NATIONAL FIELD INVESTIGATIONS CENTER
CINCINNATI

AN EVALUATION
OF THE

HAGERSTOWN, MARYLAND
WATER POLLUTION CONTROL PLANT

NOVEMBER 1973

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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by

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Waste Treatment Branch

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SUMMARY

Representatives of the U. S. Environmental Protection Agency (EPA) National Field Investigations Center - Cincinnati visited the City of Hagerstown, Maryland, Water Pollution Control Plant on May 15, 1973, to observe and evaluate plant facilities and operation.

Analysis of plant records from January 1972 through April 1973 indicated that plant personnel had experienced difficulty in maintaining consistent effluent quality. Final effluent biochemical oxygen demand (BOD_5) and total suspended solids (TSS) averaged 19.2 mg/l and 57 mg/l, respectively, in 1972 and final effluent BOD_5 and TSS averaged 22 mg/l and 37 mg/l from January through April 1973.

Analysis of process loadings indicates that some units, particularly the primary clarifiers, were severely overloaded. High organic loads had been imposed upon the secondary system because of primary system deficiencies. Both the aeration tanks and final clarifiers were hydraulically overloaded during periods of sustained high flow.

Process control had been hampered by an overall lack of

flow meters and controls. The flow could not be distributed to the various units to maximize the efficiency of the secondary system, and return and waste sludge flows could not be accurately controlled.

Recommendations are presented for both immediate and long-range modifications to improve process control capability, to increase the capacity of the secondary system, and to upgrade final effluent quality.

INTRODUCTION

In response to a request by Mr. Herbert M. Sachs, Director, Water Resources Administration, State of Maryland, through the U. S. Environmental Protection Agency (EPA) Region III, representatives of the National Field Investigations Center - Cincinnati, Waste Treatment Branch, visited the City of Hagerstown, Maryland, Water Pollution Control Plant on Mary 15, 1973. The visit was conducted to observe and evaluate the operation of the Hagerstown plant in cooperation with the Maryland Environmental Service's program for resolving wastewater treatment problems.

Branch personnel inspected the facilities, reviewed the plant records, and discussed process control methods with plant personnel. At the conclusion of the visit, Branch personnel discussed their preliminary observations with representatives of the City of Hagerstown, plant personnel, and others.

Data from the plant records were subsequently analyzed to determine if modified process control procedures would improve effluent quality.

The plant records, including BOD_5, total suspended solids, and flow data, used in this analysis were provided by the Plant Superintendent. The dimensions and capacities of the various process units were provided by representatives of J. B. Ferguson Engineering, Inc. and Associates, consulting engineers for the City of Hagerstown.

On June 13, 1973, Branch personnel again met with the Maryland Department of Health and Water Resources Administration officials and representatives of the City to suggest immediate and future modifications to improve effluent quality.

PLANT DESCRIPTION

The Hagerstown Water Pollution Control Plant is located on Antietam Creek, a tributary of the Potomac River, and provides secondary treatment by the activated sludge process to the wastes generated by an estimated population of 43,500 people. Several small industries within the City also discharge wastewater into the collection system.

The treatment plant was constructed in 1924 and has been expanded several times since then; the most recent expansion was completed in 1964. At the time of the inspection, the plant included the following facilities:

1 - Communitor

1 - Aerated Grit Chamber

1 - Gravity-type Grit Chamber (standby)

2 - Pre-aeration Tanks

2 - Rectangular Primary Clarifiers

1 - Circular Primary Clarifier

2 - Aeration Tanks - 3 compartments each

1 - Aeration Tank - 2 compartments

2 - Square Final Clarifiers

2 - Circular Final Clarifiers

2 - Chlorine Contact Tanks

1 - Gravity Sludge Thickener

2 - Fixed Cover Anaerobic Digesters

2 - Floating Cover Anaerobic Digesters

1 - Sludge Storage/Aerobic Digestion Tank

A detailed list of all units including descriptions and tank capacities is appended (Tables A-3 and A-4).

The existing plant facilities were designed on the basis of an average flow of 30,280 cu m/day (8 mgd), but this figure had often been exceeded because of severe storm water infiltration throughout the collection system and periodic flow surges from industrial sources. In fact, the average raw wastewater flow for the month of April 1973 was 42,328 cu m/day (11.183 mgd). The City has taken steps to curtail infiltration and, according to City representatives, the various industries were cooperating in an effort to eliminate flow surges.

The consulting engineers stated that the plant had also been subject to some organic load fluctuations and at times excessive amounts of grease and oils in the raw waste. The consultant also indicated that the major sources of these wastes had been identified and were complying with the City's request to pretreat or eliminate such wastes before discharging into the collection system.

