WRRC-2004-03

SCHOFIELD BARRACKS
WASTEWATER TREATMENT PLANT
OPTIMIZE AERATION, SECONDARY CLARIFIER, AND DISINFECTION PROCESSES
WRRC Report: WRRC-2004-03

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Prepared for:

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PREFACE

This project could not have been accomplished without the valuable help of the operating staff at the facility. It should be remembered that operating staff that took part in this from the beginning to the end contributed the most. We at the Water Resources Research Center, University of Hawaiʻi at Mānoa thank all the operators that contributed to the excellent effluent water quality that we were ultimately able to attain. We would also like to thank Mr. Russell Leong, Wastewater Program Manager, responsible for interacting with us, for all his tireless efforts to help improve the effluent water quality.

We had 2 individuals that were on the Army operating staff at the beginning, but were no longer with us after August 2001, that had blocked all the team efforts to improve the effluent water quality. Since their departure, the control strategies were continuously improving the effluent water quality.

The other negative impact on the facility effluent water quality was the toxic episodes that occurred throughout the project. It certainly seems the Schofield Barracks Army Command must step up to the plate and assist the operating staff at the facility by making it very clear to all activities under the Command that releasing toxic (illegal and/or unauthorized substances) materials into the collection system that discharges into the Schofield Barracks Wastewater Treatment Plant will not be tolerated and is punishable by law and that all laws will be strictly enforced.

Again, thank you for the opportunity to provide assistance in rectifying the Consent Order and providing a better environment for Hawaiʻi.

EXECUTIVE SUMMARY

The Water Resources Research Center, University of Hawai'i was given a grant to assist the operating personnel at the Schofield Barracks Wastewater Treatment Plant in improving the process control for the biological system to improve the bacteriological effluent water quality. The operating personnel were included in all process concepts that were used throughout the grant period. These included going from Phase I conventional process control to Phase II low DO process modification control to Phase III pseudo-anoxic selector process control.

With each process modification and control change the effluent water quality kept improving to the point that the State of Hawai'i, Department of Health closed out their Consent Order Docket Number 92-WW-EO-4 for the Schofield Barracks Wastewater Treatment Plant. This accomplishment was due to the concerted and diligent efforts of the operating personnel at the facility.

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The Directorate of Public Works, US Army Garrison - Hawai'i gave a grant to the Water Resources Research Center (WRRC), University of Hawai'i at Mānoa to evaluate the Schofield Barracks Wastewater Treatment Plant physical plant and operational capability to produce a reliable final effluent (water quality) that can meet the bacteriological quality required by the State of Hawai'i, Department of Health, Chapter 62 Wastewater Systems. This grant was passed through the US Army Corps of Engineers, Institute for Water Resources (2 percent Fee) and then through the US Geological Survey, Office of External Research (1 percent Fee) before coming to the University of Hawai'i at Mānoa, Office of Research Services.

INTRODUCTION

The Schofield Barracks Wastewater Treatment Plant (SBWWTP) had been having difficulty maintaining their final water quality discharging from the facility to the Waialua Sugar Irrigation System Ditch. The main challenge had been their bacteriological quality of 23 total coliform per 100 milliliter. The Army was under a Compliance Plan requiring several different Action Plans. Among these plans was the need to perform a research project to develop preventive and corrective maintenance tasks specific to the aeration basin, secondary clarifiers, and disinfection system to meet permit requirements.

The SBWWTP is located on Wheeler Army Air Field and services Schofield Barracks, Wheeler Army Air Field, Schofield Barracks East Range, and the Helemano Military Reservation. The liquid stream consists: preliminary treatment (screenings [2 mechanically cleaned screens], washing, and compaction [1 washer/compactor], and grit removal [2 grit channels and 2 grit washers]), equalization system (side-line operation - 6 basins with 4 pumps), primary clarification (continuous sludge withdrawal - 2 circular clarifiers), aeration basins (biological treatment - 6 basins with 6 [now only 3] feed points each), final clarification (liquid/solids separation - 3 circular clarifiers), sand-media filters (partial flow - 3 circular up-flow filters), disinfection (serpentine tank - chlorine), and effluent pumping (discharged to Waialua Sugar Irrigation System Ditch - 3 pumps). The solids stream consists: sludge thickening (primary sludge and waste activated sludge co-thickened - 1 dissolved air flotation thickener), sludge stabilization (anaerobic digestion - 3 tanks [2 primary and 1 secondary]), sludge dewatering (centrifugation - 2 centrifuges), and disposal (transportation to landfill - roll-off bins).

PURPOSE

The overall goal was to provide operational direction through the research to achieve compliance with Chapter 62 Wastewater Systems irrigation water bacteriological criteria while continuing to produce final effluent quality that complied with the secondary treatment requirements for BOD_5 (30 mg/l) and TSS (30 mg/l).

To achieve the goal of this research the following objectives were addressed:

- Research the chlorine disinfection effectiveness at the facility.
- Research the plant operational optimization for the secondary system.
- Provide troubleshooting assistance with the secondary and disinfection processes.

METHODS FOR ASSESSMENT

The process control methods and tools for the activated sludge facility can be separated into 1) pre-grant data gathering and 2) grant data gathering.

Pre-Grant Process Sampling (January 1, 1988 to December 31, 2000)

The plant personnel performed total suspended solids (TSS), volatile suspended solids (VSS), and pH tests on several process points in the plant (see Table 1 for details) to assist with making process decisions to control the activated sludge facility. They also conducted the sludge volume index (SVI - 30 minute) testing for referencing the MLSS settling characteristics as well.

Table 1 - Pre-Grant Process Samples

Location	Abbreviation	Sample nomenclature	Abbreviation
aeration basins	ABs	mixed liquor suspended solids	MLSS
RAS distribution tank	RAS DT	return activated sludge	RAS_{TSS}
effluent pumping station	EPS	effluent	Eff

Grant Process Sampling (January 1, 2001 to December 31, 2003)

The plant personnel performed the same tests and included others as we progressed through what became 3 phases (Phase I - January 1, 2001 to June 30, 2002, Phase II - July 1, 2002 to February 28, 2003, and Phase III March 1, 2003 to December 31, 2003) of control strategy for the activated sludge process. This also included recording settled volumes at 5, 10, 15, 30, and 60 minutes for the SVI test. The additional testing was gradually implemented into the routine laboratory testing.

Table 2 - Grant Process Samples

Location	Abbreviation	Sample nomenclature	Abbreviation
aeration basins	ABs	mixed liquor suspended solids	MLSS
aeration basins	ABs	filamentous rating	FR
aeration basins	ABs	microscopic rating	MR
final clarifiers	FCs	sludge blanket depth	SBD
final clarifiers	FCs	clarifier core sample	FC_{TSS}
RAS distribution tank	RAS DT	return activated sludge	RAS_{TSS}
effluent pumping station	EPS	effluent	Eff

All other testing that is reviewed for successful compliance with the Chapter 62 Wastewater Systems for influent and effluent water quality was performed by an outside (third party - Food Quality Laboratory) laboratory.

DISINFECTION PROCESS ADVICE PRIOR TO ON-SITE INTERACTION

The WRRC was asked for any recommendations that could be easily implemented to improve the disinfection effectiveness. It was pointed out that there was insufficient initial mixing between the secondary effluent and the chlorine solution in the beginning of the chlorine contact tank. It was suggested that a mixer and baffle be provided to be incorporated into a mixing chamber. This would provide the best opportunity for chlorine and microorganisms to come into contact improving the disinfection process. The results of this addition (installed March 2001) provided by the Army are best illustrated when looking at Figures 5 and 6. Figure 6 best illustrates the impact of the initial mixing with monthly median TC values all being less than 23 TC/100 ml.

PROCESS PERFORMANCE

The process control and resulting performance are separated into 1) all results (a performance summary of pre-grant and grant), 2) pre-grant results and 3) grant results. The facility has been using the AllMax Professional Solutions, Inc. Operator 10® Plus (Op10) Application to accumulate data since January 1, 1998. This database software has been valuable for recording, storing, and displaying data for all the time periods addressed in this report.

Performance Summary from January 1, 1998 to December 31, 2003

Prior to implementing the training and oversight for process control at the site, the facility was being operated with all 6 aeration basins (ABs) and all 3 final clarifiers (FCs) on-line. This had been the practice for many years with no modifications in the process control relative to number of operating ABs or FCs. The on-line tanks (ABs and FCs) are shown in Figure 1 that illustrates the changes from 6 ABs to 5 then 4 and 3 FCs to 2.

As can be seen in Figure 1, the 6 year period is separated into Pre-Grant (3 years) and the 3 years of the Grant broken down to the 3 control phases. Pre-grant used conventional control strategies operating within normal dissolved oxygen (DO) levels (2 - 3 mg/l), without automated DO control, using 6 aeration basins (ABs). Phase I used conventional control strategies operating within normal DO levels, without automated DO control, normally using 4 ABs. Phase II used a sludge reaeration control strategy with a low DO level (less than 0.5 mg/l) in Zone 3, with automated DO control. Phase III used an anoxic zone followed by 2 oxic zones controlling the DO in the Zone 3 with low to moderate DO levels (0.3 - 0.8 mg/l), with automated DO control. The AB and gate configurations for the pre-grant and 3 phases of the grant are shown in the Appendix A (Figures A1 - A4).

Performance is evaluated based on the effluent water quality while maintaining an environment in the activated sludge process that promotes a good flocculating, settling, and compacting sludge for the clarification step. The following figures (Figure 2 - BOD_5 Concentrations, Figure 3 - TSS Concentrations, Figure 4 - Total Coliform (TC) Densities from laboratory data, Figure 5- Times Exceeded 240 TC/100 ml, and Figure 6 - Monthly Median TC from laboratory data reduction) show the effluent water quality for this period. BOD_5, TSS and TC data show that the effluent water quality continued to improve over time with the best water quality during the last year and a half (July 1, 2002 to December 31, 2003. This shows the improvement differences that low DO control (Phase II) had over the conventional control (Phase I) and the stability that the pseudo-anoxic configuration (Phase III) provided beyond the low DO control.

Performance Summary Pre-Grant (January 1, 1998 to December 31, 2000)

As stated earlier, all the ABs (6) and FCs (3) were on-line pre-grant (refer to Figure A1). The facility performance was meeting the BOD_5 (30 mg/l) and TSS (30 mg/l), but not meeting the TC density (23 TC/100 ml - 30 day average and the 240 TC/100 ml - maximum). These performance results can be reviewed in Figures 7 through 11, which clearly show the non-compliant TC density data in Figures 9 to 11. Figure 10 shows that the 240 TC/100 ml was exceeded 78 times in 30 of 36 months and Figure 11 shows that the 23 TC/100 ml median was exceeded 21 of 36 months.

The conventional control strategies with all ABs and FCs on-line had the highest average BOD_5 (2.6 mg/l) and TSS (8 mg/l) values and the most variation in TC densities (21 months greater than 23 TC/100 ml median and 30 months with a density that exceeded 240 TC/100 ml). This inconsistency with the TC densities is the reason for the WRRC being brought in to work with the operating personnel and develop new operating strategies for the facility.

While operating strategies may have created circumstances that allowed the excursions in effluent water quality, it must be pointed out that there is a long history of indiscriminant discharge of harmful (toxic) elements into the collection system which have had anything from minor to very significant impact on the operating stability and effluent water quality from the facility. It is highly likely that these occurrences contributed to the lowest effluent water quality over the last 6 years.

Performance Summary Grant (January 1, 2001 to December 31, 2003)

Meetings with the operating personnel were conducted early in the Grant period to determine what changes could make improvements to the chlorination system so that it would disinfect better than previously (refer to Pre-Grant figures). Additional meetings were held to better understand personnel process knowledge and explore their desire to co-operate in establishing new protocols for the secondary system.

The Grant on-line AB tanks varied from a few days with 6 ABs, to a few more days with 5 ABs, and overwhelmingly with 4 ABs. Table 3 exhibits the number of tanks on-line for each Phase and the summary. As can be easily seen, Phase II and III used 4 ABs and 2 FCs almost exclusively. The changes for the on-line ABs was mainly due to recovery from toxic episodes the impacted the biological process and needed some process modifications to improve the return to normal operations.

