average TSS concentration in the east and west digesters were 7,900 and 2,725 mg/l, respectively, and DO concentrations ranged from 0.2-0.5 and 3.9-4.3 mg/l, respectively. On July 19 and July 22, all digested sludge was pumped from the west digester. The solids concentration of the 27,000 gals. of sludge pumped to the drying beds on July 19 was such that the cake remaining from 10 inches of sludge did not require removal before refilling. On July 22, 18,000 gals. of digested sludge was pumped to the drying bed. This digested sludge had a TSS concentration of 13,250 mg/l (2,000 lbs.).

During the study, the pH on the west digester ranged from 5.2 on July 20 to 3.8 on July 22. The low pH cannot be adequately dealt with at this time for lack of information; however, it was probably due to septic sludge in the bottom of the digester. Balancing the solids levels, maintaining adequate air, and pumping from both digesters to the sludge drying beds should eliminate these low pH values.

In conclusion, the solids levels in the two digesters need to be balanced to enhance digester operation and to increase DO levels. To accomplish this, the waste line from the east digester and the supernate line from the west digester will need to be opened and cleaned. An alternative to cleaning the plugged lines would be the use of a portable sludge pump to maintain a solids balance in the two digesters. Both digesters appear to be structurally unsound.

EAST SIDE WASTEWATER TREATMENT PLANT

TREATMENT FACILITY

Treatment Processes

A schematic diagram of the 0.4 mgd completely mixed activated sludge wastewater treatment plant (WTP), serving east Pascagoula, is presented in Figure 10. Design data are enumerated in Table IX. The WTP began operation in January 1970 and serves an estimated population of 5,000.

The WTP influent is pumped to the elevated grit chamber and then flows by gravity through the subsequent treatment units. Aeration in the aeration tanks and aerobic digester is supplied by a single 15-hp mechanical aerator in each tank. After clarification and chlorinating, the plant effluent flows into Lake Avenue via a canal.

Return sludge is pumped to the head of the plant and waste sludge is pumped to the aerobic digester. Four sludge drying beds are available to dewater digested sludge.

Personnel

The plant is staffed by a single operator, 8 hours per day.

STUDY RESULTS AND OBSERVATIONS

A complete listing of analytical data and study methods are presented in Appendices A, B, and D. Formulae used for general calculations are presented in Appendix C. Significant results and observations are discussed in the following sections.

Flow

Wastewater Treatment Plant (WTP) flows were measured using a 90° V-notched weir, located at the effluent of the chlorine contact tank. A recorder and totalizer were available but inoperative during the study. Plant flow, determined from an EPA-installed Stevens Stage Recorder, during the study was 0.138 mgd. This flow was significantly lower than design flow and the reported average daily flow of 0.4 mgd. Since the TA study, the plant flow meter has been repaired and calibrated. The average daily flow is reported by WTP personnel to still be about 0.4 mgd.

Return sludge flow was reported to be 35 percent (0.14 mgd) of design flow. This rate was based on the capacity of the two return sludge pumps; one pump operating at any given time.

Activated sludge was wasted from the digester to drying beds three times per week. Waste volumes were not available during the study.