A partial flow diagram, Figure 1, illustrates the various units and the general flow pattern. In the primary system the raw waste is pre-aerated and then settled. The secondary system consists of two individual activated sludge systems each of which has separate final clarifiers and return sludge lines. The aeration tanks are equipped with swing-type air diffusers arranged in a spiral roll configuration. Some flexibility had been provided to enable several modifications of the flow pattern through the compartments of each tank.

Settled sludge from the final clarifiers is returned to the head of the aeration tanks, and a portion of the return sludge may also be diverted to the pre-aeration tanks to achieve some degree of pretreatment of the incoming waste. Excess sludge is drawn from each return sludge line to waste to the primary clarifiers. The effluent from the final clarifiers is chlorinated and discharged into Antietam Creek.

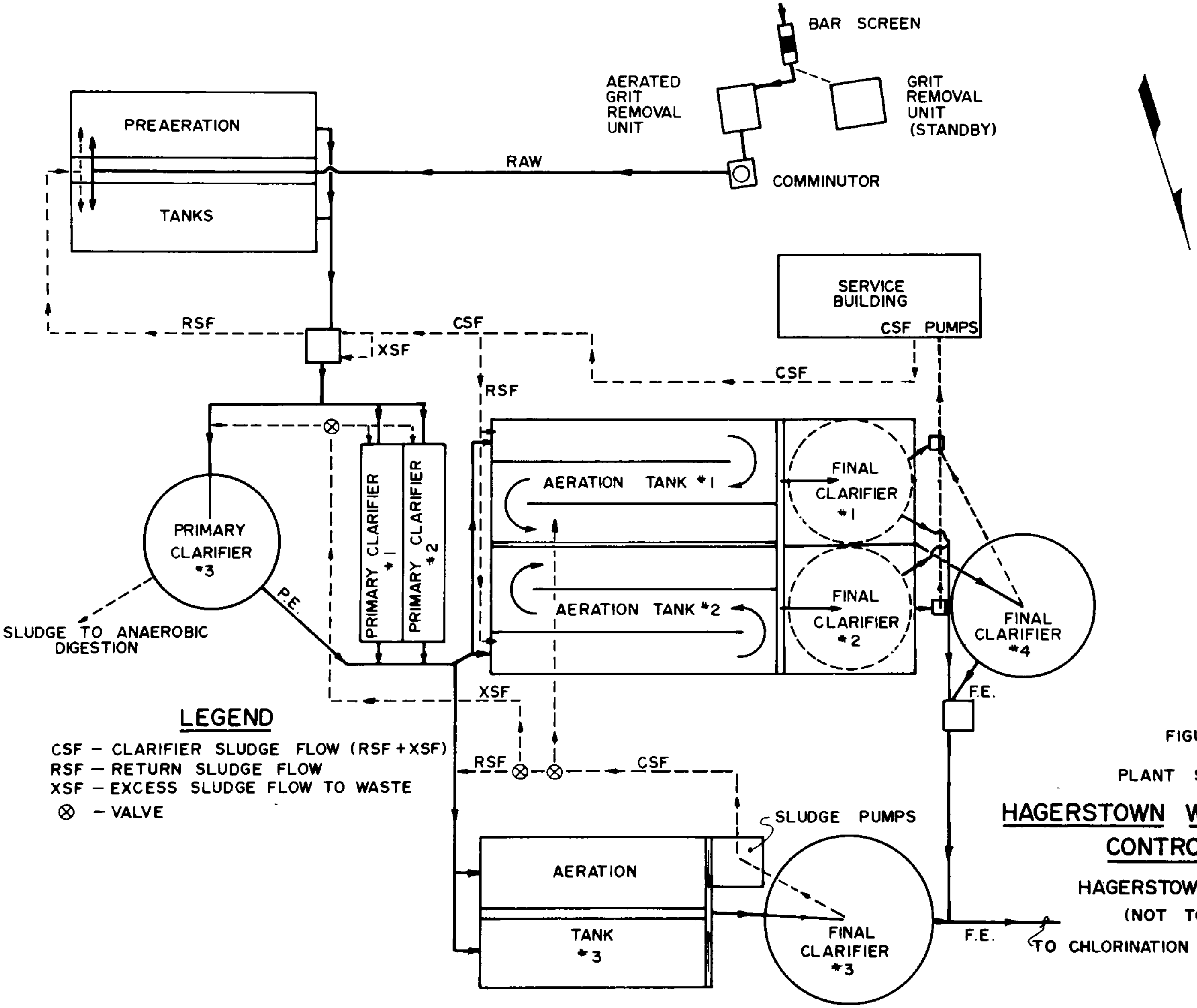

FIGURE 1

PLANT SCHEMATIC

HAGERSTOWN WATER POLLUTION CONTROL PLANT

HAGERSTOWN, MARYLAND

(NOT TO SCALE)

PLANT EVALUATION

Plant Performance

The efficiency of the primary and secondary systems and the overall plant in removing biochemical oxygen demand (BOD_5) and total suspended solids (TSS) is illustrated in Tables 1 and 2.