Table 3 - Grant On-line Tanks Days

			ABs, number				FCs, number	
Phase	Days	Months	6	5	4	3	3	2
All	1,095	36	19	70	920	86	382	713
I	546	18	15	51	421	59	382	164
II	243	8	4	11	228	0	0	243
III	306	10	0	8	271	27	0	306

The ABs and gate configurations for the 3 phases of the grant are shown in the Appendix A (Figures A2 - A4). These differences were based on the agreed upon process strategies as they were developed to improve the effluent water quality in order to meet the bacteriological requirements (23 TC/100 ml 30-day median and 240 TC/100 ml maximum).

Figure 12 shows the on-line ABs and FCs during the 3 phases. The availability of the created excess ABs were very helpful during toxic episodes, so that the 5th and 6th (rarely Phase I and II) ABs could provide tankage during recovery to normal operations.

Figure 13 shows the BOD_5 results, which displayed decreasing and more consistent results as the operating strategies moved from Phase I to Phase II and then to Phase III. This also occurred for the TSS results as shown in Figure 14. It should be noted that increased troop preparations for overseas duty increased the frequency and intensity of the toxic episodes that occurred from September through December resulting in higher BOD_5 and TSS effluent water quality.

Figure 15 shows the effluent TC densities that were clearly inconsistent. Figure 16 shows that the 240 TC/100 ml was exceeded 25 times in 13 of 18 months during Phase I, with 1 very questionable (BOD_5 and TSS both = 1 mg/l) exceeder in 1 of 10 months during Phase III. Figure 17 shows that the 23 TC/100 ml median was only exceeded 2 of 18 months during Phase I and none in Phases II and III.

Performance Summary Phase I (January 1, 2001 to June 30, 2002)

During Phase I, the process strategy was to increase the mixed liquor (ML) concentration from 800's mg/l to the 1,000s mg/l by reducing the number of ABs on-line. The ABs and gate configuration is shown in Figure A2 (Appendix A) and the Figure 18 shows the on-line ABs and FCs during Phase I. As can be seen in this figure the 4 ABs and 2 FCs was settled on during this phase (utilizing only the necessary tankage to maintain the best effluent water quality). Figure 19 shows the gradual improving consistency and decreased BOD_5 concentrations, while Figure 20 shows the gradual improving consistency and decreased TSS concentrations. Figure 21 shows the TC densities with 25 samples greater than 240 TC/100 ml, Figure 22 shows that the 240 TC/100 ml was exceeded 13 of 18 months, and Figure 23 shows that the 23 TC/100 ml median was exceeded 2 of 18 months. There was improvement throughout Phase I, but not enough to properly meet the bacteriological requirements.

Performance Summary Phase II (July 1, 2002 to February 28, 2003)

During Phase II, only 2 FCs were used and the 5th and 6th ABs were only used to recover from toxic episodes (see Figure 24). An on-line dissolved oxygen (DO) probe and control loop with 1 of the blowers was implemented as part of this phase to control the DO at the effluent end on 1 of the ABs. This allowed the control strategy to change the feed to the ABs and control the DO to a low value (0.25 mg/l) to reduce nitrification in the ML effluent (see Figure A3 - Appendix A for ABs and gate configuration). This reduction in nitrification suppressed the de-nitrification problems that were being observed in the FCs during the previous control strategies.

Figure 25 shows the gradual improving consistency and decreased BOD_5 concentrations, while Figure 26 shows the gradual improving consistency and decreased TSS concentrations. Figure 27 shows the TC densities with no samples greater than 240 TC/100 ml and only 8 greater than 23 TC/100 ml, Figure 28 shows that the 240 TC/100 ml was not exceeded, and Figure 29 shows that the 23 TC/100 ml median was not exceeded. There was sufficient improvement throughout Phase II that the bacteriological requirements were properly met.

As part of the phase, operational guidelines (see Appendix B - Table B1 Phase II Low DO Operational Guidelines) were developed with the operating personnel with the intent to be used with proper judgment in making process changes to maintain good effluent water quality while creating good flocculating, settling and compacting sludge.

Performance Summary Phase III (March 1, 2003 to December 31, 2003)

Phase III like Phase II used only 2 FCs and only used a 5th AB as part of the recovery from using only 3 ABs (see Figure 30). The facility could have operated on only 3 ABs, if aeration system (blower and diffusers) could provide sufficient air. The increased diffuser pressure loss, due to the 25 percent reduction of diffusers, limited the air capacity of the blower. Even using a second blower (which would approach surge conditions) was unsuccessful in delivering sufficient air to maintain the desired DO for operations. It was decided during Phase II to try a pseudo-anoxic process as the next phase in control strategies. This means that the zone 1 (each AB has 3 zones from influent to effluent) would have very limited air provided (only enough to support some mixing) and zone 2 and 3 would have all air available based on DO control (see Figure A4 - Appendix A for ABs and gate configuration). This process modification brought the most stable control and effluent water quality of all the phases.

Figure 31 shows the improved consistency and low BOD_5 concentrations, while Figure 32 shows the improved consistency and low TSS concentrations. These values were elevated from mid-September through December because of the troop activities (which included preparation for off-site training and return cleanup from off-site training) bringing toxic elements to the facility impacting the biological process sufficiently to deteriorate the effluent water quality as seen in the 2 figures. Figure 33 shows the TC densities with one sample greater than 240 TC/100 ml (it is very difficult to accept the result - 1,400 TC/100 ml - on June 17, 2003 with both BOD_5 and TSS = 1 mg/l) and only 3 others greater than 23 TC/100 ml, Figure 34 shows that the 240 TC/100 ml was exceeded only that once, and Figure 35 shows that the 23 TC/100 ml median was not exceeded. There was sufficient improvement throughout Phase III that the bacteriological requirements were properly met.

As part of the phase, operational guidelines (see Appendix B - Table B2 Phase III Anoxic Operational Guidelines) were developed with the operating personnel with the intent to be used with proper judgment in making process changes to maintain good effluent water quality while creating good flocculating, settling and compacting sludge.

CONCLUSIONS

Throughout this project the team effort that was provided by all parties involved in maintaining the best effluent water quality was excellent and made possible the outcome we had. There are several conclusions that can be stated.

- Initial mixing in the chlorine contact tank improved the disinfection process such that the microbial effluent water quality was improving as the TSS effluent water quality continued to improve during the grant period.

- Phase I, conventional process control with 4 ABs on-line, no automated DO control showed improvements (microbial more than the BOD_5 or TSS - see Figures 2, 3, and 6) over the pre-grant process control with 6 ABs on-line and no automated DO control.

- Phase I, conventional process control with 4 ABs on-line, with automated DO control showed much better improvements (microbial and BOD_5 more than the TSS - see Figures 13, 14, and 17) over the Phase I no automated DO control.

- Phase II, sludge reaeration process control with 4 ABs on-line, with automated DO control showed very good improvement (microbial and BOD_5 more than the TSS - see Figures 13, 14, and 17) over the Phase I with automated DO control.

- Phase III, anoxic zone process control with 4 ABs on-line, with automated DO control showed the best improvements for BOD_5, TSS, and microbial (see Figures 13, 14, and 17) effluent water quality and also seemed to dampen toxic episode events compared to the other control strategies (the dampening effect should not be relied on, the toxic sources need to be found and controlled properly at their point of origin).

- Toxic episodes persisted throughout the grant period causing degradation in the effluent water quality (most effected was the TSS) best illustrated by the TSS spikes (see Figure 3) throughout the six-year period looked at for this report.

- The biological process at the facility recovers quite well under the circumstances of the toxic episodes, but the toxic episodes should be eliminated as soon as possible.

RECOMMENDATIONS

The following are recommendations that should be considered by the operating staff at the facility whether Army civil service or others.

- Operate the facility in the anoxic zone process control strategy as it seems to dampen toxic episodes and under all normal conditions provide the best effluent water quality.

- Increase the return activated sludge pumping capability for FC 3, each pump should be able to pump at least 1,800 gpm to 2,000 gpm.

- Develop a control strategy for the equalization basin that increases the average flow through the plant during wet weather events.

- Develop a control strategy for the equalization basin for normal flow that ranges from 1.5 to 4.2 mgd capitalizing on the minimum number of cells that must be on-line.

- As a *last resort* during a wet weather event when the equalization basin is becoming full and the high incoming flow must be passed through the plant, consider closing Gate 1 and opening Gate 5 on each on-line AB and turn off the blower/s providing aeration air (remember this is a *last resort*).