FIGURE 10
EAST SIDE WTP
PASCAGOULA, MS

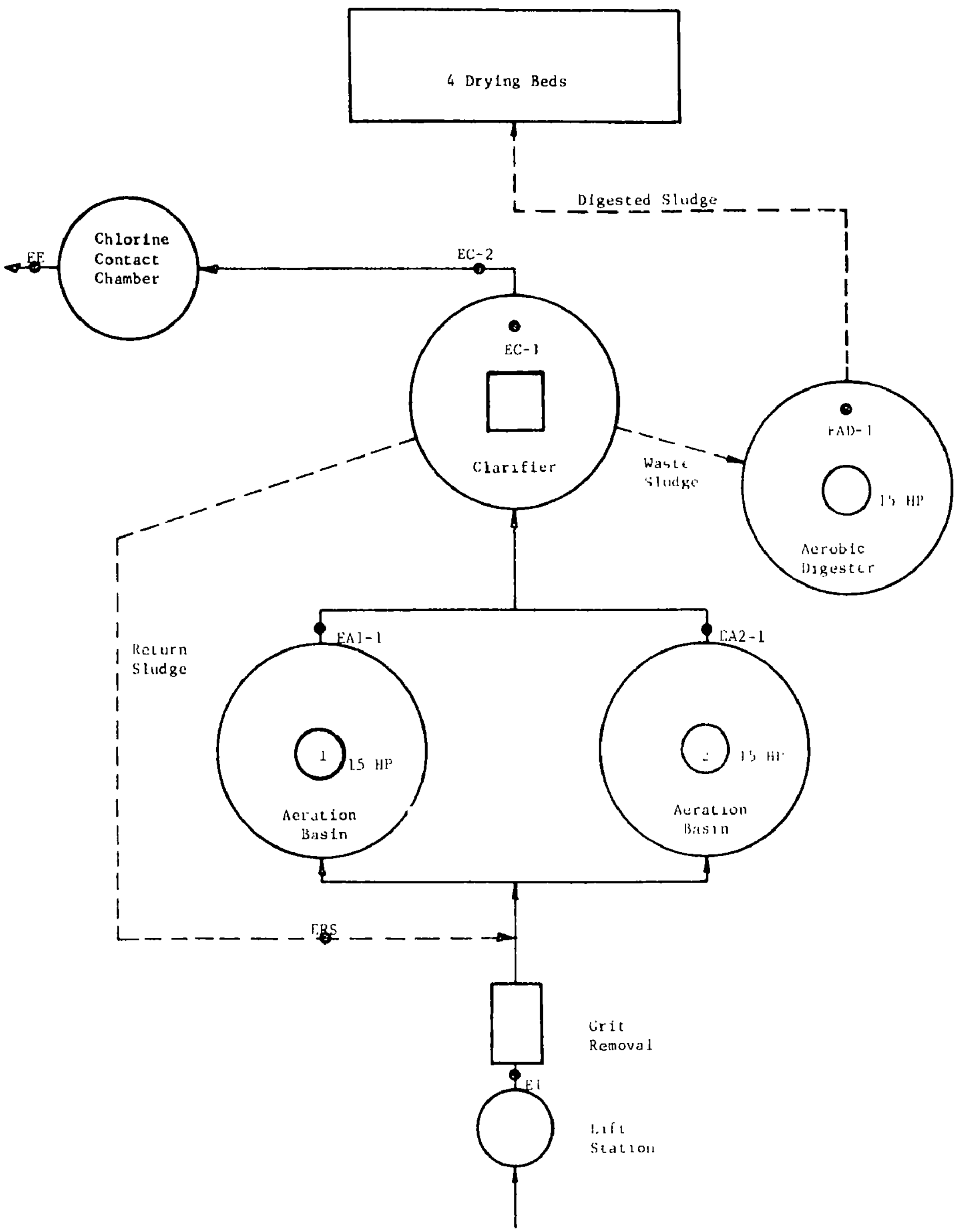


TABLE IX
DESIGN DATA - EAST SIDE WTP
PASCAGOULA, MS

<u>Flow Measurement</u>

Type	90^{o} V-notch weir, recorder totalizer
Design Flow	0.4 mgd
Aeration Basins	
Number	2 (circular)
Diameter	28 ft.
Depth (water)	14 ft.
Area	615 sq. ft.
Volume	8,616 cu. ft. (0.064 m.g.)/basin
Aeration	1-15 hp mechanical aerator
Clarifier	
Number	1 (circular)
Diameter	28 ft.
Depth (water)	14 ft.
Area	615 sq. ft.
Volume	8,616 cu. ft. (.064 m.g.)
Weir length	88 ft. (approximate)
Aerobic Digestor	
Number	1 (circular)
Diameter	28 ft.
Depth (water)	14 ft.
Volume	8,616 cu. ft. (0.064 m.g.)

Waste Characteristics and Removal Efficiencies

Table X presents a chemical description of the influent and effluent wastewater with calculated treatment reductions. Analyses were made on a single 24 hour, flow proportional, composite sample collected from the influent and effluent during the period July 22-23, 1976.

TABLE X
WASTE CHARACTERISTICS AND REMOVAL EFFICIENCIES
EAST SIDE WTP

Parameter	Influent	Effluent	% Reduction
BOD_5 (mg/l)	380	27	93
COD (mg/l)	816	76	91
TS (mg/l)	1,638	748	54
TVS (mg/l)	742	154	79
TSS (mg/l)	805	32	96
TVSS (mg/l)	485	16	97
TKN (mg/l)	26.5	2.55	90
NH_3-N (mg/l)	15	0.8	95
NO_2-NO_3-N (mg/l)	<0.01	0.10	--
Total Phosphorus (mg/l)	17.5	2.6	85
Chloride (mg/l)	175	165	6
Oil and Grease (mg/l)*	41.6	<5.0	>88
Pb (μg/l)	1,060	80	92
Cr (μg/l)	3,990	205	95
Cu (μg/l)	600	55	91
Cd (μg/l)	<20	<20	--
Zn (μg/l)	1,440	165	89
Settleable Solids (ml/l)	38	0.5	99

* Grab sample

The influent wastewater was much stronger than a typical domestic wastewater. The concentrations of lead, chromium, copper, and zinc were significantly high. According to plant personnel, there are no industrial connections, except the hospital, into the East Side WTP.

The decrease in NH_3-N concentration demonstrated that extremely good nitrification was occurring. However, the resulting small increase in NO_2-NO_3-N indicates denitrification was also occurring. Low DO concentrations in the aeration basins, after the aerators shut off, would account for this phenomenon.

Aeration Basins

Grab samples were taken from the aeration basins and analyzed for TSS, VSS, percent solids by centrifuge, and settleability as determined by settlometer.

Dissolved oxygen concentrations were measured while the aerators were running at the 1, 5, and 8 foot depths in the aeration basins. DO concentrations at the 1, 5, and 8 foot depths in basin EA1 were 1.2, 0.6, and 0.2 mg/l, respectively. In basin EA2, DO concentrations were 1.0, 0.5, and 0.3 mg/l, at 1, 5, and 8 foot depths, respectively. The aerators were reported to be operating on a 45 ON - 15 minute OFF time cycle. During a 15 minute OFF cycle, a DO depletion rate was determined. A DO concentration of 1.0 mg/l in EA 1 was completely depleted within 5 minutes, and a DO concentration of 1.0 mg/l in EA 2 was completely depleted within 1.5 minutes.

The results of the settlometer tests are presented in Figure 11. The sludge in EA1 settled faster than EA2; however, neither sludge compacted well. Total suspended solids levels in the aeration basins are presented in Appendix A. There is no significant difference between the solids levels in EA1 and EA2, 6,020 and 5,320 mg/l, respectively. The slow settleability of the sludge can be attributed to interference from the excessive solids concentration. Most activated sludge mixed liquor solids fall into a range of 70-80% volatile content. The volatile solids content of the MLSS during the study was 47 percent. This is unusually low and indicates retention of excessive inert solids.

Clarifier

Results of the settlometer test and observation of the settling character of the sludge revealed that settling and compaction of the activated sludge was poor (Figure 11). Supernatant in the settlometer test was clear with floating scum on the surface. Settling characteristics in the clarifier were similar to the settlometer test except for flow turbulence and solids carryover.

The hydraulic detention time calculated for the average daily flow of 0.40 mgd and a 35 percent return sludge flow was 2.8 hours. The sludge blanket depth was less than three feet below the water surface and effluent turbidity was 36 NTU's.

