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TECHNICAL ASSISTANCE PROJECT
AT THE
INDUSTRIAL WASTEWATER TREATMENT PLANT
MOORESVILLE, NORTH CAROLINA

February, 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 Industrial Wastewater Treatment Plant (IWTP) serving primarily industrial waste sources in Mooresville, NC was conducted February 18-19, 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.

This plant was selected because of difficulty in achieving design treatment efficiencies. In addition, excessive solids are frequently lost in the effluent. The specific study objectives were to:

- Optimize treatment through control testing and recommended operation and maintenance modifications;
- 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, subsequent visits to the facility will be made. The follow-up assessment will determine if recommendations were successful in improving plant operations and if further assistance is required.

The cooperation of the North Carolina Department of Natural and Economic Resources is gratefully acknowledged. The technical assistance team is especially appreciative of the cooperation and assistance received from Mr. Troy Scoggins, Sr., Director of Public Works.

SUMMARY

The Mooresville, NC industrial wastewater treatment plant (IWTP) was designed as a 4 million gallon per day (mgd) extended aeration activated sludge facility; however, the average flow during the study was 2.65 mgd. Approximately 96 percent of the influent flow is from industrial sources, primarily textile mills. Waste sludge from the IWTP is discharged to the Mooresville municipal wastewater treatment plant for conditioning and disposal.

Mission accomplished bc extensive clean up prior to visit.

A few weeks prior to the technical assistance (TA) study, conditions at the IWTP were extremely poor. Two weeks of intensive clean-up and repair prior to the study significantly improved overall operation and treatment efficiency. Improvements included removing sludge accumulated in the clarifier and chlorine contact chamber and cleaning clogged influent ports along the clarifier rim-feed canal.

Lack of trained personnel was a major problem at the time of the study. The city has subsequently hired a new operator and is actively training treatment plant personnel. During the TA study, no in-plant control testing was performed; however, subsequent phone conversations indicate that control testing has been initiated.

Tremendous improvements have been made in improving treatment efficiency and plant operations during the past few months. Consistently high treatment efficiency can be achieved through continued effort by properly trained personnel.

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:

1. An in-plant control testing schedule should be initiated and trend charts established and maintained.
2. Operator and laboratory training should be emphasized and encouraged.
3. Additional personnel should be hired to provide daily operation and maintenance of the plant.
4. Influent bar screens need to be cleaned on a regular basis.

TREATMENT FACILITY

TREATMENT PROCESSES

A schematic diagram of the 4 mgd industrial wastewater treatment plant (IWTP) serving Mooresville, North Carolina is presented in Figure 1. Design data are enumerated in Table 1. The plant began operation in 1961 and was upgraded in 1973 to the existing extended aeration activated sludge facility.

PERSONNEL

Lack of trained employees to operate the plant and perform routine control testing is a major problem. As of March 18, 1976, the city had employed a new chief operator and was sending eight employees to an operator's training course.

FIGURE I
MOORESVILLE IWTP
MOORESVILLE, N.C.