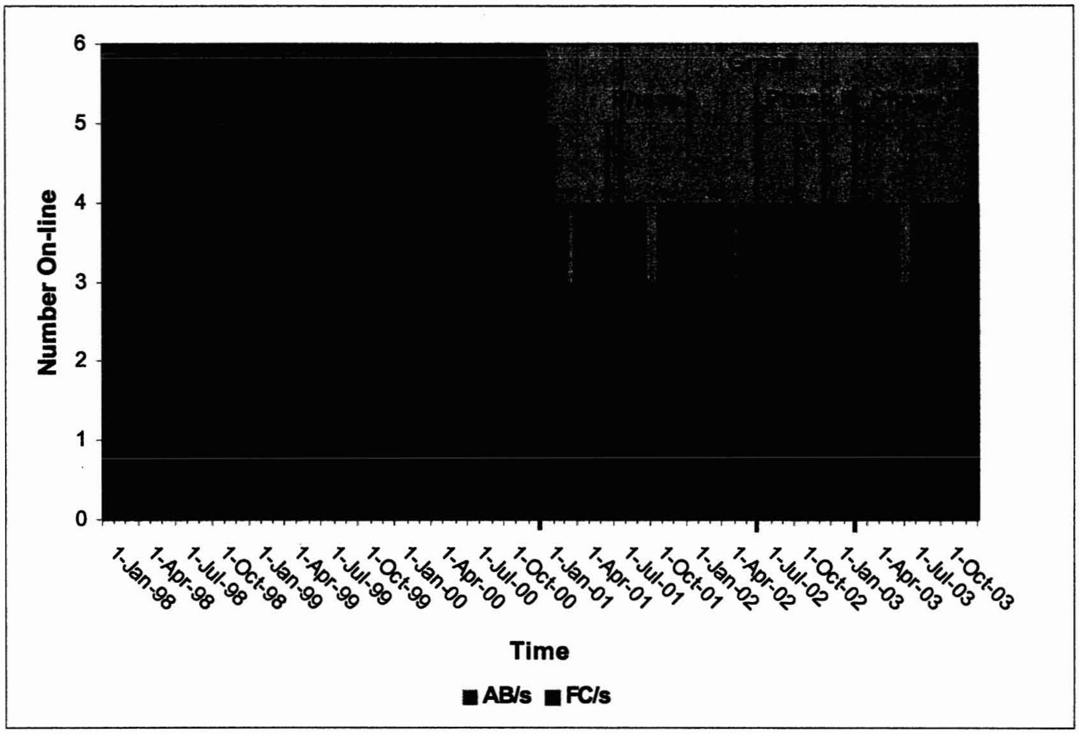

Figure 1 - On-line Tanks from January 1, 1998 to December 31, 2003

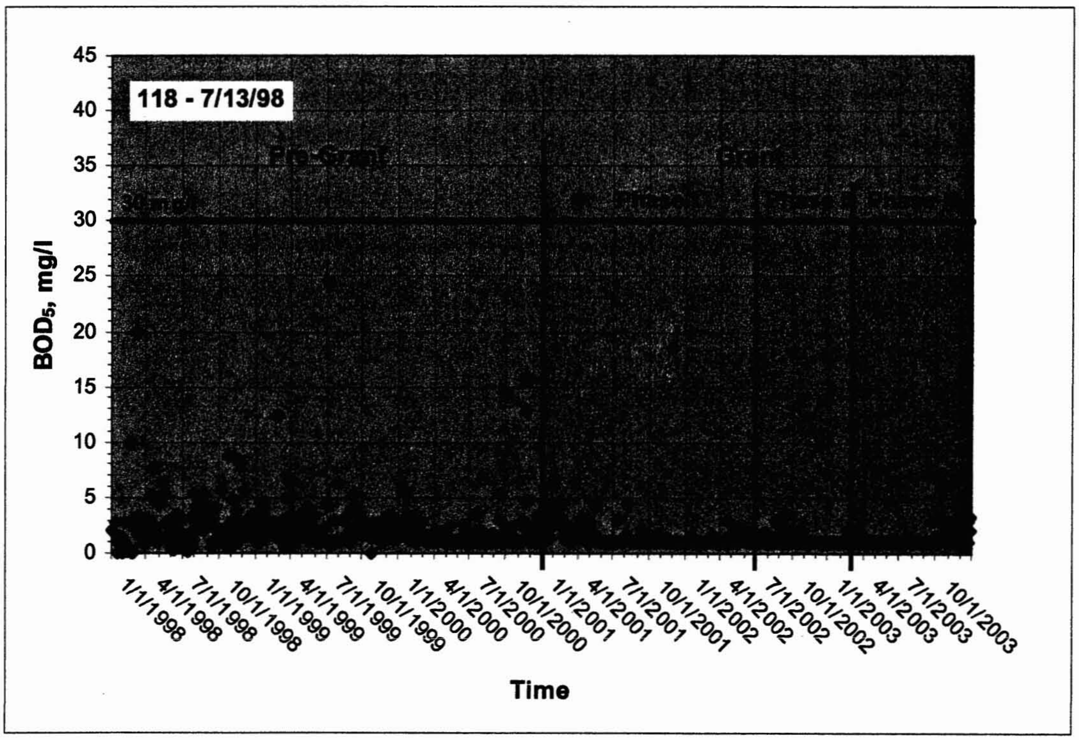

Figure 2 - Effluent BOD_5 Concentrations from January 1, 1998 to December 31, 2003

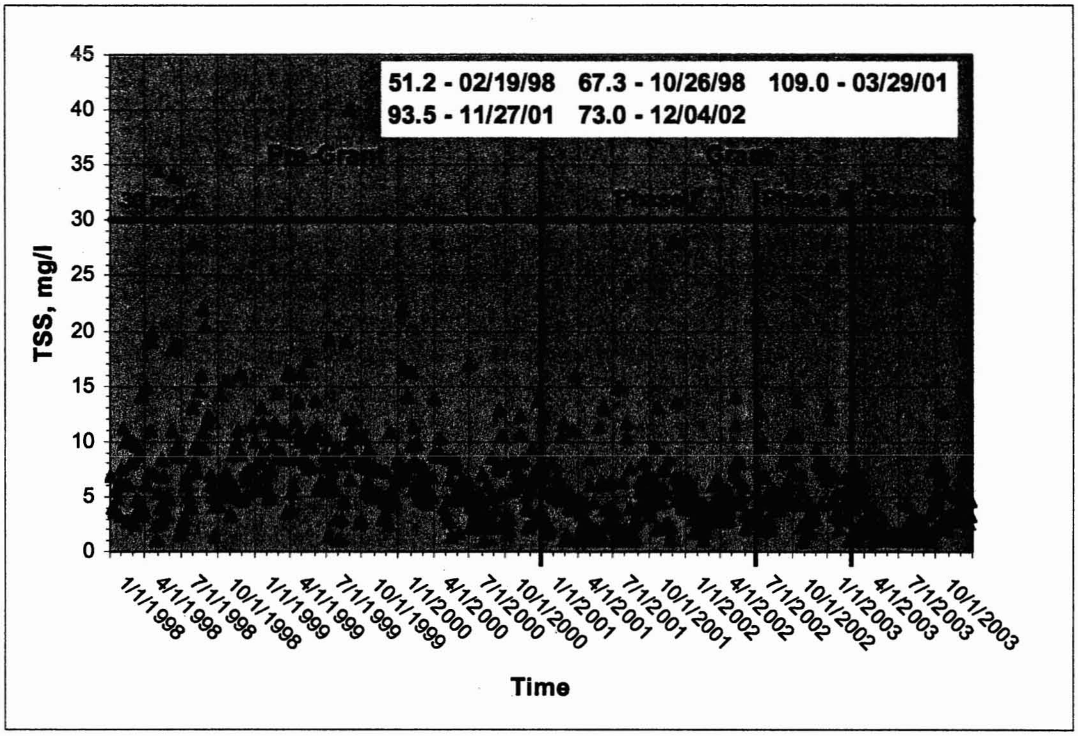

Figure 3 - Effluent TSS Concentrations from January 1, 1998 to December 31, 2003

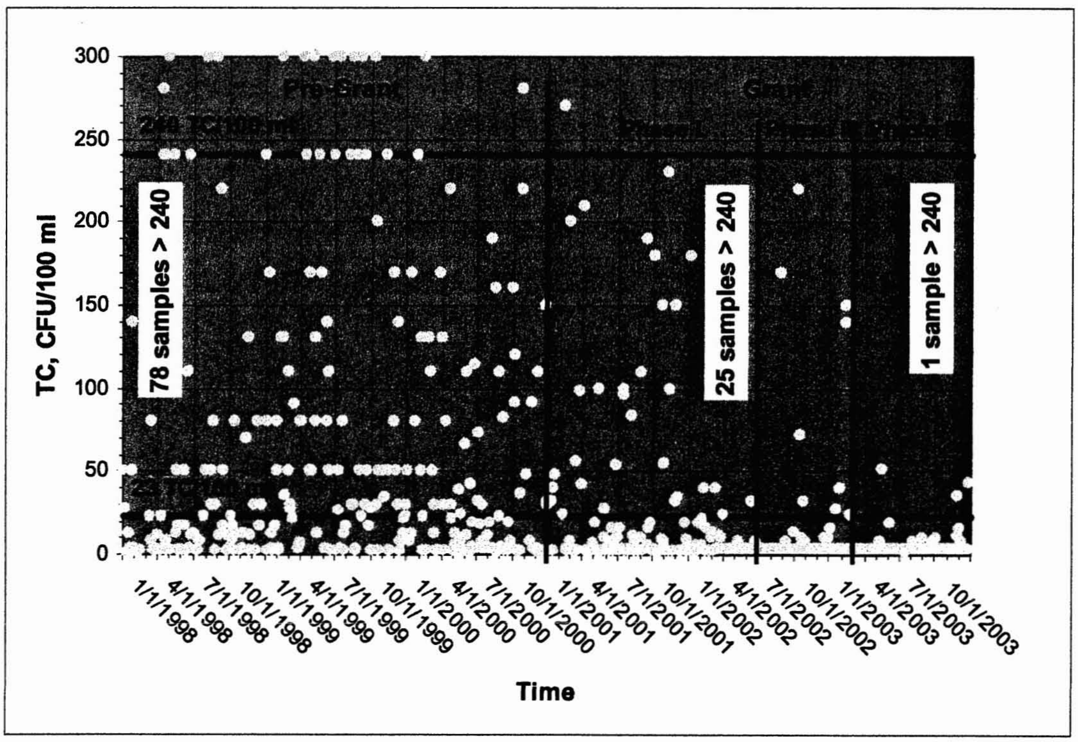

Figure 4 - Effluent Total Coliform Densities from January 1, 1998 to December 31, 2003

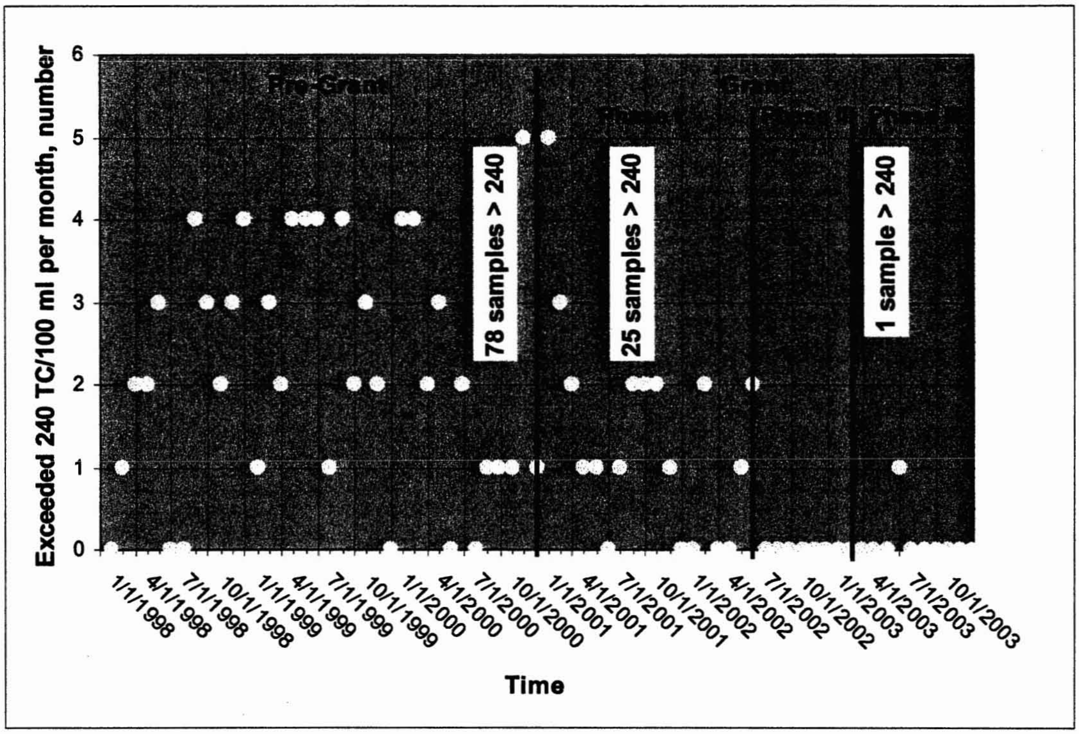

Figure 5 - Times Exceeded 240 TC/100 ml from January 1, 1998 to December 31, 2003