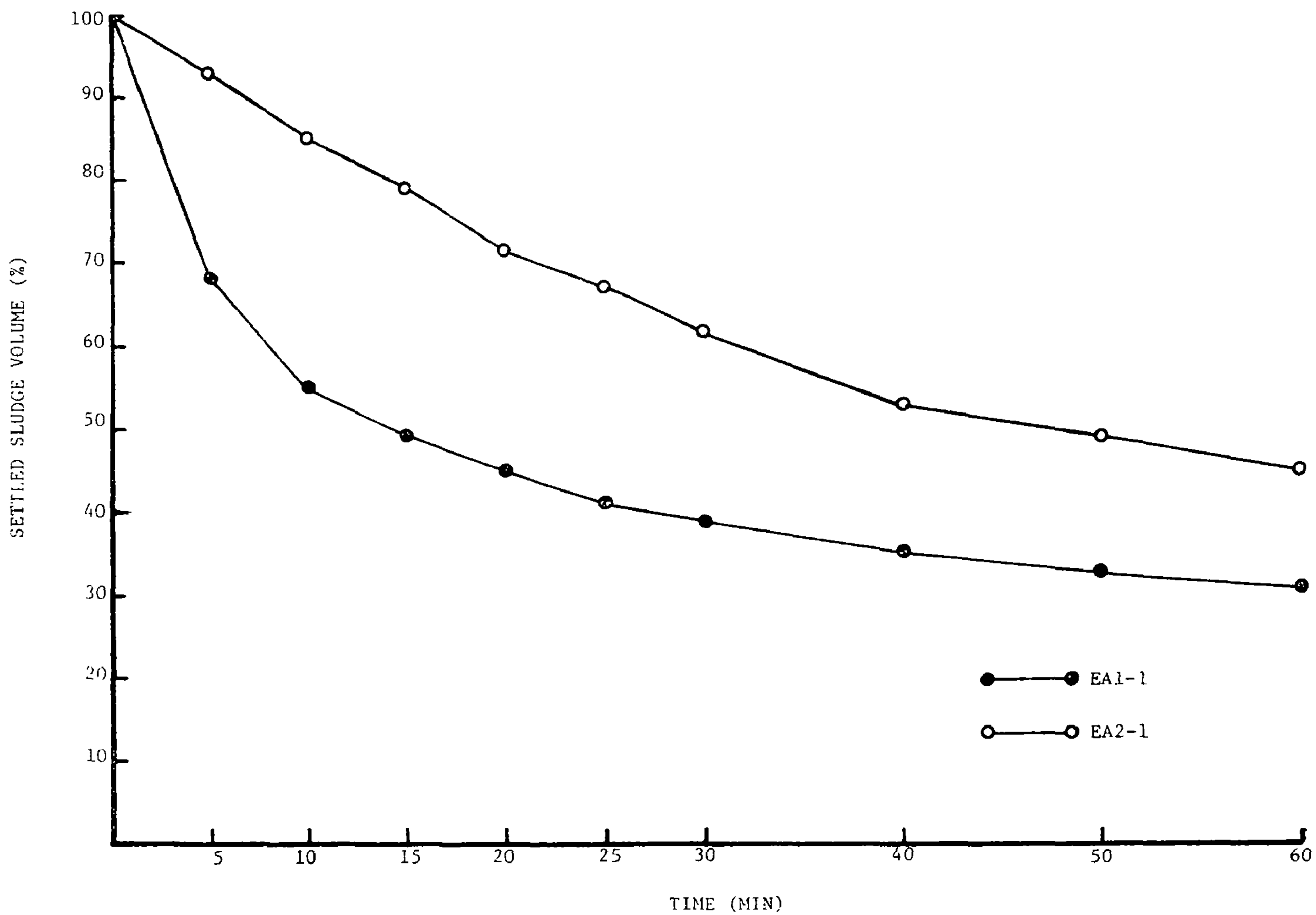
Sludge was returned from the clarifier at a 0.14 mgd rate. The return sludge concentration was 11,967 mg/l. These data indicate that solids carryover was caused by the high sludge blanket in the clarifier. This condition may be corrected by wasting activated sludge down to a level to maintain an F/M ratio of about 0.4. As sludge is wasted, the volatile content of the MLSS should increase to about 75 percent.

Based on average daily flow (0.4 mgd) and study organic loadings, a MLSS of 3400 mg/l would be recommended.

Aerobic Digester

During the study, DO concentrations at the 1, 5, and 8 feet depths were 3.6, 3.4, and 3.3 mg/l, respectively. Solids (TSS, TVSS) concentrations were 23,500 and 9,700 mg/l, respectively. Volatile content in the digester was comparable with the aeration basin at 41 percent.