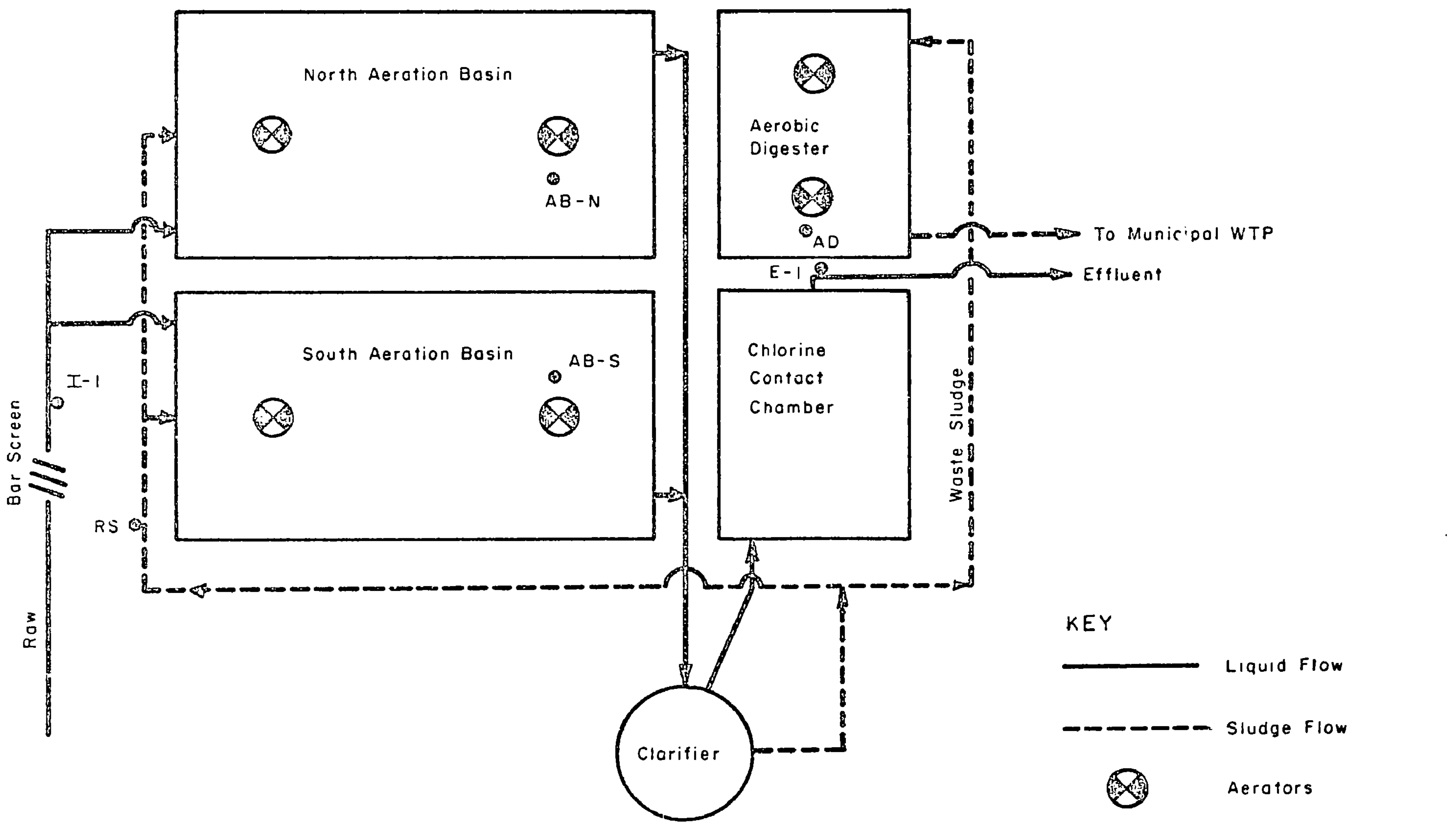


TABLE I
DESIGN DATA
INDUSTRIAL WASTEWATER TREATMENT PLANT
MOORESVILLE, NC

FLOW MEASUREMENT

Type	Parshall flume, recorder, totalizer
Size	18 in.
Location	Influent
Design Flow	
Avg.	4.0 mgd
Max.	8.0 mgd

AERATION BASINS

Number	2
Volume (each)	267,380 cu. ft. (2 m.g.)
Length	260 ft.
Width	120 ft.
Depth (water)	12 ft. (with side slope)
Detention	24 hrs.
Aerators	
Number	4
Size (each)	75 hp

CLARIFIER

Diameter	86 ft.
Sidewater Depth	12 ft.
Volume	69,600 cu. ft. (.52 m.g.)
Detention	3 hrs.
Overflow rate	700 gal/day/sf
Sludge recycle	
Number pumps	2
Capacity (each)	2800 gpm

AEROBIC DIGESTER

Volume	24,500 cu. ft. (0.18 m.g.)
Length	120 ft.
Width	84 ft.
Depth (water)	11 ft (with side slopes)
Aerators	
Number	2
Size (each)	25 hp

CHLORINATION FACILITIES

Chlorine Contact Tank	
Volume	16,500 cu. ft. (0.12 m.g.)
Length	120 ft.
Width	84 ft.
Depth (water)	9.5 ft.
Detention	45 min.
Chlorinators	
Number	2
Capacity	500 lbs/day

STUDY RESULTS AND OBSERVATIONS

A complete listing of all analytical data and 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 is measured with an 18-inch Parshall flume, recorder and totalizer. The flume was checked and found to be installed properly. The recorder and totalizer were determined to be recording accurately.

The average hourly flow into the plant during the study period was 2.65 mgd. The flow record for February 9-16, 1976 is presented in Appendix D. Typical weekday flows vary from approximately 6 mgd to 0.4 mgd. An estimated 96 percent of the influent wastewater is from industrial sources, primarily textile mills.

should have been pointed out in summary

The return sludge is not metered, however, practically all sludge is returned to the aeration basins.