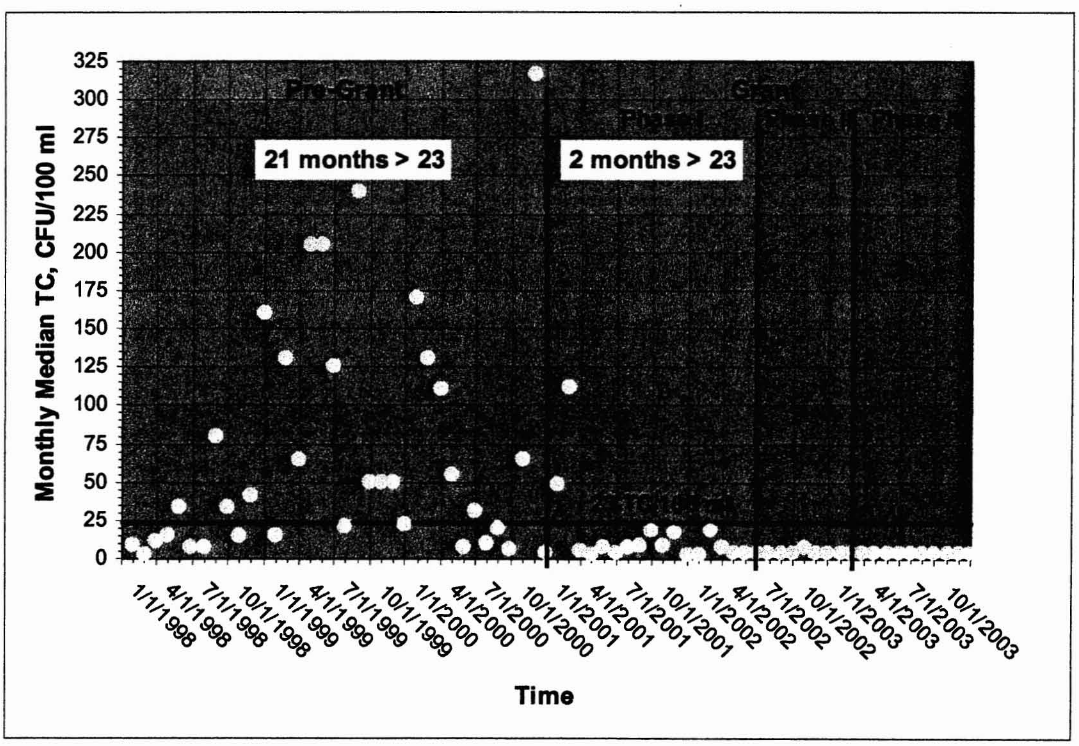

Figure 6 - Monthly Median TC from January 1, 1998 to December 31, 2003

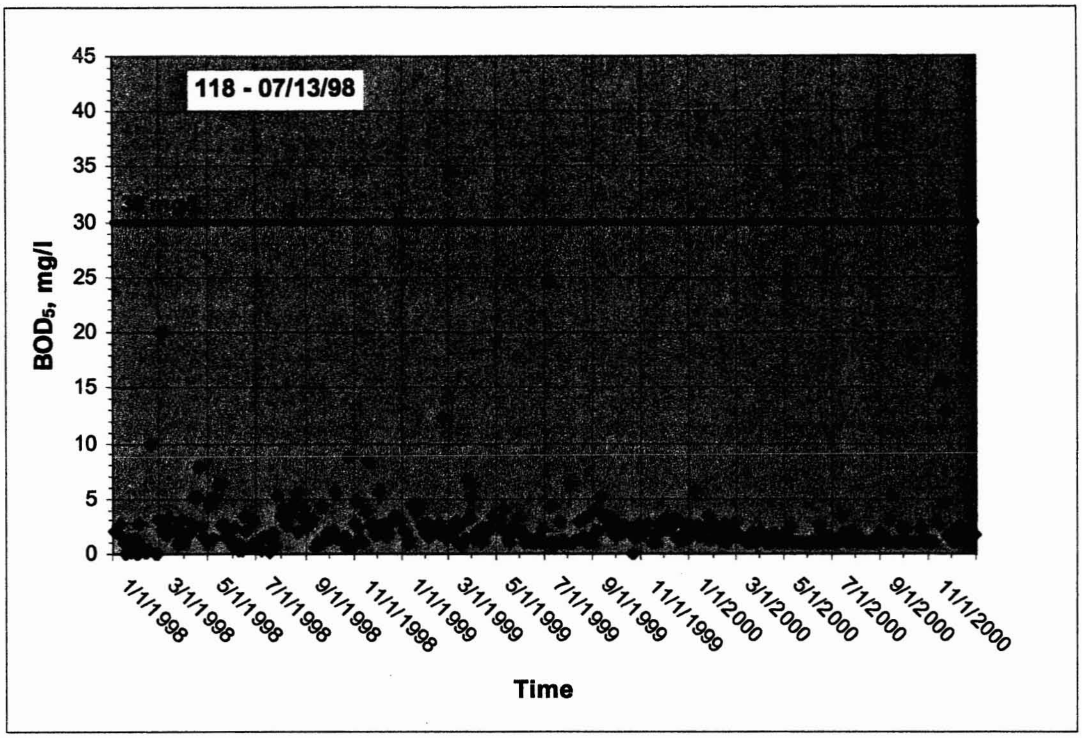

Figure 7 - Pre-Grant Effluent BOD_5 Concentrations (January 1, 1998 to December 31, 2000)

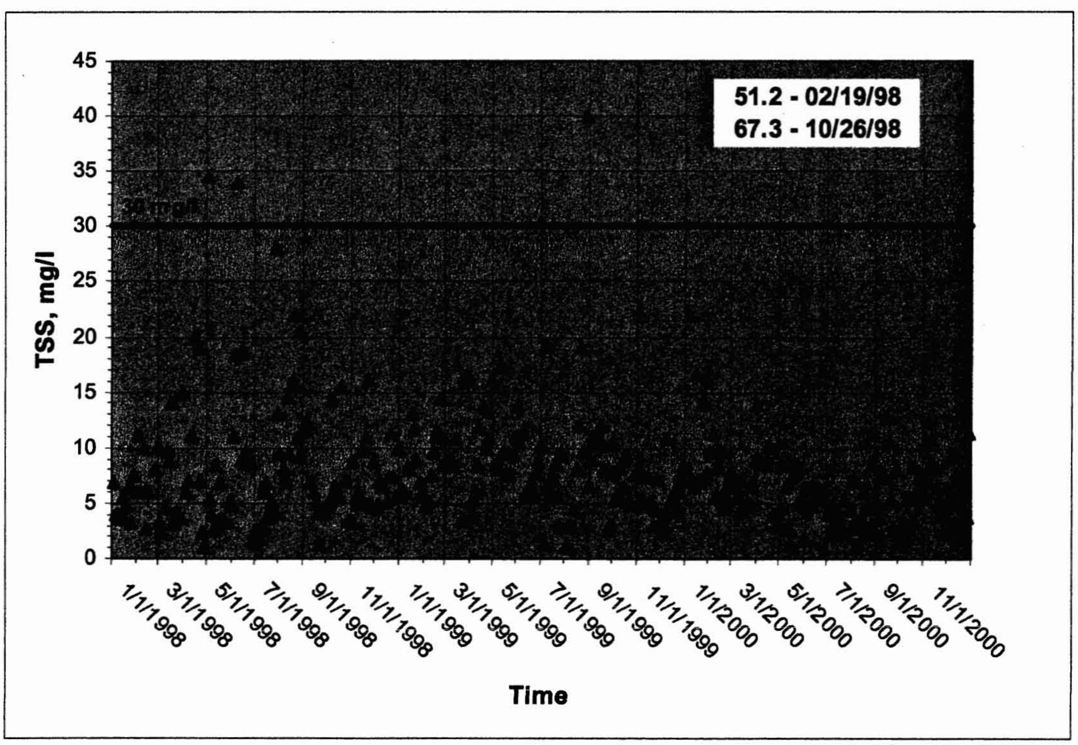

Figure 8 - Pre-Grant Effluent TSS Concentrations (January 1, 1998 to December 31, 2000)

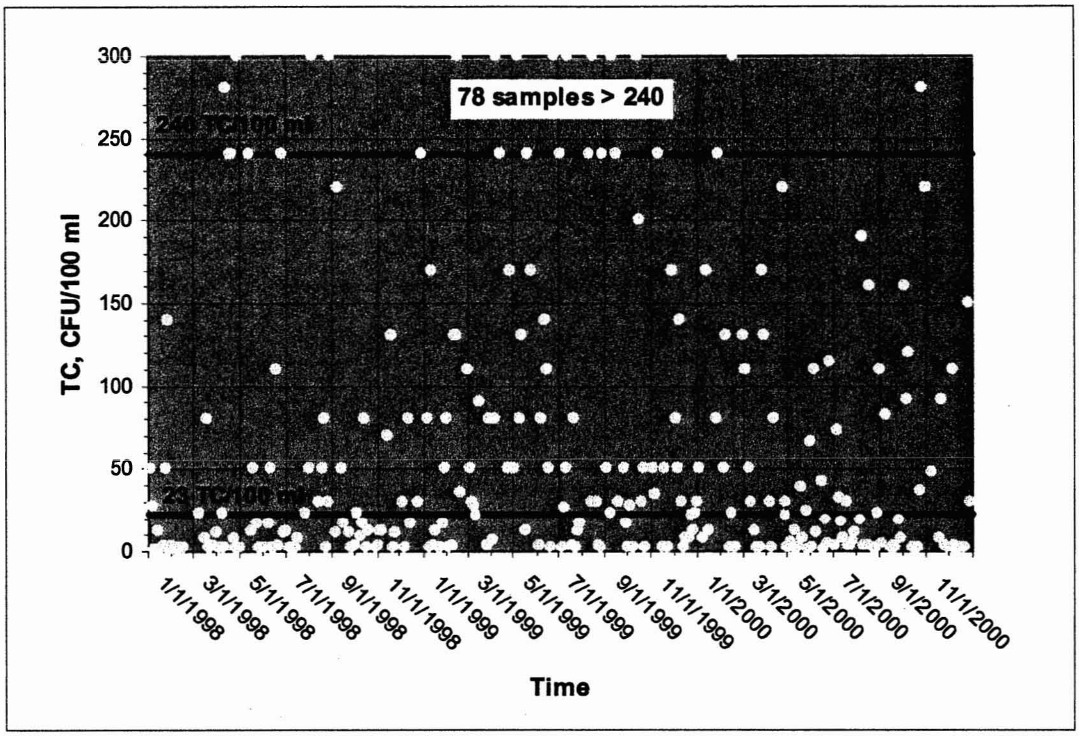

Figure 9 - Pre-Grant Effluent Total Coliform Densities (January 1, 1998 to December 31, 2000)

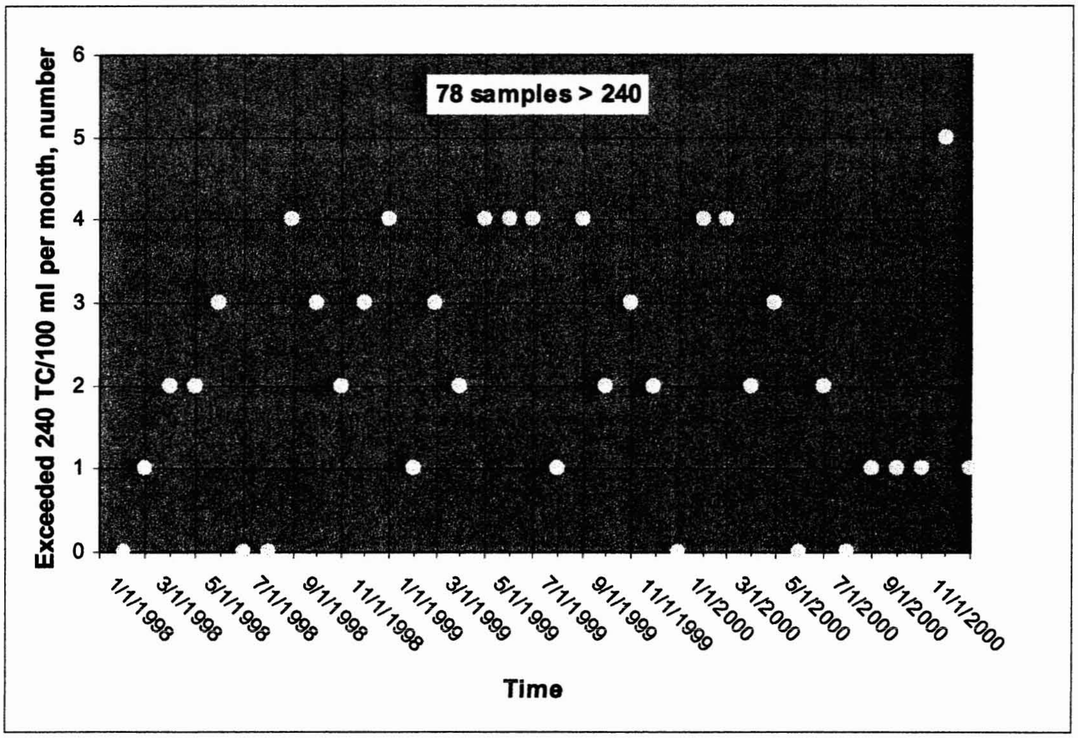

Figure 10 - Pre-Grant Times Exceeded 240 TC/100 ml (January 1, 1998 to December 31, 2000)