FIGURE 11
SETTLOMETER
EAST SIDE WTP



APPENDIX A
LABORATORY DATA
FOSTER ST., BAYOU CASOTTE AND EAST SIDE WTP
PASCAGOULA, MISSISSIPPI

Influent & Effluent

O+M SAD #	STATION	MONTH	DAY	YEAR	TIME	BOD_5 mg/l	COD mg/l	Total Solids mg/l	Total Volatile Solids mg/l	Total Suspended Solids mg/l	Volatile Suspended Solids mg/l	Settleable Solids ml/l	TKN-N mg/l	NH_3-N mg/l	NO_3-NO_2-N mg/l	Total Phosphorus mg/l	Pb µg/l	Cr µg/l	Cu µg/l	Cd µg/l	Zn µg/l	Oil and Grease mg/l	Cl_2 Residual mg/l	Chloride mg/l
4,047	FI	7	20/21	76	24-hr comp.	400	664	1286	424	214	176	6.7	53.2	43.0	<0.01	9.10	<80	<80	90	<20	290	—	—	280
4,060	↓	7	21	76	1060	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	53	—	—
4,076		7	21/22	76	24-hr comp.	310	540	1184	374	175	145	7.0	41.4	30.0	0.02	9.30	<80	<80	90	<20	260	—	—	280
4,089		7	22	76	1010	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	51	—	—
4,105		7	22/23	76	24-hr comp.	330	544	1302	426	225	175	6.5	42.3	27.5	<0.01	9.30	<80	<80	100	<20	300	—	—	260
4,048	FDI	7	21	76	0945	1400	2400	2398	830	770	470	17	111	24.5	0.06	20.0	80	100	75	<20	480	—	—	580
4,059	↓	7	21	76	1030	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	150	—	—
4,078		7	22	76	0850	1067	1640	2108	686	950	450	5.5	98.0	12.5	0.03	16.5	<80	<80	60	<20	500	—	—	350
4,090		7	22	76	1005	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	—	—
4,016	FE	7	20	76	0900	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.1	—
4,045	↓	7	21	76	0800	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3.5	—
4,046		7	20/21	76	24-hr comp.	33	80	1008	159	30	20	<0.1	31.3	28.0	0.03	15.0	<80	<80	18	<20	50	—	1.3	280
4,058		7	21	76	1030	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	<5.0	—	—
4,069		7	22	76	0745	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3.1	—
4,077		7	21/22	76	24-hr comp.	20	96	970	162	44	26	0.1	34.0	39.0	0.03	14.8	<80	<80	18	<20	48	—	—	280
4,091		7	22	76	1000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	<5.0	—	—
4,106		7	23	76	24-hr comp.	25	100	962	184	46	28	0.2	32.3	30.0	0.03	9.00	<80	<80	18	<20	50	—	—	280
4,049	BI	7	20/21	76	24-hr comp.	200	384	1038	302	84	62	9.0	28.1	24.5	<0.01	8.20	90	<80	110	<20	260	—	—	240

APPENDIX A
LABORATORY DATA
FOSTER ST., BAYOU CASOTTE AND EAST SIDE WTP
PASCAGOULA, MISSISSIPPI

Influent, Effluent and Supernatant

OHM SAD #	STATION	MONTH	DAY	YEAR	TIME	BOD_5 mg/l	COD mg/l	Total Solids mg/l	Total Volatile Solids mg/l	Suspended Solids mg/l	Volatile Suspended Solids mg/l	Settleable Solids ml/l	TKN-N mg/l	NH_3-N mg/l	NO_3-NO_2-N mg/l	Total Phosphorus mg/l	Pb µg/l	Cr µg/l	Cu µg/l	Cd µg/l	Zn µg/l	Oil & Grease mg/l	Cl_2 Residual mg/l	Chloride mg/l	% Solid V/V Centrifuge
1092	BI	7	21	76	1610	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	52	—	—	—
1093		7	22	76	0825	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	34	—	—	—
1079		7	21/22	76	24-hr Comp.	210	457	1142	374	160	118	20	29.5	22.5	<0.01	10.0	<80	<80	120	<20	280	—	—	245	—
1107		7	22/23	76	24-hr Comp.	350	456	1110	350	80	60	—	28.5	24.5	0.02	10.8	<80	<80	130	<20	300	—	—	255	—
1050	BE	7	20/21	76	24-hr Comp.	76	296	1014	210	105	87	1.5	24.5	19.0	0.03	7.2	<80	<80	120	<20	300	—	1.4	275	—
1062		7	20	76	0900	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8.4	—	—
1080		7	21/22	76	24-hr Comp.	84	161	944	154	12	9	<0.1	25.0	18.0	0.03	6.5	<80	<80	60	<20	140	—	Grab 2.8	260	—
1108		7	22/23	76	24-hr Comp.	42	162	954	186	30	24	—	22.7	18.5	0.02	5.8	<80	<80	60	<20	110	—	Grab 4.0	265	—
1099	EI	7	22	76	1115	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	42	—	—	—
1103		7	21/22	76	24-hr Comp.	380	816	1638	742	805	485	38	26.5	15.0	<0.01	17.5	1060	4,000	600	<20	1400	—	—	175	—
1104	EE	7	21/22	76	24-hr Comp.	27	76	748	154	32	16	0.5	2.55	0.80	0.10	2.6	80	200	55	<20	160	—	—	165	—
1100		7	22	76	1115	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	<50	—	—	—
1029	BSN	7	20	76	1030	—	—	—	—	22	18	—	—	—	—	—	—	—	—	—	—	—	—	—	<1.0
1061		7	21	76	0900/1300	—	100	836	196	27	19	—	13.0	11.0	1.90	2.2	<80	<80	35	<20	90	—	—	—	<1.0
1082		7	22	76	0830	—	—	840	188	48	42	—	—	—	—	—	—	—	—	—	—	—	—	220	<1.0
1102		7	22	76	6-hr Comp.	—	334	830	132	28	22	—	13.4	11.5	4.90	3.4	<80	<80	35	<20	120	—	—	220	—
1041	FSN	7	21	76	0805	—	—	6760	2540	5790	2500	—	—	—	—	—	—	—	—	—	—	—	—	—	5.5
1066		7	22	76	0740	—	—	1772	549	103	60	—	—	—	—	—	—	—	—	—	—	—	—	—	<1.0