WASTE CHARACTERISTICS AND REMOVAL EFFICIENCIES

Table II presents a chemical description of the influent and effluent with calculated percent treatment reductions shown for all parameters. Analyses were made on 24-hour composite samples.

TABLE II
WASTE CHARACTERISTICS AND REMOVAL EFFICIENCIES

Parameter	Influent (mg/l)	Effluent (mg/l)	% Reduction
BOD_5	133	8	94 – very good
COD	537	122	77 – not bad
Total Suspended Solids	92	12	87 – good
Volatile Suspended Solids	76	11	86
Total Solids	1,204	960	20 – dissolved?
NH_3-N	2.75	.20	93 excellent removal or reduction
NO_3-NO_2-N	<.01	1.30	--
TKN-N	11.6	2.92	75
Total Phosphorus	9.0	7.7	14
Lead	<.08	<.08	--
Chromium	<.08	<.08	--
Cadmium	<.02	<.02	--
Copper	.23	.08	65 – [illegible]
Zinc	.160	.275	0

The influent BOD_5/COD ratio of 0.25 and relatively low influent BOD_5 concentration reflects the primarily inorganic industrial nature of the influent wastewater. Hourly pH measurements ranged from 6.9 to 7.6 during the 24-hour composite sampling period.

AERATION BASINS

Grab samples were taken from each aeration basin at sampling locations designated AB-N and AB-S. Samples were analyzed for total suspended solids (TSS), volatile suspended solids (VSS), percent solids by centrifuge, and settleability as determined by the settlometer.

Dissolved oxygen (DO) concentrations were measured at two sampling stations in each aeration basin at one and ten foot depths. Concentrations ranged from 2.0 to 3.1 mg/l and did not vary significantly with depth.

The results of the settlometer test are presented in Figure 2. The settled sludge volume after 60 minutes of settling was 69 percent. Although the activated sludge did not settle and concentrate as well as would be desired, the supernatant was free of suspended material.

Presented in Table III are various activated sludge operational parameters calculated during the study period and the corresponding recommended values for the extended aeration activated sludge process.

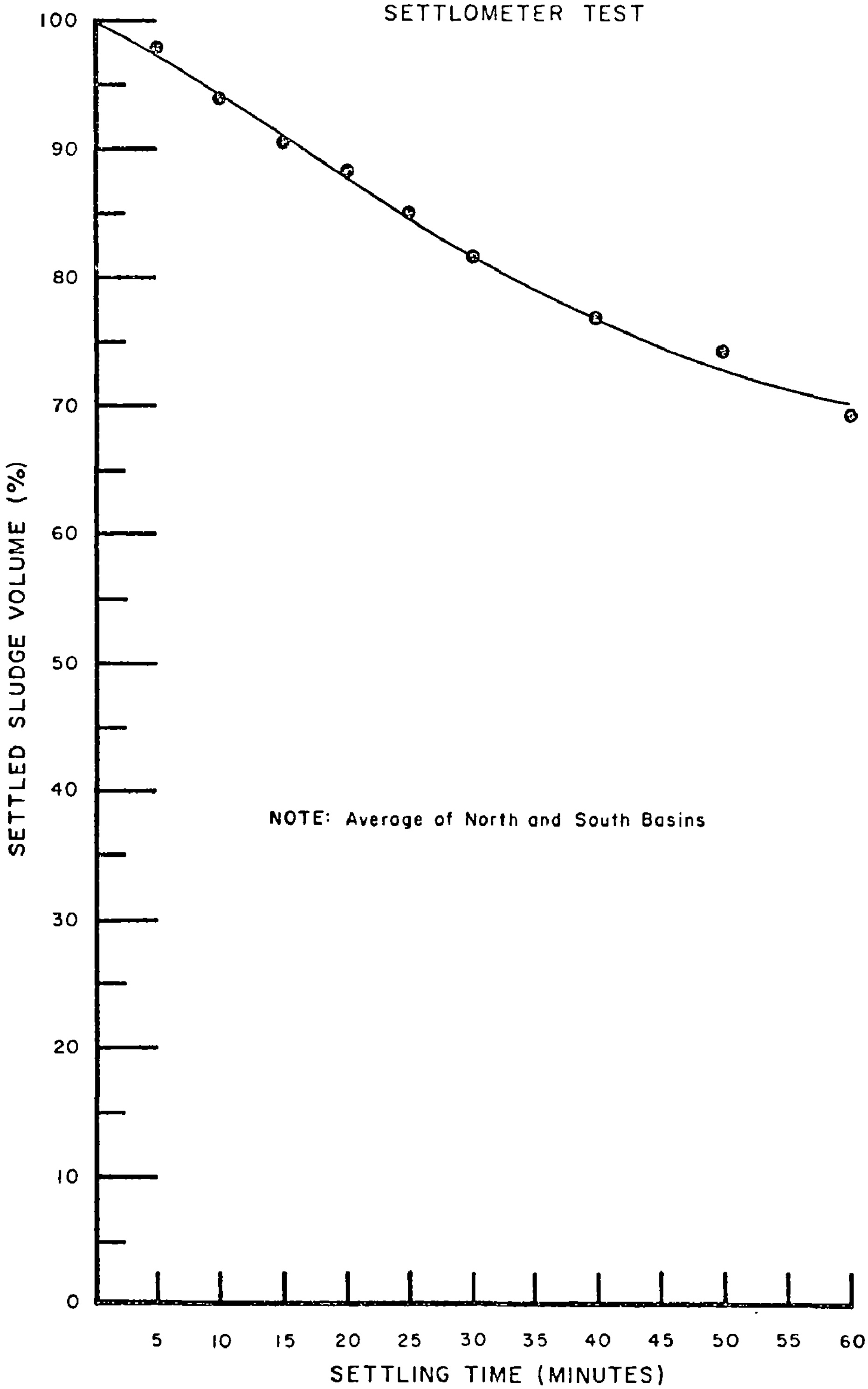
The food to microorganism (F/M) ratio was low due to the low BOD_5 concentration of the influent wastewater. The average mixed liquor suspended solids (MLSS) and mixed liquor volatile suspended solids (MLVSS) for the two aeration basins were 2412 and 1812 mg/l, respectively. The MLSS has been reduced to approximately 1900 mg/l since the TA study with no improvement in settleability.