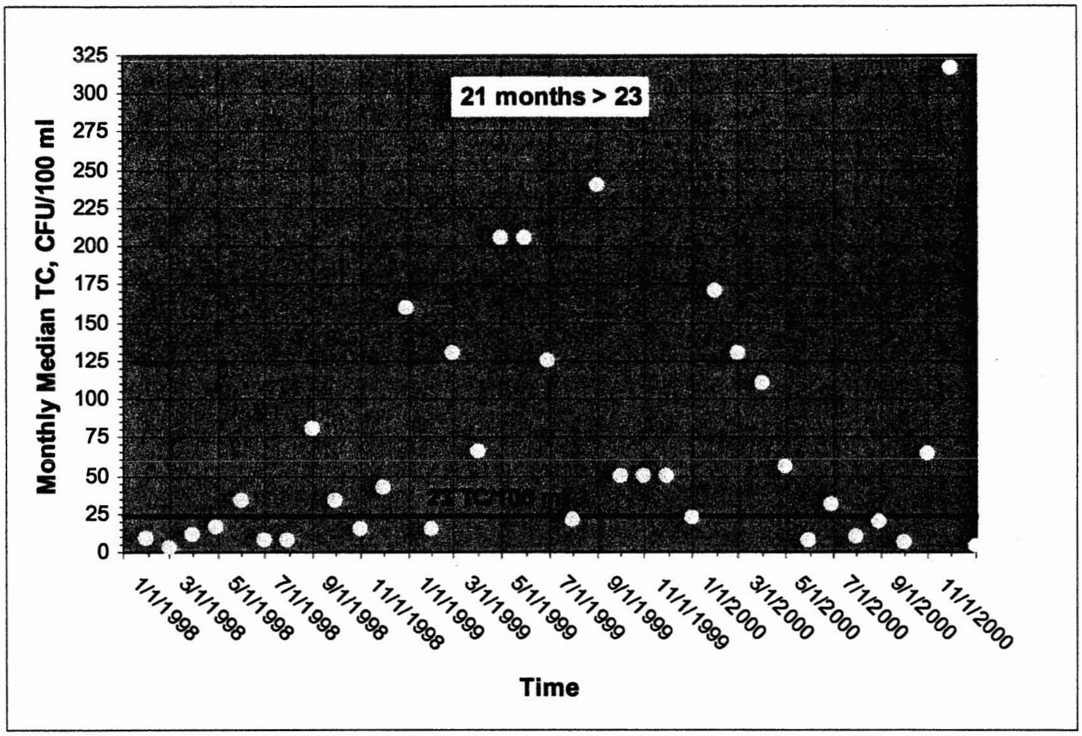

Figure 11 - Pre-Grant Monthly Median TC/100 ml (January 1, 1998 to December 31, 2000)

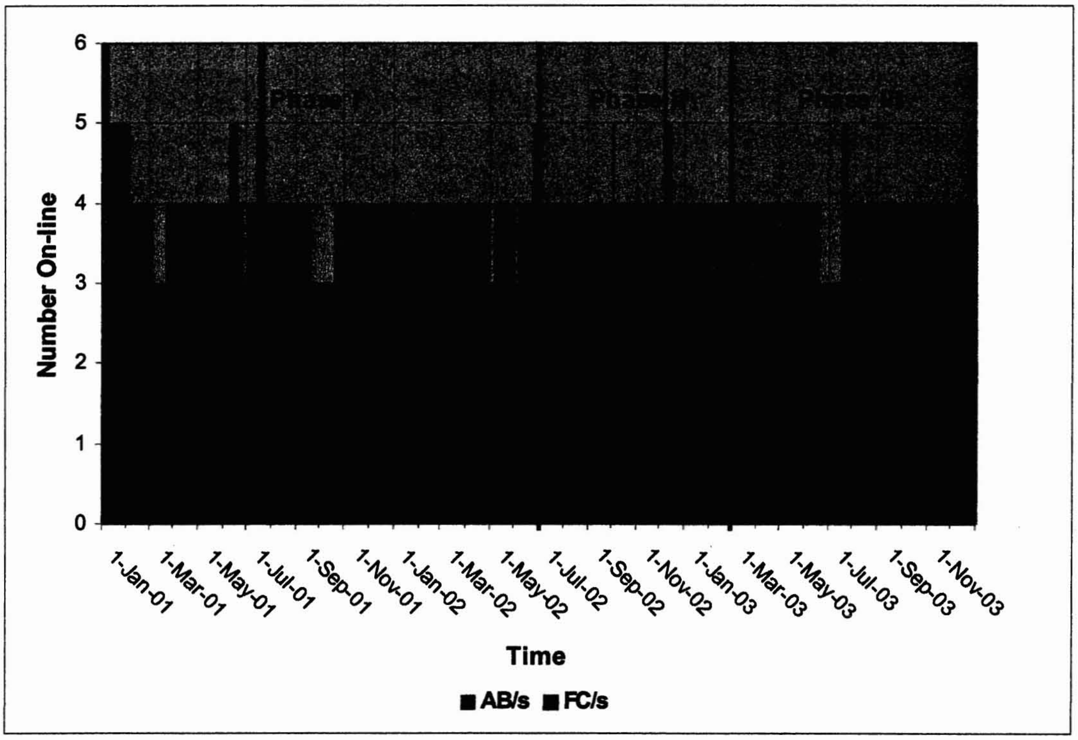

Figure 12 - Grant On-line Tanks (January 1, 2001 to December 31, 2003)

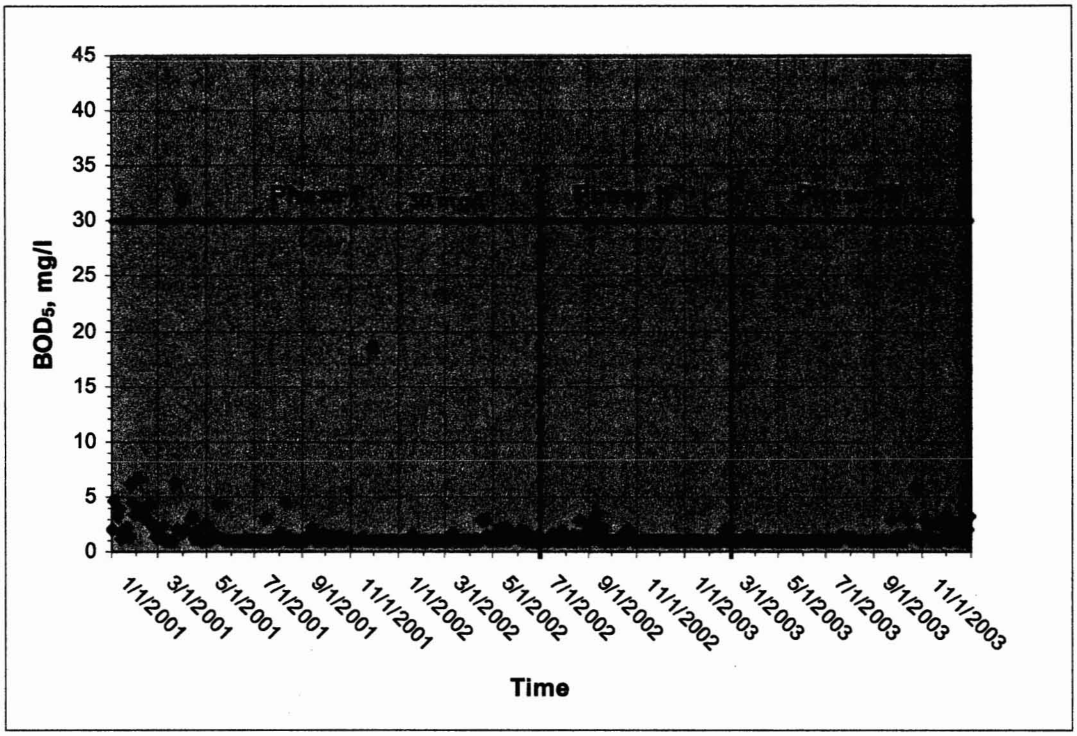

Figure 13 - Grant Effluent BOD_5 Concentrations (January 1, 2001 to December 31, 2003)

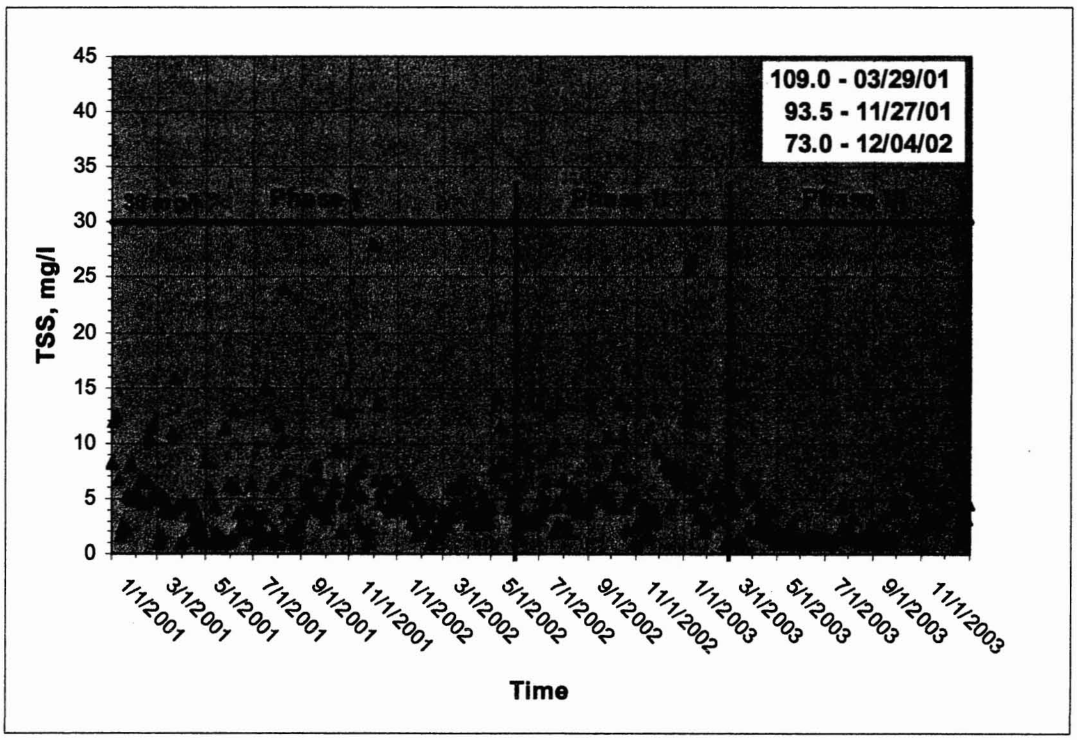

Figure 14 - Grant Effluent TSS Concentrations (January 1, 2001 to December 31, 2003)

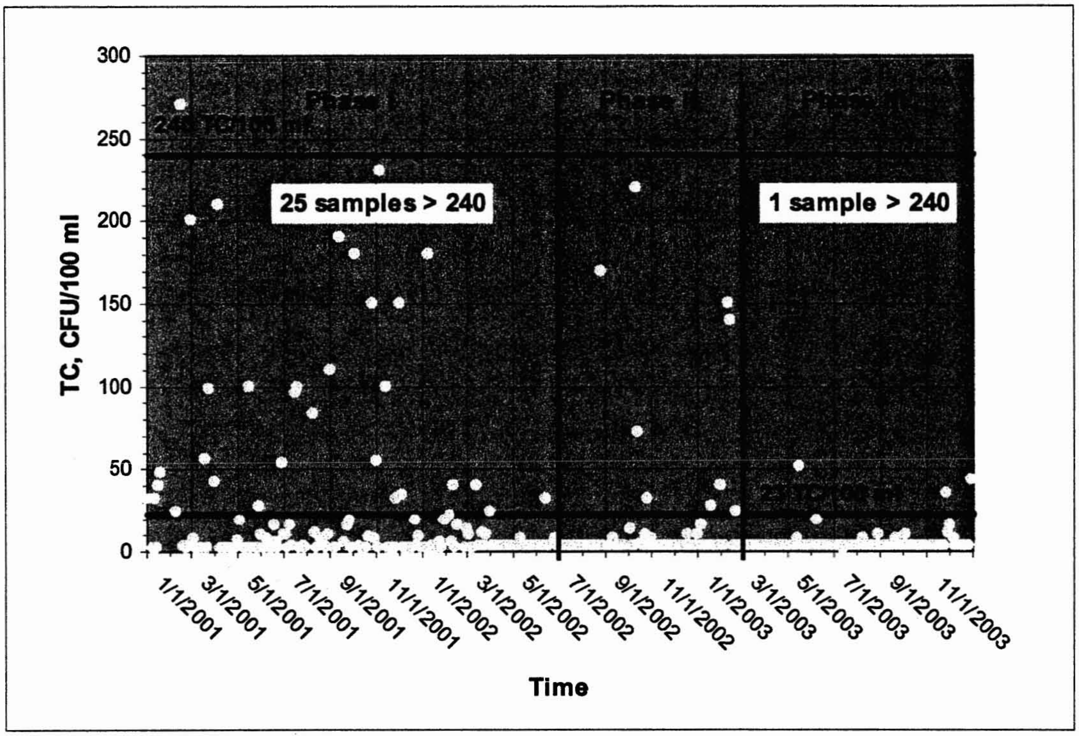

Figure 15 - Grant Effluent Total Coliform Densities (January 1, 2001 to December 31, 2003)