APPENDIX A
LABORATORY DATA
FOSTER ST., BAYOU CASOTTE AND EAST SIDE WTP
PASCAGOULA, MISSISSIPPI

Aeration Basins

O+M SRD #	STATION	MONTH	DAY	YEAR	TIME	Total Suspended Solids mg/l	Volatile Suspended Solids mg/l	% Solids V/V Centrifuge	SETTLOMETER 5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	40 min.	50 min.	60 min	COMMENTS
1017	FA-1-1	7	20	76	0900	4540	3030	7.5	98	96	94	92	89	86	81	77	72	Cloudy but no straggler Floc
1032		7	21	76	0730	5220	3520	9.0	97	95	94	93	91	90	88	86	83	Settled to 68% after 2hrs.-no rising
1070		7	22	76	0810	5020	3440	9.5	96	95	93	93	91	89	86	83	80	
1018	FA2-1	7	20	76	0900	5560	3660	9.0	97	96	94	93	90	88	85	83	79	Cloudy but no straggler Floc
1033		7	21	76	0735	6200	4160	10.5	97	95	94	93	92	91	89	87	85	Settled to 76% after 2hrs-no rising
1071		7	22	76	0810	6120	4100	10.0	99	97	96	96	95	94	92	91	89	
1019	FA3-1	7	20	76	0900	5580	3720	9.5	99	97	95	94	92	90	87	84	81	Cloudy but no straggler Floc
1034		7	21	76	0740	5780	3920	10.0	98	96	95	94	93	93	91	89	87	Settled to 77% after 2hrs-no rising
1072		7	22	76	0815	6060	4040	10.0	98	97	96	95	94	93	91	89	87	
1020	FA4-1	7	20	76	0900	5460	3650	9.0	98	96	94	93	90	87	85	81	77	Relatively clear supernatant
1035		7	21	76	0745	5860	3900	9.5	97	96	94	93	92	90	87	85	82	Settled to 68% after 2hrs-no rising
1073		7	22	76	0815	5880	4030	10.0	99	97	95	94	92	90	87	85	82	
1021	FA5-1	7	20	76	1100	5160	3680	9.3	97	94	90	87	85	83	78	75	71	Clear supernatant
1036		7	21	76	0750	5380	3640	9.0	96	94	92	90	89	87	84	81	78	Settled to 62% after 2hrs-no rising
1074		7	22	76	0815	5760	3940	10.0	98	97	96	94	92	90	87	85	82	
1022	FAT	7	20	76	1100	5137	3338	7.8	96	93	90	87	86	84	81	77	74	Cloudy supernatant without straggler Floc.
1037		7	21	76	0755	6500	4375	9.5	97	94	93	91	90	90	87	86	84	Settled to 73% after 2hrs-no rising
1075		7	22	76	0820	5800	3825	10.0	98	97	95	95	93	91	88	86	83	

APPENDIX A
LABORATORY DATA
FOSTER ST., BAYOU CASOTTE AND EAST SIDE WTP
PASCAGOULA, MISSISSIPPI

Aeration Basins & Return Sludge

C+M SRD #	STATION	MONTH	DAY	YEAR	TIME	Total Suspended Solids mg/l	Volatile Suspended Solids mg/l	% Solids V/V Centrifuge	Cl^- mg/l	SETTLOMETER 5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	40 min.	50 min.	60 min.	120 min.	COMMENTS
1023	BA1-1	7	20	76	1030	2460	1720	5.5	—	85	63	55	51	49	46	43	40	37	26	Supernatant very Turbid-Solid dark gray color
1054	↓	7	21	76	0925	2460	1740	5.0	—	80	57	51	47	44	42	38	35	34	—	Settled to 25% after 90 min.
1086	↓	7	22	76	0904	2540	1760	6.0	—	90	65	57	53	50	47	43	40	38	26	Turbid Supernatant
1024	BA2-1	7	20	76	1030	2240	1550	5.0	—	75	55	50	46	43	41	38	35	34	24	Turbid Supernatant-solids dark granular
1056	↓	7	21	76	0927	2920	2080	5.0	—	85	63	56	53	48	46	43	40	38	—	Settled to 28% after 90 min.
1087	↓	7	22	76	0902	2600	1820	5.5	—	80	60	54	50	47	45	41	38	36	25	Turbid Supernatant
1025	BAT	7	20	76	1045	2371	1621	5.0	—	—	—	—	—	—	—	—	—	—	—	—
1055	↓	7	21	76	0925	2400	1767	5.3	—	—	—	—	—	—	—	—	—	—	—	—
1088	↓	7	22	76	0900	2700	1900	5.5	—	—	—	—	—	—	—	—	—	—	—	—
1094	EA1-1	7	22	76	1103	6020	2800	6.5	—	68	55	49	45	41	39	35	33	31	25	Supernatant clear
1095	EA2-1	7	22	76	1105	5320	2580	5.5	180	93	85	79	72	67	62	53	49	45	30	Floating Debris @ 5 min.
1015	ERS-T	7	20	76	0900	9246	6304	15.0	—	—	—	—	—	—	—	—	—	—	—	—
1042	↓	7	21	76	0800	9967	6467	16.0	—	—	—	—	—	—	—	—	—	—	—	—
1031	ERS-2	7	20	76	1330	9467	6100	16.0	—	—	—	—	—	—	—	—	—	—	—	—
1026	BRS	7	20	76	1055	8550	5900	19.0	—	—	—	—	—	—	—	—	—	—	—	—
1057	↓	7	21	76	0930	4550	3100	10.0	—	—	—	—	—	—	—	—	—	—	—	—
1085	↓	7	22	76	0856	5550	3850	12.0	—	—	—	—	—	—	—	—	—	—	—	—
1098	ERS	7	22	76	1200	11967	5767	13.0	—	—	—	—	—	—	—	—	—	—	—	—

APPENDIX A
LABORATORY DATA
FOSTER ST., BAYOU CASOTTE AND EAST SIDE WTP
PASCAGOULA, MISSISSIPPI

Aerobic Digestors

O+M SRD #	STATION	MONTH	DAY	YEAR	TIME	Total Suspended Solids mg/l	Volatile Suspended Solids mg/l	% Solid V/V Centrifuge	Cl mg/l
1038	FAD-1	7	21	76	0810	57130	40000	64.0	—
1063	↓	7	22	76	0750	13983	7817	19.0	—
1039	FAD-2	7	21	76	0810	89	56	41.0	—
1064	↓	7	22	76	0750	9867	5900	18.5	—
1040	FAD-3	7	21	76	0810	25250	14150	33.5	—
1065	↓	7	22	76	0750	22800	12800	31.0	—
1027	BAD1-1	7	20	76	1043	8067	4867	10.0	—
1051		7	21	76	0915	7867	4667	9.0	—
1084	↓	7	22	76	0853	7767	4600	9.0	454
1028	BAD2-1	7	20	76	1040.	2800	1933	4.5	—
1053		7	21	76	0920	2800	1950	4.3	—
1083	↓	7	22	76	0850	2575	1700	4.0	305
1101	BADS	7	22	76	1115	13250	8900	20.0	—
1096	EAD-1	7	22	76	1200	23500	9700	22.0	—