TABLE III
MEASURED AND RECOMMENDED PARAMETERS FOR THE EXTENDED AERATION ACTIVATED SLUDGE PROCESS

	Measured	Recommended (3)(4)
Hydraulic Detention Time (hrs)	16	18-36
Sludge Age (days)	40	≥10
Lbs BOD_5/day/lb MLVSS (F/M)	.05	.05-.15
Lbs COD/day/lb MLVSS	0.2	<0.2
Lbs BOD_5/day/1000 cu. ft. of aeration basin	5.5	10-25
Return sludge rate (% of average flow)	unknown 1/	75-150

1/ - Return sludge could be estimated from the capacity of the 2800 gpm return sludge pump and a visual estimate of the waste sludge flow.

FIGURE 2
SETTLOMETER TEST



CLARIFIERS

The circular secondary clarifier has a rim feed, rim take-off flow configuration. On November 10, 1975 an O&M inspection revealed zero percent reduction in TSS and flooding of the influent rim-feed trough directly into the effluent trough due to the clogged influent ports. During the two weeks prior to the technical assistance study the clarifier was completely cleaned resulting in an immediate improvement in operation, as shown in Table I.

The measured and recommended parameters for a secondary clarifier following extended aeration activated sludge waste-sater treatment are presented in Table IV. Measured values in Table IV were calculated using the average flow (2.65 mgd) during the study and indicate adequate clarifier capacity. The hydraulic loading at design flow is high for a clarifier following extended aeration treatment.

TABLE IV
MEASURED AND RECOMMENDED PARAMETERS FOR CLARIFIERS FOLLOWING EXTENDED AERATION ACTIVATED SLUDGE TREATMENT

	Measured*	Recommended (1)(2)
Hydraulic Loading (gpd/sq. ft.)	456(688)	200-400
Solids Loading (lbs/day/sq. ft.)	9.2(14)	20-30
Hydraulic Detention (hrs.)	4.7(3.1)	2-3
Depth (ft.)	12	12-15

* () indicate values assuming the design flow of 4 mgd.

CHLORINE CONTACT CHAMBER

A few weeks prior to the TA study an excessive quantity of sludge had collected in the chlorine contact chamber resulting in anaerobic conditions and a tremendous chlorine demand. However, the chlorine contact chamber was subsequently cleaned out and was operating properly during the study.

AEROBIC DIGESTER

Waste activated sludge is conditioned in the aerobic digester and then discharged to the head of the municipal wastewater treatment plant. Dissolved oxygen in the digester was measured at the 1 and 14 foot depths and found to be 6.2 and 5.2 mg/l, respectively.