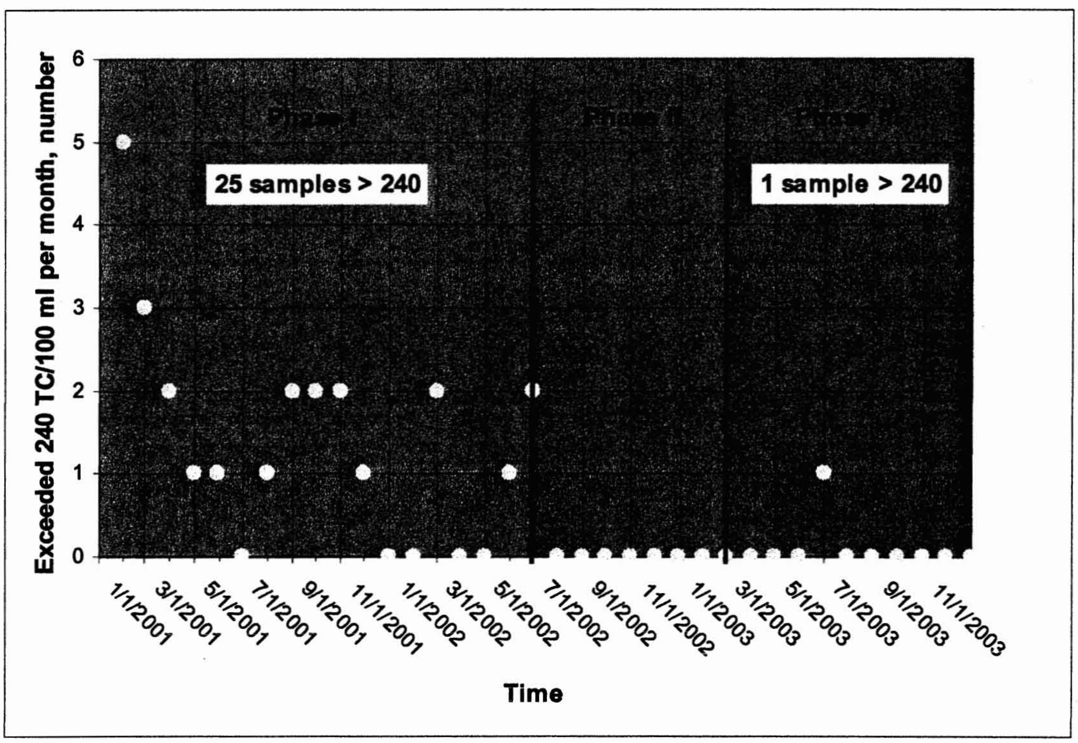

Figure 16 - Grant Times Exceeded 240 TC/100 ml (January 1, 2001 to December 31, 2003)

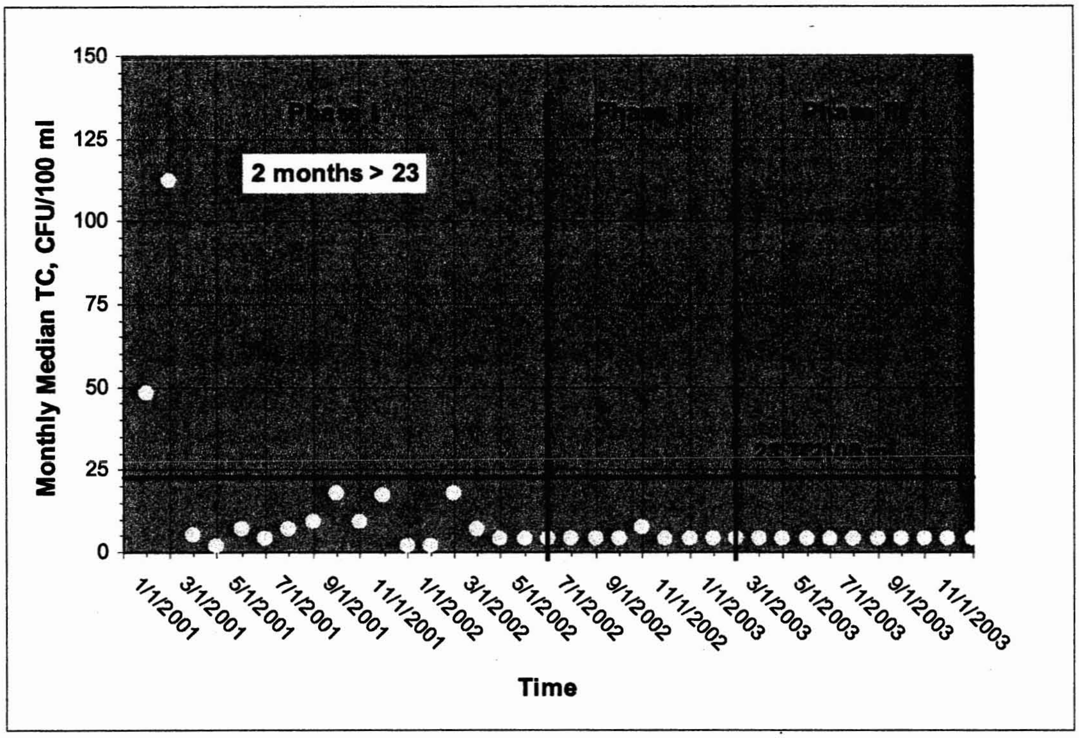

Figure 17 - Grant Monthly Median TC/100 ml (January 1, 2001 to December 31, 2003)

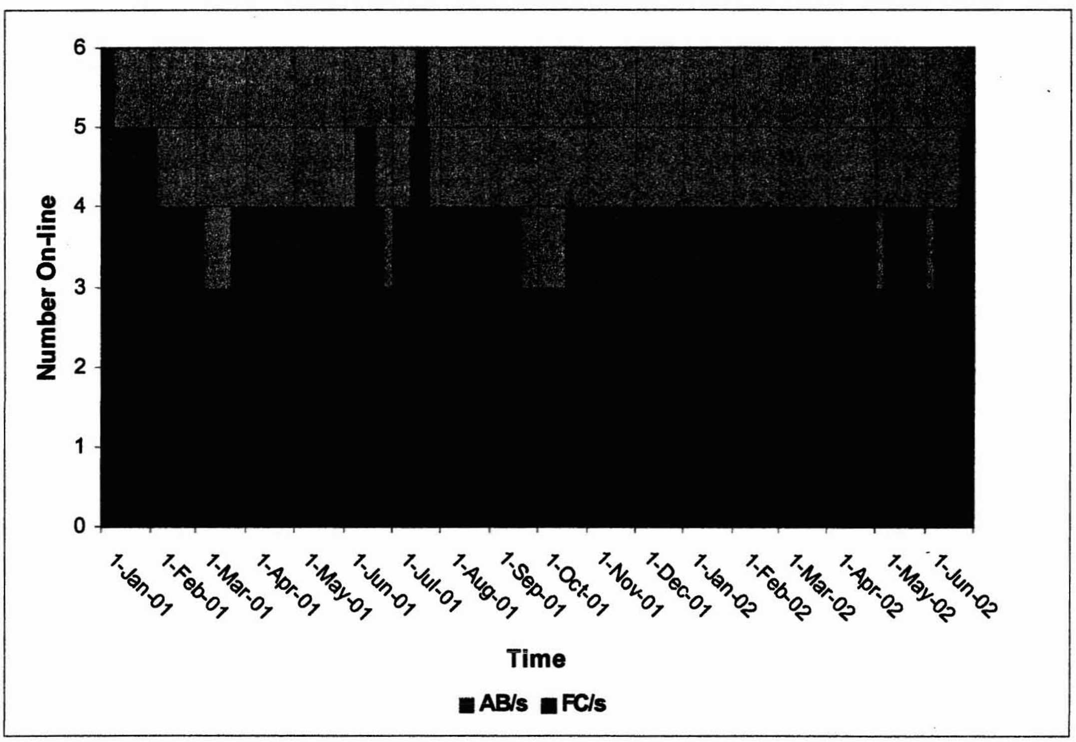

Figure 18 - Phase I On-line Tanks (January 1, 2001 to June 30, 2002)

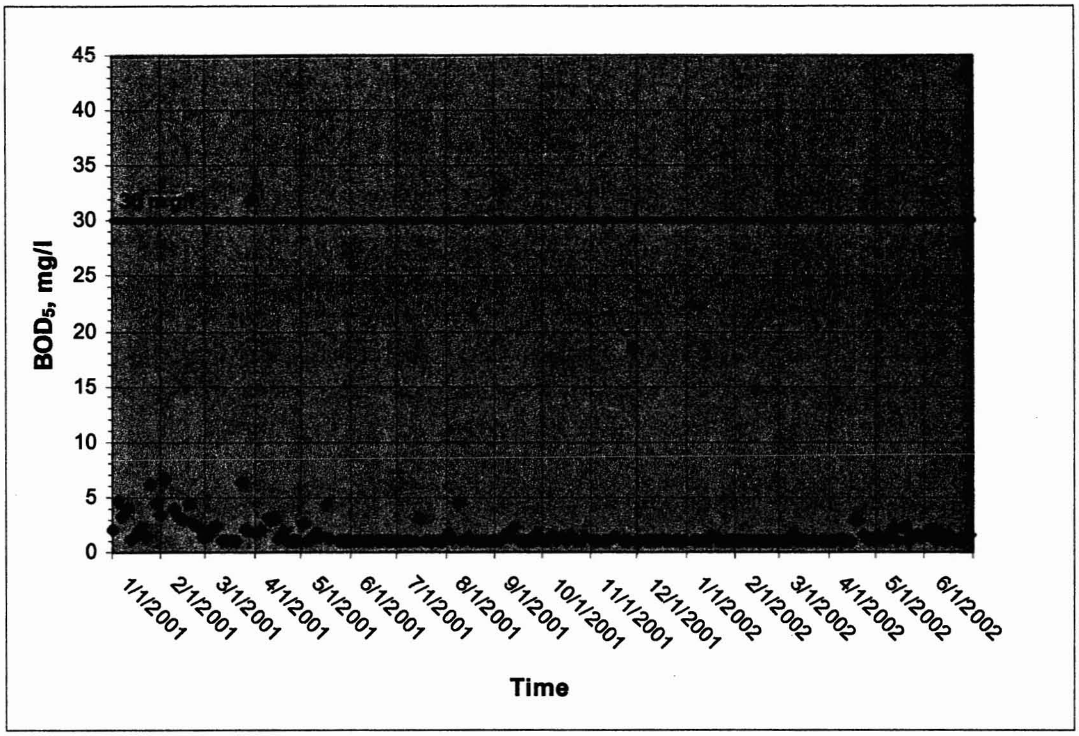

Figure 19 - Phase I Effluent BOD_5 Concentrations (January 1, 2001 to June 30, 2002)