APPENDIX A
LABORATORY DATA
FOSTER ST., BAYOU CASOTTE AND EAST SIDE WTP
PASCAGOULA, MISSISSIPPI

Clarifiers

[illegible] #	STATION	MONTH	DAY	YEAR	TIME	Turbidity NTU
1013	FC1-2	7	20	76	0900	9.5
1043	↓	7	21	76	0800	8.0
1067	↓	7	22	76	0735	8.0
1014	FC2-2	7	20	76	0900	9.8
1044	↓	7	21	76	0800	9.0
1068	↓	7	22	76	0735	8.0
1030	BC-2	7	20	76	1145	17
1052	↓	7	21	76	0915	20
1081	↓	7	22	76	0805	27
1047	EC-2	7	22	76	1200	36

APPENDIX B
GENERAL STUDY METHODS

To accomplish the stated objectives, the study included extensive sampling, physical measurements and daily observations. Foster Street and Bayou Casotte plant influent-effluent stations were sampled for three consecutive 24-hour periods and East Side influent-effluent stations were sampled for one 24-hour period with ISCO Model 1392-X automatic samplers. Aliquots of sample were pumped at hourly intervals into individual refrigerated glass bottles which were composited proportional to flow at the end of each sampling period.

Stevens Type F water level recorders were installed on all plant effluents to record gage height of the individual flow devices through the 24-hour compositing periods. These gage heights were converted to daily total flow (mgd).

Dissolved oxygen was determined at stations throughout the plants and in the aeration basins using a YSI Model 51A dissolved oxygen meter.

Temperature and pH levels were determined at specified stations throughout the plants. Individual samples of the 24-hour compositing period were used to determine hourly influent pH variations.

Depth of the secondary clarifier sludge blankets were determined daily using equipment suggested by Alfred W. West, EPA, NFIC, Cincinnati.

Sludge activity was determined by the oxygen uptake procedure presented in Appendix E.

A series of standard operational control tests were run daily:

(1) Settleability of mixed liquor suspended solids (MLSS) as determined by the settlometer test;

(2) Percent solids of the mixed liquor and return sludge determined by centrifuge;

(3) Suspended Solids and Volatile Suspended Solids analysis on the aeration basin mixed liquor and return sludge;

(4) Turbidity of each final clarifier effluent.

An amperometric titrator (Fischer & Porter Model 17T1010) was used to determine effluent chlorine concentrations.

The procedure for BOD_5 determinations deviated from Standard Methods. Samples were set up and returned in an incubator to Athens, GA for completion.

Visual observations of individual unit processes were recorded.

APPENDIX C

Activated Sludge

Formulae Used for General Calculations

Aeration Basin

1. lbs. of solids in aeration basin
   Basin volume = m.g.; MLSS (conc.) = mg/1
   (MLSS conc.) x (Basin vol.) x 8.34 = lbs. of solids

2. Aeration basin loading (lbs. BOD or COD/day)
   Inf. flow to aeration basin = mgd
   Inf. BOD or COD = mg/1
   (BOD or COD) x flow x 8.34 = lbs. BOD of COD/day

3. Sludge Age (days)
   MLSS conc. (avg. of daily values) = mg/1
   Aeration Basin Vol. = m.g.
   TSS, Primary Eff. or Basin Inf. conc. = mg/1
   Plant Flow = mgd

   $$\frac{(\text{MLSS}) \times (\text{Basin Vol.}) \times (8.34)}{(\text{TSS}) \times (\text{Flow}) \times 8.34}$$

4. Sludge Vol. Index (SVI)
   30 min. settleable solids (avg. of daily values) = %
   MLSS conc. = mg/1

   $$\frac{(\%,\ 30 \text{ min. set. solids}) \times (10{,}000)}{\text{MLSS}}$$

5. Sludge Density Index (SDI)
   SVI Value $\frac{100}{\text{SVI}}$

6. Detention time (hours)
   Volume of basins = gal.
   Plant flow = gal./day
   Return sludge flow = gal./day

   $$\frac{\text{Basin volume} \times 24}{(\text{Flow}) + (\text{Return sludge flow})}$$

7. F/M Ratio (Food/Microorganism) BOD or COD
   Basins Inf. BOD_5 conc. (avg. or daily value) = mg/1
   Basins Inf. COD conc. (avg. or daily value) = mg/1
   Plant Flow = mgd
   MLVSS conc. (avg. or daily value, note Volatile SS) = mg/1
   Basin Vol. = m.g.

   $$\frac{(BOD_5 \text{ conc.}) \times (\text{plant flow}) \times (8.34)}{(\text{MLVSS}) \times (\text{Basin Vol.}) \times 8.34} = \text{lbs. BOD/lb. MLVSS}$$

$$\frac{\text{(COD conc.) x (plant flow) x (8.34)}}{\text{(MLVSS) x (Basin Vol.) x (8.34)}} = \text{lbs. COD/lb. MLVSS}$$

8. Mean cell residence time (MCRT) = days
   MLSS conc. (avg. or daily value) = mg/l
   Basin vol. = m.g.
   Clarifier vol. = m.g.
   Waste activated sludge conc. = mg/l
   Waste activated sludge flow rate = mgd
   Plant effl. TSS = mg/l
   Plant flow = mgd

$$\frac{\text{(MLSS) x (Basin vol. + Clarifier vol.) x 8.34}}{\text{(Waste activated sludge conc.) x (waste flow) x 8.34 + (Plant effl. TSS x plant flow x 8.34)}} = \text{days}$$

Clarifier

1. Detention time = hours
   Plant flow to each clarifier = gals./day
   Individual clarifier vol. = gals.

$$\frac{\text{(clarifier Vol. (each) x 24}}{\text{Plant flow + Return Sludge Flow}} = \text{hours}$$

2. Surface loading rate = gal./day/sq. ft.
   Surface area/clarifier = sq. ft.
   plant flow to clarifier = gal./day

$$\frac{\text{Plant flow to clarifier}}{\text{Clarifier surface area}} = \text{gal./day/sq. ft.}$$