In 1972, final effluent BOD_5 and TSS averaged 19.2 mg/l and 57 mg/l; the corresponding plant removals were 85 percent BOD_5 and 30 percent TSS. From January through April 1973 final effluent BOD_5 and TSS averaged 22 mg/l and 37 mg/l which represented plant reductions of 79 percent and 54 percent, respectively. These data, particularly final effluent TSS, illustrate the difficulty the operators had in maintaining satisfactory effluent quality. The best overall TSS reduction was 80 percent, and the average effluent TSS exceeded plant influent TSS concentrations in four of the 16 months analyzed.

The primary treatment system operated inefficiently throughout this 16-month period. Primary effluent (PE) monthly average BOD_5 and TSS concentrations were greater than the corresponding plant influent values in every month except July 1972. The lack of efficient primary treatment resulted in high BOD and suspended

TABLE 1

BOD_5 AND TOTAL SUSPENDED SOLIDS, mg/l

HAGERSTOWN, MD., W.P.C.P.

Monthly Averages

MONTH		BOD Raw	BOD PE	BOD FE	TSS Raw	TSS PE	TSS FE
Jan.	1972	187	210	21.1	95	577	96
Feb.	"	118	161	22.3	81	388	89
Mar.	"	95	166	20.6	72	246	49
Apr.	"	120	204	24.9	75	975	76
May	"	95	201	8.6	67	950	44
June	"	100	129	14.2	62	1370	88
July	"	70	44	17.4	49	115	29
Aug.	"	147	176	25	78	365	39
Sept.	"	141	142	18.6	102	217	31
Oct.	"	201	226	18.1	120	1563	24
Nov.	"	170	619	14.3	98	2241	72
Dec.	"	82	316	25	72	956	51
AVG.(1972)		127	216	19.2	81	830	57
Jan.	1973	110	361	19	93	1235	45
Feb.	"	95	503	22	60	1749	25
Mar.	"	137	663	19	90	2835	28
Apr.	"	69	295	28	75	853	51
AVG.(1973)		103	456	22	80	1668	37

TABLE 2

BOD AND TOTAL SUSPENDED SOLIDS PERCENT REDUCTIONS

HAGERSTOWN, MD., W.P.C.P.

Monthly Averages

MONTH	B O D Primary* %	B O D Secondary %	B O D Plant %	T S S Primary* %	T S S Secondary %	T S S Plant %
Jan. 1972	NR**	90	89	NR	83	NR
Feb. "	NR	86	81	NR	77	NR
Mar. "	NR	88	78	NR	80	32
Apr. "	NR	88	79	NR	92	NR
May "	NR	96	91	NR	95	34
June "	NR	89	86	NR	94	NR
July "	37	61	75	NR	75	41
Aug. "	NR	86	83	NR	89	50
Sept. "	NR	87	87	NR	86	70
Oct. "	NR	92	91	NR	98	80
Nov. "	NR	98	92	NR	97	27
Dec. "	NR	92	70	NR	95	29
AVG. (1972)	NR	91	85	NR	93	30
Jan. 1973	NR	95	83	NR	96	51
Feb. "	NR	96	77	NR	99	58
Mar. "	NR	97	86	NR	99	69
Apr. "	NR	91	59	NR	94	32
AVG. (1973)	NR	95	79	NR	98	54

*Combined treatment by preaeration tanks and primary clarifiers.

**No Reduction. Months in which effluent BOD_5 and TSS values were greater than the corresponding influent values.

solids loadings on the secondary system which no doubt affected overall plant performance.

Process Loadings

The individual process units were evaluated by determining either the hydraulic or organic load, or both, for each unit.

The monthly average wastewater flows used to calculate the various process loadings are listed in Table 3. As noted previously, the engineer's design capacity for the primary and and secondary systems was based on an average flow of 30,280 cu m/day (8 mgd). The maximum daily flow (not shown in Table 3) recorded since January 1972 was 60,560 cu m/day (16 mgd) or double the design capacity.

The primary clarifiers were evaluated by calculating the hydraulic detention times and the surface overflow rates based on monthly average plant flows. Although excess sludge was also pumped to the primary clarifiers, this flow had not been measured and therefore was not included in this analysis. As illustrated in Table 4, the surface overflow rates exceeded the design rate of 40.7 cu m/day sq m (1,000 gal/day/sq ft) by as much as 100 percent. The increase in primary effluent BOD_5 and TSS concentrations over the plant influent values indicates that significant amounts

TABLE 3

INFLUENT FLOW

HAGERSTOWN, MD., W.P.C.P.