LABORATORY

Laboratory support for the IWTP is accomplished at the Mooresville Municipal WTP. The physical facilities are adequate; however, only limited testing is performed. An in-plant control testing schedule should be initiated immediately to include chemical and physical measurements, e.g. settlometer, clarifier sludge blanket depth and aeration basin TSS, VSS and DO. Trend charts should be established and maintained to include MLSS, settlometer, influent and effluent waste characteristics, flow, aeration basin DO, depth of clarifier sludge blanket and F/M ratios. These parameters should serve only as a guide and are intended to establish trends such that gradual changes in plant conditions can be noticed prior to a deterioration in effluent quality. All plant changes should be done one at a time and maintained for approximately two weeks to allow the plant to reach equilibrium.

Assistance in laboratory operations will be provided by the O&M technical assistance team upon request.

REFERENCES

1. "Process Design Manual for Suspended Solids Removal", US-EPA Technology Transfer, January 1975.

2. "Sewage Treatment Plant Design", American Society of Civil Engineers, Manual of Engineering Practice No. 36, 1959.

3. "Wastewater Engineering", Metcalf and Eddy, Inc., 1972.

4. "Operation of Wastewater Treatment Plants", A Field Study Training Program, US-EPA, Technical Training Grant No. 5TT1-WP-16-03, 1970.

APPENDIX A
LABORATORY DATA
INDUSTRIAL WASTEWATER TREATMENT PLANT
MOORESVILLE, NORTH CAROLINA

O+M SRD #	STATION	MONTH	DAY	YEAR	TIME	Suspended Solids mg/1	Volatile Suspended Solids mg/1	Total Solids mg/1	Total Volatile Solids mg/1	TKN-N mg/1	NH_3-N mg/1	NO_3-NO_2-N mg/1	Total-P mg/1	Pb μg/1	Cr μg/1	Cu μg/1	Cd μg/1	Zn μg/1	BOD 5 mg/1	COD mg/1	% Solids by Centrifuge(V/V)
	I-1	2	18 19	76	24 hr. comp.	92	76	1,204	230	11.6	2.75	<.01	9.0	<80	<80	230	<20	160	133	537	
	I-2	2	19	76	0930	152	84	--	--	--	--	--	--	--	--	--	--	--	218	--	
	E-1	2	18 19	76	24 hr. comp.	12	11	960	84	2.92	.20	1.30	7.7	<80	<80	80	<20	275	8	122	
	AB-S	2	18	76	1030	2,550	1,950	--	--	--	--	--	--	--	--	--	--	--	--	--	3.5
	AB-N	2	18	76	1030	2,275	1,675	--	--	--	--	--	--	--	--	--	--	--	--	--	3.1
	AD	2	18	76	1030	5,233	3,467	--	--	--	--	--	--	--	--	--	--	--	--	--	6.0
	RS	2	18	76	1030	4,167	3,067	--	--	--	--	--	--	--	--	--	--	--	--	--	6.0

APPENDIX B
GENERAL STUDY METHODS

To accomplish the stated objectives, the study included sampling, physical measurements and observations. Plant influent and effluent sample stations I-1 and E-1, respectively, were sampled for 24 hours 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 the sampling period.

Dissolved oxygen was determined in the aeration basins and aerobic digester using a YSI model 51A dissolved oxygen meter.

The plant flow totalizer was used to determine total daily flow and the recorder was used for hourly flows. Accuracy of the plant flow recorder and totalizer was checked with instantaneous readings from the parshall flume.

Water temperature was recorded while measuring the dissolved oxygen concentration. Individual samples from the 24-hour composite samples were used to determine hourly influent pH variation.

A series of standard operational control tests were run:

- Settleability of mixed liquor suspended solids (MLSS) as determined by the settlometer test;
- Percent solids of the mixed liquor and return sludge determined by centrifuge;
- Suspended Solids and Volatile Suspended Solids analysis on the aeration basin mixed liquor and return sludge.

Visual observations of individual unit processes were recorded.

Mention of trade names or commercial product does not constitute endorsement or recommendation for use by the Environmental Protection Agency.

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/l
   (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/l
   (BOD or COD) x flow x 8.34 = lbs. BOD or COD/day

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

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

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/l
   Basins Inf. COD conc. (avg. or daily value) = mg/l
   Plant Flow = mgd
   MLVSS conc. (avg. or daily value, note Volatile SS) = mg/l
   Basin Vol. = m.g.

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

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

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

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

Clarifier

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

$$\frac{(\text{clarifier Vol. (each)} \times 24}{\text{Plant flow to each clarifier}} = \text{hours}$$

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
INFLUENT FLOW