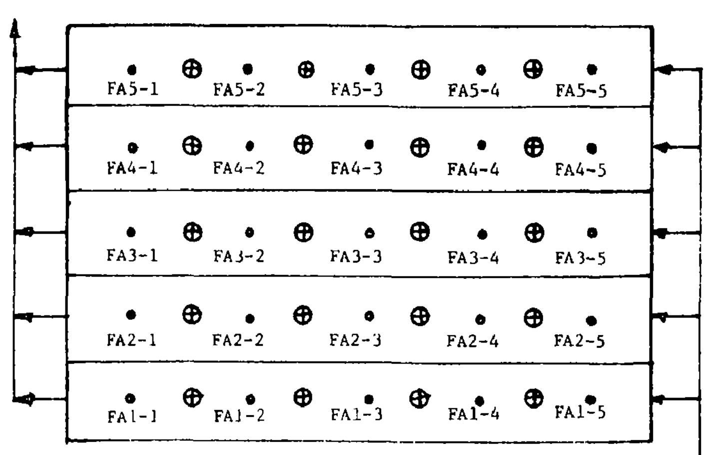
3. Weir Overflow Rate (gal./day/lin. ft.)
   Weir Length = ft.
   Plant flow to clarifier = gal./day

$$\frac{\text{Plant flow}}{\text{Weir length}} = \text{gal./day/lin. ft.}$$

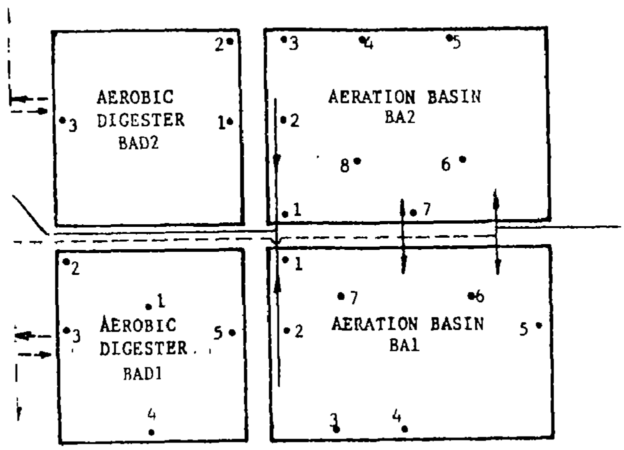
APPENDIX D
DISSOLVED OXYGEN DATA
FOSTER ST. WTP

DATE	TIME	STA.	DEPTH (ft.)	D.O. (mg/l)	TEMP. (°C)
7/20/76	1330	FA1-5	1	0.2	29
			3	0.25	
			5	0.5	
			8	0.3	
			B	0.0	
		FA2-5	1	0.2	
			5	0.2	
			9	0.1	
		FA3-5	1	0.1	
			5	0.0	
			9	0.0	
		FA4-5	1	0.2	
			5	0.0	
			9	0.0	
		FA5-5	1	0.2	
			5	0.1	
			9	0.1	
		FA1-3	1	0.2	
			5	0.1	
			9	0.1	
		FA2-3	1	0.2	
			5	0.1	
			9	0.1	
		FA3-3	1	0.2	
			5	0.1	
			9	0.0	
		FA4-3	1	0.25	
			5	0.2	
			9	0.1	
		FA5-3	1	0.2	
			5	0.1	
			9	0.2	
		FA1-1	1	0.2	
			5	0.2	
			8	0.1	
		FA2-1	1	0.2	
			5	0.1	
			9	0.0	
		FA3-1	1	0.2	
			5	0.1	
			9	0.0	
		FA4-1	1	0.2	
			5	0.1	
			9	0.0	
		FA5-1	1	0.2	
			5	0.1	
			9	0.0	29

DATE	TIME	STA.	DEPTH (ft.)	D.O. (mg/l)	TEMP. (°C)
7/21/76		FA1-5	1	0.3	28.5
			5	0.2	
			9	0.1	
		FA2-5	1	0.1	
			5	0.0	
			10	0.0	
		FA3-5	1	0.2	
			5	0.1	
			10	0.0	
		FA4-5	1	0.6	
			5	0.1	
			10	0.1	
		FA5-5	1	0.8	
			5	0.2	
			10	0.1	
		FA1-3	1	0.2	
			5	0.1	
			9	<0.1	
		FA2-3	1	0.2	
			5	<0.1	
			8	0.0	
		FA3-3	1	0.2	
			5	0.1	
		FA4-3	1	0.2	
			5	<0.1	
			10	<0.1	
		FA5-3	1	0.3	
			5	0.2	
			9	0.1	
		FA1-1	1	0.3	
			5	0.2	
			8	<0.1	
		FA2-1	1	0.1	
			5	<0.1	
			10	<0.1	
		FA3-1	1	0.2	
			5	0.1	
			10	<0.1	
		FA4-1	1	0.2	
			5	<0.1	
			10	<0.1	
		FA5-1	1	<0.1	
			5	<0.1	
			10	<0.1	



APPENDIX D
AERATION AND DIGESTER BASIN DISSOLVED OXYGEN
BAYOU CASSOTE, MS



Date 7/20/76 7/21/76

STATION #	TIME	TEMPERATURE	1 ft. DO	5 ft. DO	10 ft. DO			TIME	TEMPERATURE	1 ft DO	5 ft DO	14 ft DO
BA1 - 1	1400	29	0.0					1130	28	0.1	0.1	
BA1 - 2			0.2	0.1								
BA1 - 3			0.2	0.1								
BA1 - 4			0.2	0.0					28.5	0.2	0.1	
BA1 - 5			0.2	0.1						0.1	0.1	
BA1 - 6			0.2	0.1								
BA1 - 7			0.2	0.1								
BA2 - 1			0.1	0.0					29	0 2	0.1	
BA2 - 2			0.1	0.0								
BA2 - 3			0.2	0.0								
BA2 - 4			0.0	0.0						0.1	0.1	
BA2 - 5			0.0	0.0								
BA2 - 6			0.2	0.1								
BA2 - 7			0.2	0.1								
BA2 - 8			0.1	0.0						0.2	0.1	
BAD1 - 1		27.5	0 4	0.2	0.2							
BAD1 - 2			0.5	0.4								
BAD1 - 3			0.5	0.4				1200	27	0 4	0.2	
BAD1 - 4			0.5	0.3						0 5	0 4	
BAD1 - 5		27.0	0.4	0.3						0.5	0.2	
BAD2 - 1		26.5	4.2	4.0	3.9				26.5	4 3	4 3	4 0
BAD2 - 2			4.2	4.0								
BAD2 - 3			4.2	4 0						4.2	4.1	