Monthly Averages

MONTH		INFLUENT FLOW (cu m/day)	INFLUENT FLOW (mgd)
Jan.	1972	21,011	5.551
Feb.	"	25,254	6.672
Mar.	"	31,154	8.231
Apr.	"	29,069	7.680
May	"	31,650	8.362
June	"	29,705	7.848
July	"	28,596	7.555
Aug.	"	18,418	4.866
Sept.	"	16,366	4.324
Oct.	"	15,185	4.012
Nov.	"	18,505	4.889
Dec.	"	33,259	8.787
AVG. (1972)		24,848	6.565
Jan.	1973	34,690	9.165
Feb.	"	43,433	11.475
Mar.	"	31,120	8.222
Apr.	"	42,328	11.183
AVG. (1973)		37,893	10.011

TABLE 4

PRIMARY CLARIFIER DETENTION TIMES AND SURFACE OVERFLOW RATES

HAGERSTOWN, MD., W.P.C.P.

Monthly Averages

MONTH	Detention Time (Hrs.) (Calculated at Average Flow)	Surface Overflow Rate* cu m/day/sq m (gal/day/sq ft)
Jan. 1972	1.6	47.3 (1161)
Feb. "	1.3	56.9 (1396)
Mar. "	1.0	70.2 (1722)
Apr. "	1.1	65.5 (1607)
May "	1.0	71.3 (1749)
June "	1.1	66.9 (1642)
July "	1.1	64.4 (1581)
Aug. "	1.8	41.5 (1018)
Sept. "	2.0	36.9 (905)
Oct. "	2.1	34.2 (839)
Nov. "	1.8	41.7 (1023)
Dec. "	1.0	74.9 (1838)
AVG. (1972)	1.4	55.9 (1373)
Jan. 1973	0.9	78.1 (1917)
Feb. "	0.8	97.8 (2400)
Mar. "	1.0	70.1 (1720)
Apr. "	0.8	95.3 (2340)
AVG. (1973)	0.9	85.3 (2094)

*Design overflow rate 1,000 gal./day/sq.ft.

of excess sludge were washed out of the primary clarifiers. The overloaded primary clarifiers not only reduced primary treatment efficiency, they also limited the ability to effectively waste excess sludge from the secondary system.

The aeration system was evaluated by determining the detention time provided by the aeration tanks (Table 5), the organic load imposed on the system (Table 6), and the quantity of air provided (Table 7). Each of the two individual secondary systems was evaluated separately whenever possible. Return sludge flow was not metered, therefore an estimate of 50 percent of the plant influent flow was used.

The detention time provided by the combination of Aeration Tanks Nos. 1 and 2 in parallel averaged as low as 3.5 hours at flow and 2.35 hours at total flow in February and April 1973. Since a minimum of six hours at flow and four hours at total flow are normally required to achieve adequate treatment, these results indicate that additional aeration tank capacity is needed to accommodate periods of sustained high flow. The differences in the detention times provided by those systems also indicate that the flow had not been proportioned between them to fully utilize the available aeration tank capacity.

The aeration tanks were also organically overloaded. As

TABLE 5

AERATION TANK DETENTION TIME

HAGERSTOWN, MD. W.P.C.P.

Monthly Averages

MONTH	Detention Time (Hrs.) (Calculated at Average Flow)		Detention Time (Hrs.) (Calculated at Flow + 50% Return)	
	Tanks 1&2	Tank 3	Tanks 1&2	Tank 3
Jan. 1972	7.9	9.9	5.3	6.6
Feb. "	6.4	8.9	4.3	5.9
Mar. "	5.3	6.9	3.5	4.6
Apr. "	5.8	6.8	3.9	4.5
May "	5.4	6.0	3.6	4.0
June "	5.6	6.7	3.7	4.5
July "	6.0	6.6	4.0	4.4
Aug. "	10.3	8.6	6.8	5.7
Sept. "	11.8	9.3	7.9	6.2
Oct. "	12.6	10.2	8.4	6.8
Nov. "	9.4	9.9	6.3	6.6
Dec. "	4.9	6.4	3.3	4.3
AVG. (1972)	7.6	8.0	5.1	5.3
Jan. 1973	4.6	6.6	3.1	4.4
Feb. "	3.5	6.1	2.4	4.0
Mar. "	5.4	6.5	3.6	4.3
Apr. "	3.5	6.8	2.4	4.5
AVG. (1973)	4.3	6.5	2.9	4.3

shown in Table 6, the organic load to the aeration tanks fluctuated drastically, and frequently exceeded the design loading of 641 g BOD_5/day/cum (40 lb BOD_5/day/1000 cu ft). The magnitude of those overloads, which were more than twice the design load of 1973, again emphasizes the need for additional aeration tank capacity.