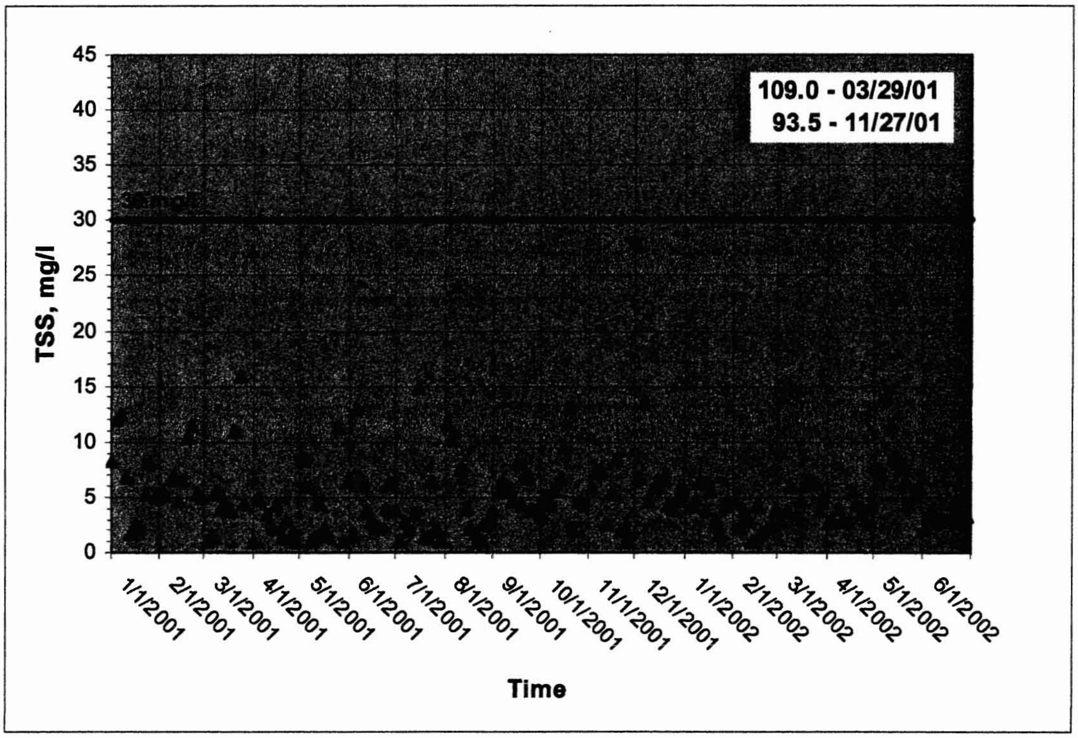

Figure 20 - Phase I Effluent TSS Concentrations (January 1, 2001 to June 30, 2002)

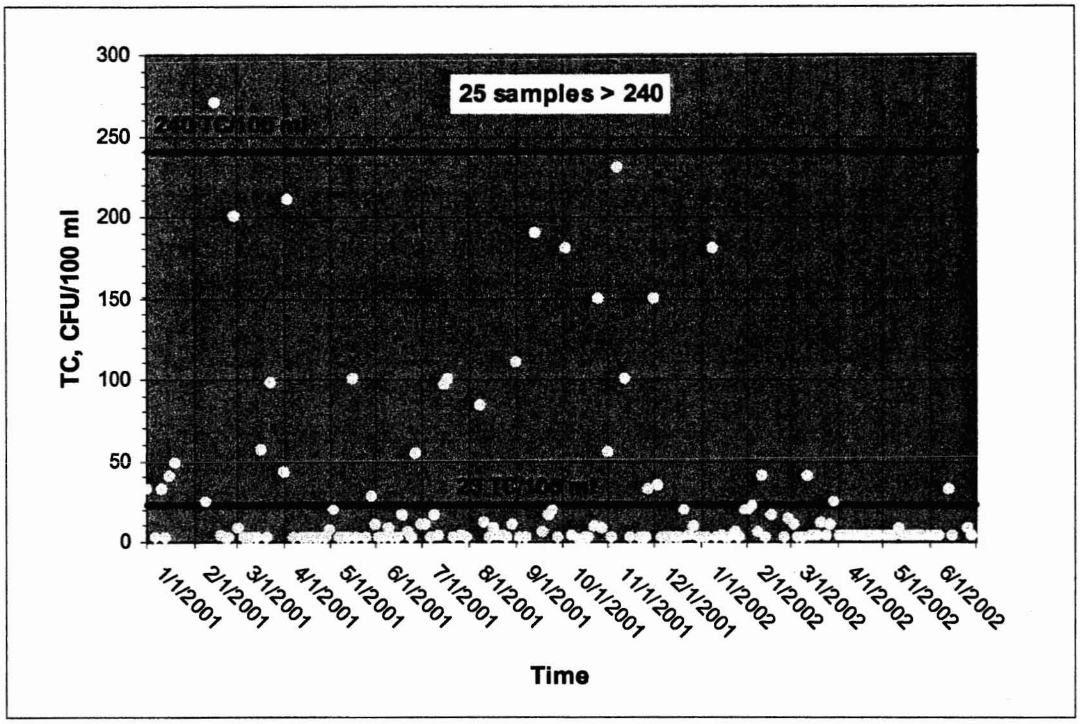

Figure 21 - Phase I Effluent Total Coliform Densities (January 1, 2001 to June 30, 2002)

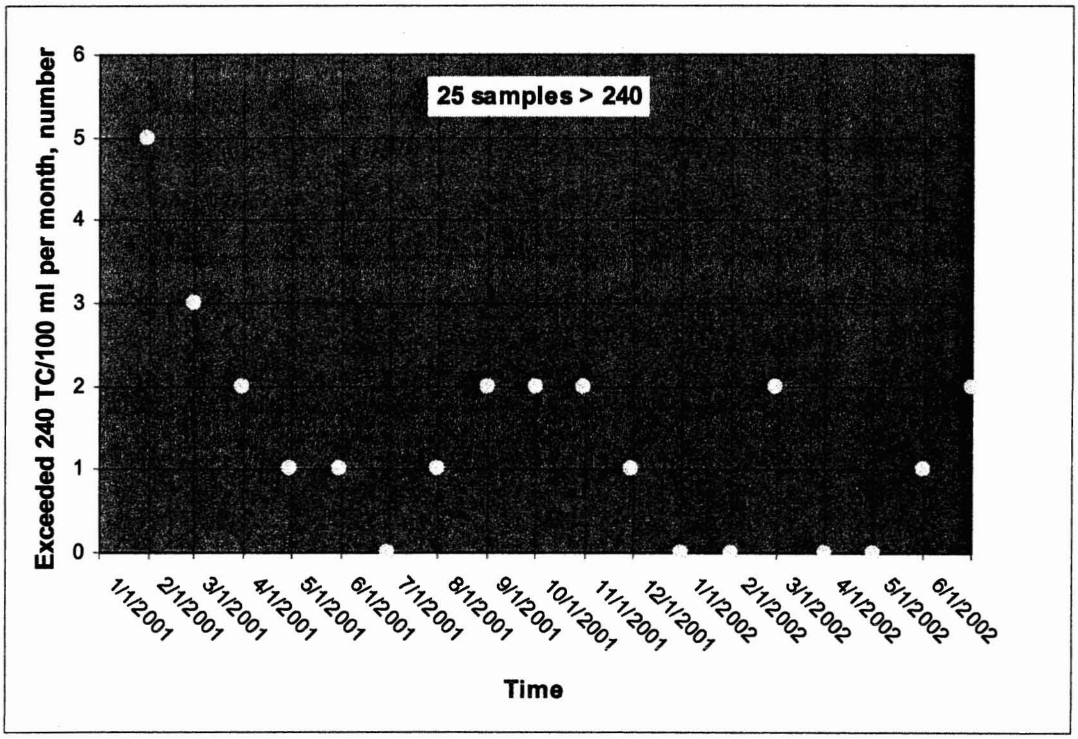

Figure 22 - Phase I Times Exceeded 240 TC/100 ml (January 1, 2001 to June 30, 2002)

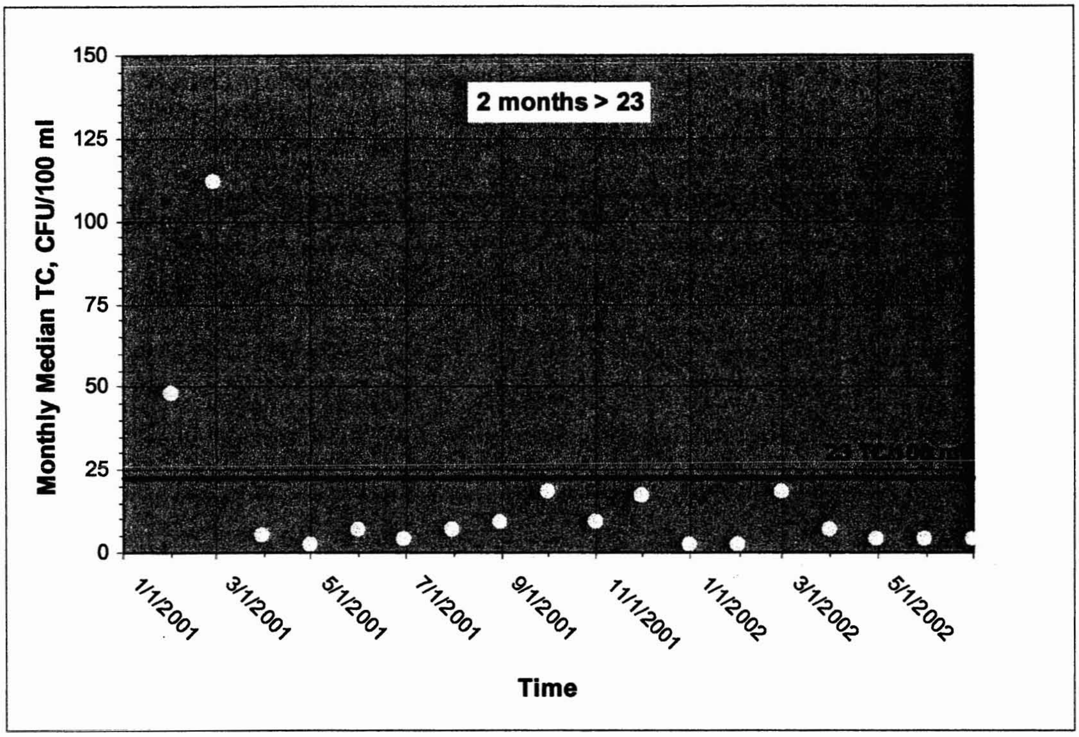

Figure 23 - Phase I Monthly Median TC/100 ml (January 1, 2001 to June 30, 2002)

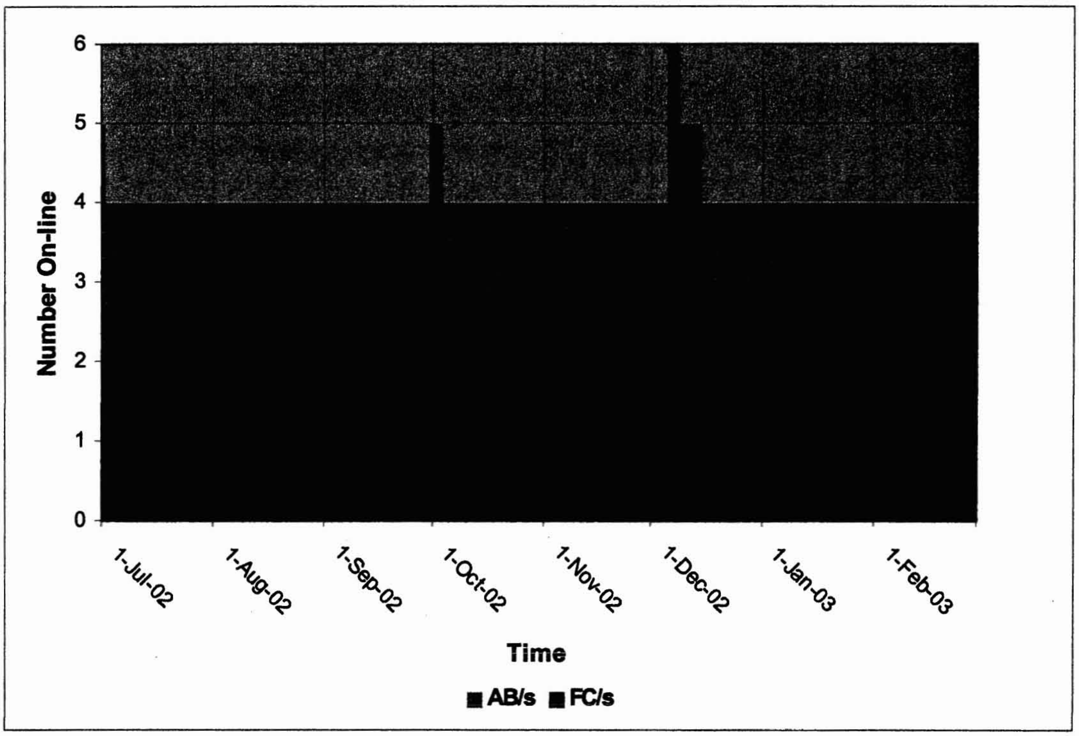

Figure 24 - Phase II On-line Tanks (July 1, 2002 to February 28, 2003)