APPENDIX E

OXYGEN UPTAKE PROCEDURE 1/

A. Apparatus

1. Electronic DO analyzer and bottle probe
2. Magnetic stirrer
3. Standard BOD bottles (3 or more)
4. Three wide mouth sampling containers (approx. 1 liter each)
5. DO titration assembly for instrument calibration
6. Graduated cylinder (250 ml)
Adapter for connecting two BOD bottles

B. Procedure

1. Collect samples of return sludge, aerator influent and final clarifier overflow. Aerate the return sludge sample promptly.

2. Mix the return sludge and measure that quantity for addition to a 300 ml BOD bottle that corresponds to the return sludge proportion of the plant aerator, i.e. for a 40% return sludge percentage in the plant the amount added to the test BOD bottle is:

$$\frac{300 \text{ X } .4}{1.0 + .4} = \frac{120}{1.4} = 86 \text{ ml}$$

3. Carefully add final clarifier overflow to fill the BOD bottle and to dilute the return sludge to the plant aerator mixed liquor solids concentration.

4. Connect the filled bottle and an empty BOD bottle with the BOD bottle adapter. Invert the combination and shake vigorously while transferring the contents. Re-invert and shake again while returning the sample to the original test bottle. The sample should now be well mixed and have a high D.O.

5. Insert a magnetic stirrer bar and the previously calibrated DO probe. Place on a magnetic stirrer and adjust agitation to maintain a good solids suspension.

6. Read sample temperature and DO at test time t=0. Read and record the DO again at 1 minute intervals until at least 3 consistent readings for the change in DO per minute are obtained (ΔDO/min). Check the final sample temperature. This approximates sludge activity in terms of oxygen use after stabilization of the sludge during aeration (unfed sludge activity).

7. Repeat steps 2 through 6 on a replicate sample of return sludge that has been diluted with aerator influent (fed mixture) rather than final effluent. This Δ DO/minute series reflects sludge activity after mixing with the new feed. The test results indicate the degree of sludge stabilization and the effect of the influent waste upon that sludge.

The load factor (LF), a derived figure, is helpful in evaluating sludge activity. It is calculated by dividing the DO/min of fed sludge by the DO/min of the unfed return sludge. The load ratio reflects the conditions at the beginning and end of aeration. Generally, a large factor means abundant, acceptable feed under favorable conditions. A small LF means dilute feed, incipient toxicity, or unfavorable conditions. A negative LR indicates that something in the wastewater shocked or poisoned the "bugs".

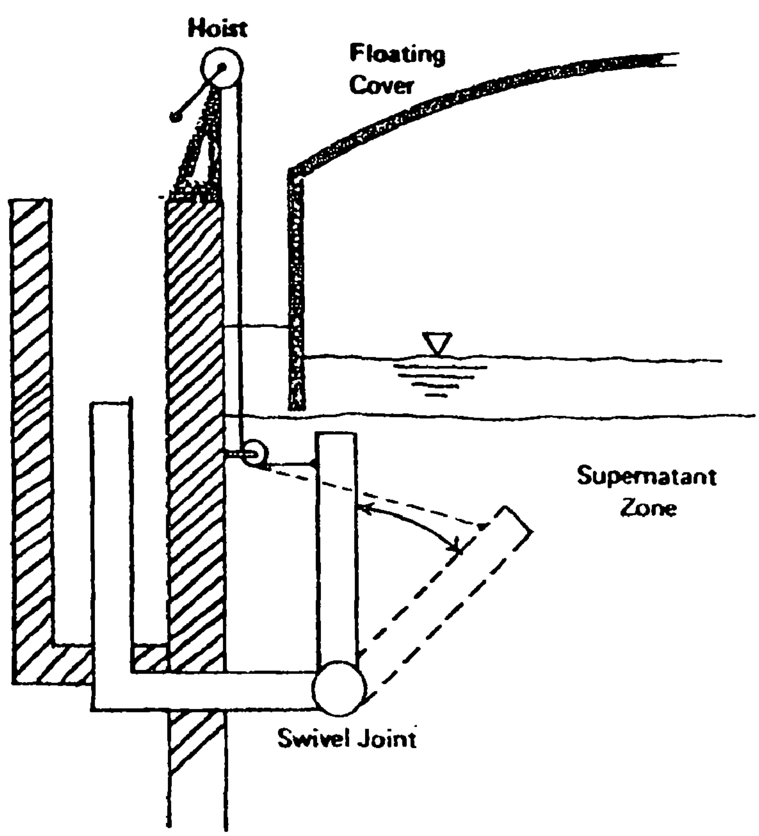
1/ Taken from "Dissolved Oxygen Testing Procedure," F. J. Ludzack and script for slide tape XT-43 (Dissolved Oxygen Analysis - Activated Sludge Control Testing) prepared by F. J. Ludzack, NERC, Cincinnati.

APPENDIX F

SUPERNATANT SELECTOR (11)

SUPERNATANT SELECTOR—An "operator-made" device was installed in an existing digester while it was down for repairs that helped draw the best possible supernatant even though liquid level varied.

A hoist was mounted on the tank wall and ¼" plastic coated boat control cable was attached to a section of movable supernatant pipe. A swivel joint composed of an ell and street ell allowed the draw-off point to be changed by operation of the hoist.



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