The quantity of air provided to the aeration tanks was evaluated on the basis of both influent flow and BOD_5 load (Table 7). Based on the organic load, the amount of air supplied to the aeration tanks was at times below the minimum desired rate of 62.4 cu m air/kg BOD_5 (1000 cu ft air/lb BOD_5). These data indicate that additional blower capacity may be needed to insure adequate dissolved oxygen residuals in the aeration tanks at peak organic loads.

The monthly average surface overflow rates for the final clarifiers exceeded the design rate of 32.6 cu m/day/sq m (800 gal/day/sq ft) by as much as 50 percent as shown in Table 8. Overflow rates of this magnitude indicate that additional final clarifier capacity is needed to accommodate periods of high flow and to permit maintenance and repair of individual clarifiers without degrading effluent quality.

TABLE 6

ORGANIC LOAD TO AERATION TANKS*

HAGERSTOWN, MD., W.P.C.P.

Monthly Averages

MONTH	Based on PE BOD_5*	
	Tanks 1 & 2	Tank 3
Jan. 1972	638 (39.8)	511 (31.9)
Feb. "	606 (37.8)	436 (27.2)
Mar. "	760 (47.4)	577 (36.0)
Apr. "	842 (52.5)	721 (45.0)
May "	888 (55.4)	803 (50.1)
June "	555 (34.6)	460 (28.7)
July "	175 (10.9)	159 (9.9)
Aug. "	412 (25.7)	494 (30.8)
Sept. "	290 (18.1)	366 (22.8)
Oct. "	433 (27.0)	535 (33.4)
Nov. "	1576 (98.3)	1499 (93.5)
Dec. "	1542 (96.2)	1178 (73.5)
AVG. (1972)	726 (45.3)	644 (40.2)
Jan. 1973	1876 (117)	1331 (83)
Feb. "	3431 (214)	2004 (125)
Mar "	2950 (184)	2469 (154)
Apr. "	2004 (125)	1042 (65)
AVG. (1973)	2565 (160)	1715 (107)

*Based on PE BOD_5. gr BOD_5/day/cu m (lbs/day/1000 cu ft)

TABLE 7

ESTIMATED AIR SUPPLY TO AERATION TANKS*

HAGERSTOWN, MD., W.P.C.P.

Monthly Averages

MONTH	cu m Air/cu m Flow** (cu ft Air/gal Flow)	cu m Air/kg PE BOD 5*** (cu ft Air/lb PE BOD_5)
Jan. 1972	17.2 (2.3)	81.8 (1312)
Feb. "	14.2 (1.9)	88.2 (1414)
Mar. "	12.0 (1.6)	115.3 (1848)
Apr. "	12.7 (1.7)	62.4 (1000)
May "	11.6 (1.55)	57.6 (924)
June "	12.3 (1.65)	95.6 (1533)
July "	12.7 (1.7)	288.8 (4630)
Aug. "	20.2 (2.7)	114.7 (1838)
Sept. "	22.4 (3.0)	157.9 (2532)
Oct. "	23.9 (3.2)	105.9 (1697)
Nov. "	19.8 (2.65)	32.0 (513)
Dec. "	11.2 (1.5)	35.5 (569)
AVG. (1972)	15.7 (2.1)	103.0 (1651)
Jan. 1973	10.5 (1.4)	29.3 (469)
Feb. "	8.2 (1.1)	16.8 (269)
Mar. "	12.0 (1.6)	17.8 (285)
Apr. "	9.0 (1.2)	29.4 (471)
AVG. (1973)	9.7 (1.3)	23.3 (374)

* Plant personnel estimated that a supply of 255 cu.m/min (9000 cfm) was available for aeration tanks.

** Minimum desired rate: 7.5 cu.m air/cu.m (1.0 cu.ft. air/gal.)

*** Minimum desired rate: 62.4 cu.m air/kg. BOD_5 (1,000 cu.ft. air/lb. BOD)

TABLE 8

FINAL CLARIFIER DETENTION TIME AND SURFACE OVERFLOW RATE

HAGERSTOWN, MD., W.P.C.P.

Monthly Averages

MONTH	Detention Time (Hrs.) (Calculated at Flow + 50% Return)		Surface Overflow Rate* cu m/day/sq m (gal/day/sq ft)	
	Clar. 1, 2 & 4	Clar. 3	Clar. 1, 2 & 4	Clar. 3
Jan. 1972	2.3	2.4	22.0(541)	22.4(551)
Feb. "	1.8	2.2	27.3(670)	24.9(612)
Mar. "	1.5	1.7	33.2(814)	32.0(785)
Apr. "	1.7	1.6	29.9(734)	32.6(800)
May "	1.6	1.5	32.1(787)	36.8(904)
June "	1.6	1.6	31.2(765)	32.8(806)
July "	1.7	1.6	29.0(711)	33.3(817)
Aug. "	3.0	2.1	16.9(416)	25.8(634)
Sept. "	3.4	2.3	14.8(363)	23.7(581)
Oct. "	3.6	2.5	13.8(339)	21.7(533)
Nov. "	2.7	2.4	18.5(453)	22.3(548)
Dec. "	1.4	1.6	35.4(868)	34.3(843)
AVG. (1972)	2.2	2.0	25.3(622)	28.6(701)
Jan. 1973	1.3	1.6	37.6(924)	33.8(829)
Feb. "	1.0	1.5	49.3(1211)	36.5(897)
Mar. "	1.6	1.6	32.3(792)	34.3(842)
Apr. "	1.0	1.7	49.3(1210)	32.5(797)
AVG. (1973)	1.2	1.6	42.1(1034)	34.3(841)

* Design overflow rate: 800 gal/day/sq ft.

Discussion

The magnitude of the daily flow to the Hagerstown plant has fluctuated considerably and periods of sustained high flow have overloaded most of the process units. The primary clarifiers in particular were severely overloaded especially when they were used for excess sludge disposal.

The efficiency of the primary clarifiers cannot be determined since the influent to these units had not been analyzed for BOD_5 and TSS. However, primary effluent BOD_5 and TSS data indicate that there were deficiencies in the primary system (pre-aeration tanks and primary clarifiers). Primary effluent BOD_5 and TSS concentrations were usually greater than the corresponding plant influent values and this was undoubtedly due to the additional load imposed on the overloaded clarifiers by the excess sludge flow. It is apparent from PE BOD_5 and TSS data that significant quantities of excess sludge had been washed out of the primary clarifiers, and consequently the secondary system received excessive organic loads. This is particularly evident when the organic loads to the aeration tanks calculated from primary effluent BOD_5 data (Table 6) are compared to organic loads calculated from plant influent BOD_5 data in Table A-1. It must be noted that this comparison has not been made to minimize the importance of primary treatment but it has been made to emphasize the need for efficient primary treatment and excess sludge handling facilities to reduce the organic load to the secondary system.

Based on the primary effluent BOD_5 load, the quantity of air supplied to the aeration tanks (Table 7) was inadequate at times. Plant personnel indicated that two blowers capable of providing an additional 85 cu m air/min (3000 cu ft/min) were inoperable. The aeration system should have sufficient air to accommodate high organic loads if these blowers are made available.

The lack of operational control and flexibility in the secondary system created overwhelming operational problems. Flow meters, control gates, and valves to enable observation and adjustment of the flow entering the aeration tanks and final clarifiers of the separate secondary systems were not provided. Therefore, the flow could not be distributed between those systems to balance the load and maximize treatment efficiency.

Measuring and adjusting return sludge flow is difficult since flow meters and proper controls were not provided. All return pumps were constant speed and adjustments in the flow rate were made by throttling valves on either the pump intake or discharge lines. Since no meters were available only very coarse adjustments were possible.

Excess sludge was drawn directly from the return sludge lines to be wasted. Since separate waste sludge pumps and meters were not provided, accurate control of sludge wasting was difficult.

Although additional facilities may be required to meet future flow increases, modifications as suggested in the following section will provide needed flexibility and may alleviate operational difficulties.

RECOMMENDATIONS

Based on the previous analysis and discussion, the following recommendations are made regarding immediate modifications:

1. The Consulting Engineer should continue with plans to convert the two rectangular primary clarifiers into sludge holding/thickening tanks for excess waste sludge.
2. The circular primary clarifier should be converted into an additional final clarifier for the existing activated sludge system.
3. New pumps for pumping mixed liquor to and return sludge from the converted final clarifier should be provided with variable speed drives.
4. Meters and control valves should be installed to measure and control mixed liquor flow to the converted clarifier and return sludge flow from the clarifier.
5. Modification of the circular primary clarifier piping should also include plans for its future use as a final clarifier for an activated sludge system utilizing the existing pre-aeration tanks.

6. The two blowers, currently out of service, should be repaired to provide additional aeration capacity.

Recommendations for longer range modifications to make the existing facilities controllable and more flexible include:

1. Separate pumps and meters should be installed for excess sludge wasting.
2. Meters and valves or gates should be provided to measure and control:
    a. Sewage flow to each aeration tank.
    b. Return sludge flow to each aeration tank.
    c. Mixed liquor flow to each final clarifier.
    d. Return sludge flow from each final clarifier.
3. The Consulting Engineer should continue with plans to install a central meter and control panel to permit remote adjustment of valves and pumps while observing metered responses.
4. The installation of automatic density meter controllers should be considered to aid in sludge handling.
5. Plans should be prepared for constructing new primary sedimentation units to replace the inadequate units which were recommended for conversion previously.

Table A-2 illustrates the various detention times, loadings, etc., that could be expected if the existing pre-aeration tanks and circular primary clarifier were converted into another activated sludge system. It is apparent from these data that additional secondary system capacity and control capability will provide greater flexibility in balancing the load to the system as well as reducing the magnitude of the hydraulic and organic loads. A flow of 37,850 cu m/day (10 mgd), and an influent BOD_5 of 120 mg/l have been assumed. These assumptions are consistent with recent plant data.

APPENDIX

TABLE A-1

ORGANIC LOAD TO AERATION TANKS*

HAGERSTOWN, MD., W.P.C.P.

Monthly Averages

MONTH	Organic Load, g BOD_5/day/cu m(lb BOD_5/day/1000 cu ft)	
	Tanks 1 & 2	Tank 3
Jan. 1972	569 (35.5)	455 (28.4)
Feb. "	444 (27.7)	319 (19.9)
Mar. "	434 (27.1)	330 (20.6)
Apr. "	495 (30.9)	425 (26.5)
May "	420 (26.2)	380 (23.7)
June "	430 (26.8)	356 (22.2)
July "	281 (17.5)	255 (15.9)
Aug. "	345 (21.5)	412 (25.7)
Sept. "	290 (18.1)	366 (22.8)
Oct. "	383 (23.9)	475 (29.6)
Nov. "	433 (27.0)	412 (25.7)
Dec. "	401 (25.0)	306 (19.1)
AVG. (1972)	410 (25.6)	374 (23.3)
Jan. 1973	571 (35.6)	404 (25.2)
Feb. "	646 (40.3)	377 (23.5)
Mar. "	609 (38.0)	510 (31.8)
Apr. "	470 (29.3)	244 (15.2)
AVG. (1973)	574 (35.8)	383 (23.9)

* Based on Raw BOD_5

TABLE A-2

LOADING PARAMETERS FOR MODIFIED SECONDARY SYSTEM
HAGERSTOWN, MD., W.P.C.P.

PARAMETER	SYSTEM 1[a]	2[b]	3[c]
Avg. Flow to System - cu m/day(mgd)	20,818 (5.5)	9,463 (2.5)	7,570 (2.0)
Aerator Detention Time @ Flow (Hrs.)	5.7	6.1	7.6
Aerator Detention Time @ Flow + 50% Return Flow (Hrs.)	3.8	4.1	5.0
Organic Load to Aeration Tanks - g BOD_5/day/cu m (Lb. BOD_5/day/1000 cu ft)	503(31.4)	470(29.3)	382(23.8)
Clarifier Detention Time @ Flow + 50% Return Flow (Hrs.)	1.7	1.5	1.4
Clarifier Surface Overflow Rate - cu m/day/sq m (gal/day/sq ft)	30.4(745)	36.0(884)	34.2(840)

a) System 1 - includes existing Aeration Tanks 1 & 2 and Final Clarifiers 1, 2 & 4 (See Figure 1).

b) System 2 - includes existing Aeration Tank 3 and Final Clarifier 3 (See Figure 1).

c) System 3 - would include the existing Preaeration Tanks as the Aeration Tanks and Primary Clarifier 3 as the Final Clarifier modified as suggested in the Recommendations.

TABLE A-3

UNIT CAPACITIES (Metric)

HAGERSTOWN, MD., W.P.C.P.

AUGUST 1973

UNIT	NO.	REMARKS	DIMENSIONS, Meters	SURFACE AREA, sq m		VOLUME cu m	
				Per Unit	Total	Per Unit	Total
Grit Chamber	1	Aerated	5.49 L x 4.88 W x 3.87 D	26.79 sq m	26.79 sq m	103.6 cu m	103.6 cu m
	1	Gravity (Standby)	5.49 L x 5.49 W x 0.61 D	30.14	30.14	18.39	18.39
Preaeration Tanks	2	Diffused Air, Spiral-roll Plug Flow	28.96 L x 9.14 W x 4.57 D	264.69 sq m	529.38 sq m	1209.63 cu m	2419.26 cu m
Primary Clarifiers	2	Rectangular	22.86 L x 4.88 W x 3.05 D	111.56 sq m	223.12 sq m	340.26 cu m	680.52 cu m
	1	Circular, Center Fed	16.76 Dia. x 3.05 SWD	220.62	220.62	673.73	673.73
Aeration Tanks	2	3 Compartments per Tank Diffused Air, Spiral Roll	37.19 L x 4.88 W x 4.57 D (each compartment)	181.49 sq m (each compartment)	1088.94 sq m	829.41 cu m (each compartment)	4976.46 cu m
	1	2 Compartments, Diffused Air, Spiral Roll	28.96 L x 9.14 W x 4.57 D (each compartment)	264.69 sq m (each compartment)	529.38 sq m	1209.63 cu m (each compartment)	2419.26 cu m
Final Clarifiers	2	Square Surface with Circular Floors and Sludge Scrappers, Center Fed	15.24 L x 15.24 W x 3.05 SWD	232.26 sq m	464.52 sq m	708.39 cu m	1416.78 cu m
	1	Circular, Center Fed, Suction Sludge Collector	16.76 Dia. x 3.05 SWD	220.62	220.62	673.73	673.73
	1	Circular, Center Fed, Sludge Scrapper Mechanism	18.29 Dia. x 3.35 SWD	262.73	262.73	880.15	880.15
Chlorine Contact Tanks	2	6 Compartments per Tank	13.41 L x 18.59 W x 1.52 D	249.29 sq m	498.58 sq m	378.92 cu m	757.84 cu m
Sludge Thickener	1	Out of Service	6.10 Dia. x 3.05 SWD	29.22 sq m	29.22 sq m	88.92 cu m	88.92 cu m
Sludge Digesters	2	Anaerobic, Fixed Cover Coil Heated, Gas Mixed	15.24 Dia. x 7.47 SWD	N.A.*	N.A.	1501.38 cu m	3002.76 cu m
	2	Anaerobic, Floating Cover Coil Heated, Gas Mixed	15.24 Dia. x 6.86 SWD	N.A.	N.A.	1390.17	2780.34
	1	Aerobic Digestion/Holding Tank, Diffused Air	15.24 Dia. x 7.47 SWD	N.A.	N.A.	1501.38	1501.38

* Not Applicable.

TABLE A-4

UNIT CAPACITIES (English)

HAGERSTOWN, MD., W.P.C.P.

AUGUST 1973

UNIT	NO.	REMARKS	DIMENSIONS, Feet Each Unit	SURFACE AREA, sq ft		VOLUME, cu ft and/or Gals.	
				Per Unit	Total	Per Unit	Total
Grit Chamber	1	Aerated	18' L x 16' W x 12.7' I	288 sq ft	288 sq ft	3658 cu ft	3658 cu ft
	1	Gravity (Standby)	18' L x 18' W x 2' D	324	324 "	648	648
Preaeration Tanks	2	Diffused Air, Spiral-roll Plug Flow	95' L x 30' W x 15' D	2850 sq ft	5700 sq ft	42750 cu ft or 320,000 gals.	85500 cu ft or 640,000 gals.
Primary Clarifiers	2	Rectangular	75' L x 16' W x 10' D	1200 sq ft	2400 sq ft	12000 cu ft or 90,000 gals.	24000 cu ft or 90,000 gals.
	1	Circular, Center Fed	55' Dia. x 10' SWD	2376	2376	23790 cu ft or 178,000 gals.	23790 cu ft or 178,000 gals.
Aeration Tanks	2	3 Compartments per Tank Diffused Air, Spiral Roll	122' L x 16' W x 15' D (each compartment)	1952 sq ft (each compartment)	11712 sq ft	29280 cu ft or 219,000 gals. (each compartment)	175680 cu ft or 1.314 m gals.
	1	2 Compartments, Diffused Air, Spiral Roll	95' L x 30' W x 15' D (each compartment)	2850 sq ft (each compartment)	5700 sq ft	42750 cu ft or 320,000 gals (each compartment)	85500 cu ft or 640,000 gals.
Final Clarifier	2	Square Surface with Circular Floors and Sludge Scrappers, Center Fed	50' L x 50' W x 10' SWD	2500 sq ft	5000 sq ft	26063 cu ft or 195,000 gals.	52126 cu ft or 390,000 gals.
	1	Circular, Center Fed, Suction Sludge Collector	55' Dia. x 10' SWD	2376	2376	23790 cu ft or 178,000 gals.	23790 cu ft or 178,000 gals.
	1	Circular, Center Fed, Sludge Scrapper Mechanism	60' Dia. x 11' SWD	2827	2827	31100 cu ft or 232,700 gals.	31100 cu ft or 232,700 gals.
Chlorine Contact Tanks	2	6 Compartments per Tank	44' L x 61' W x 5' D	2684 sq ft	5368 sq ft	100,650 gals.	201,300 gals.
Sludge Thickener	1	Out of Service	20' Dia. x 10' SWD	314 sq ft	314 sq ft	23,500 gals.	23,500 gals.
Sludge Digesters	2	Anaerobic, Fixed Cover Coil Heated, Gas Mixed	50' Dia. x 24.5' SWD	N.A.*	N.A.	396,660 gals.	793,320 gals.
	2	Anaerobic, Floating Cover Coil Heated, Gas Mixed	50' Dia. x 22.5' SWD	N.A.	N.A.	367,280 gals.	734,560 gals.
	1	Aerobic Digestion/Holding Tank, Diffused Air	50' Dia. x 24.5' SWD	N.A.	N.A.	396,660 gals.	396,660 gals.

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*Not Applicable.