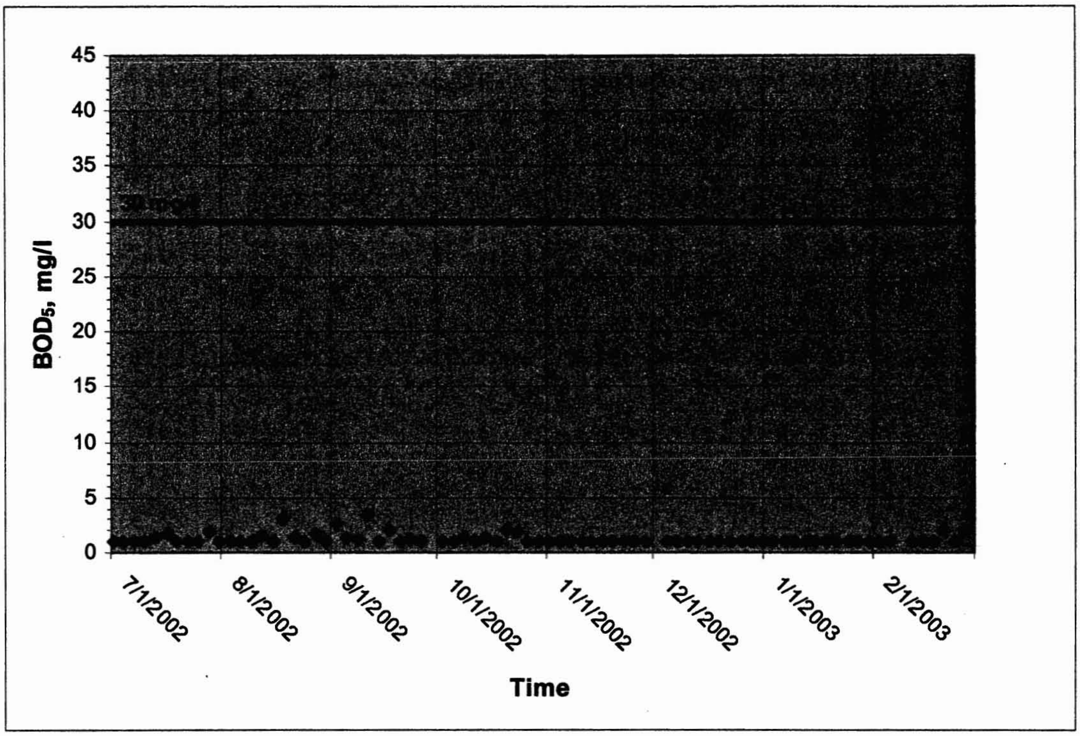

Figure 25 - Phase II Effluent BOD_5 Concentrations (July 1, 2002 to February 28, 2003)

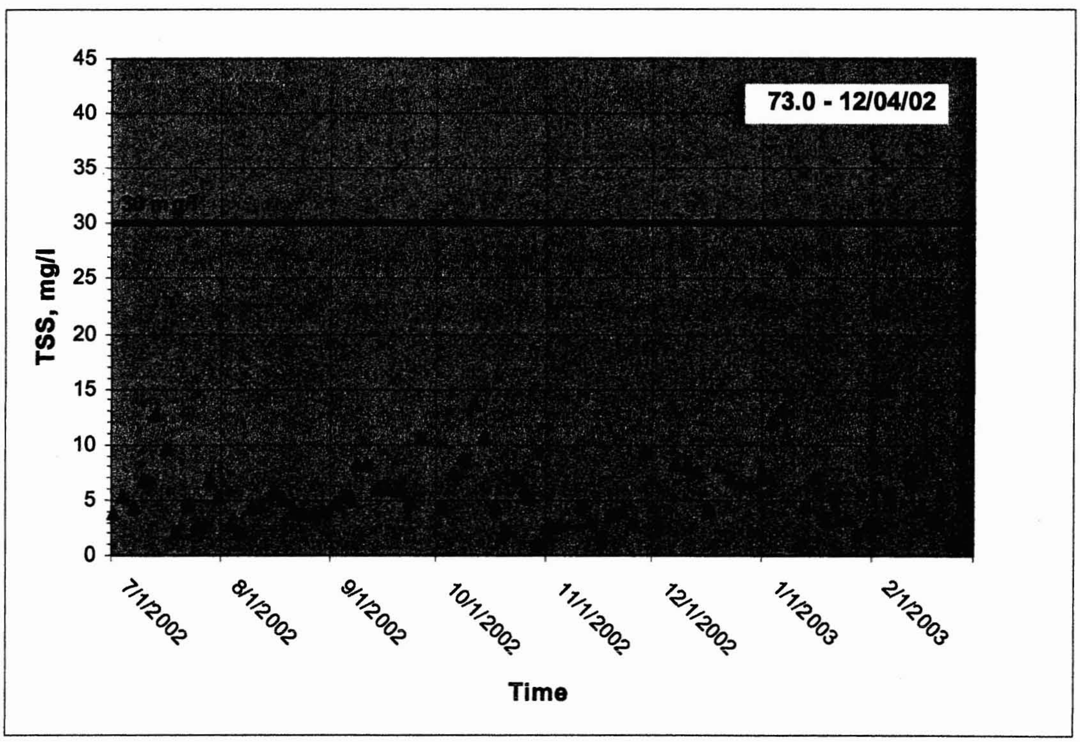

Figure 26 - Phase II Effluent TSS Concentrations (July 1, 2002 to February 28, 2003)

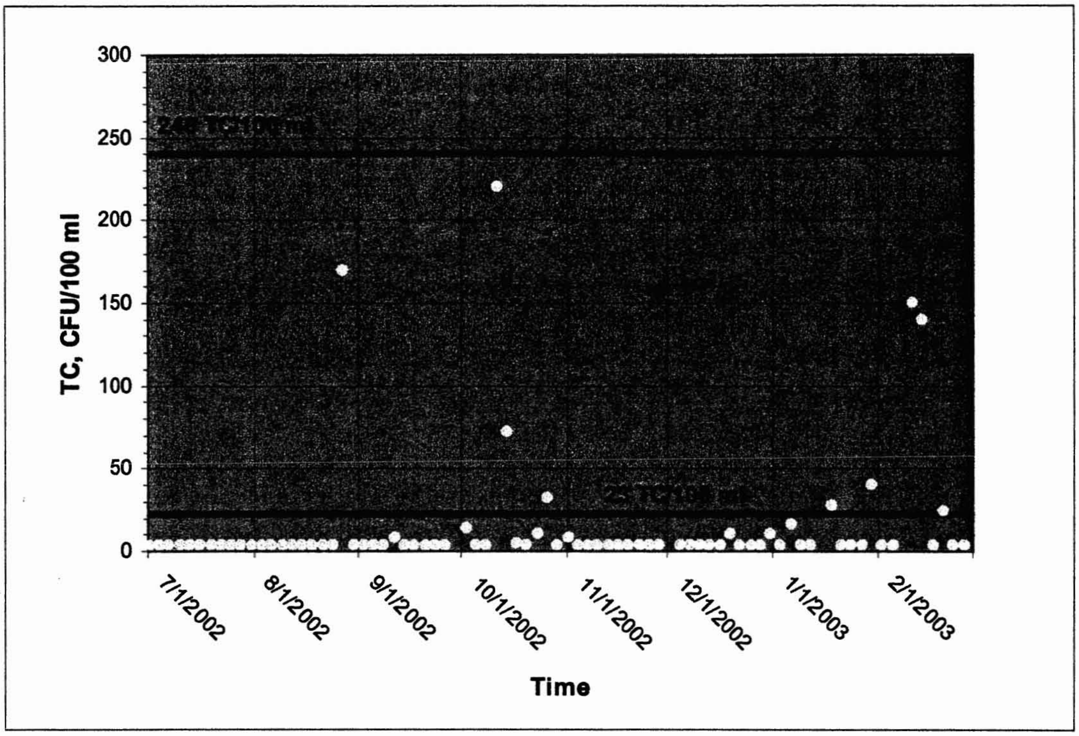

Figure 27 - Phase II Effluent Total Coliform Densities (July 1, 2002 to February 28, 2003)

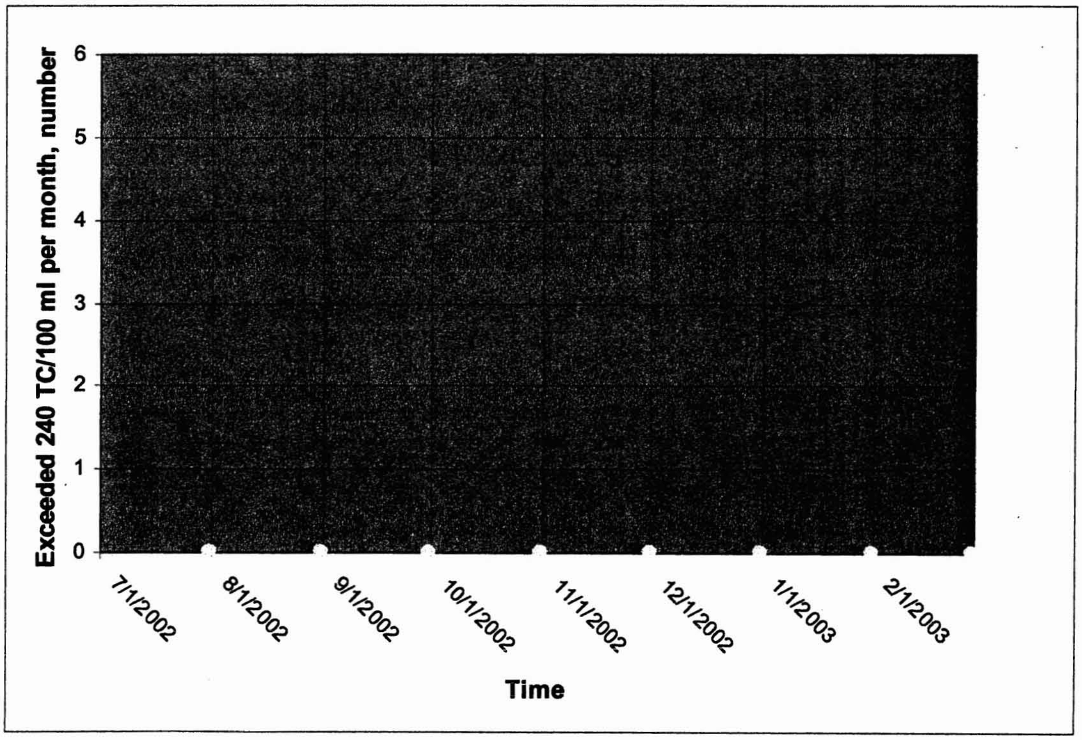

Figure 28 - Phase II Times Exceeded 240 TC/100 ml (July 1, 2002 to February 28, 2003)

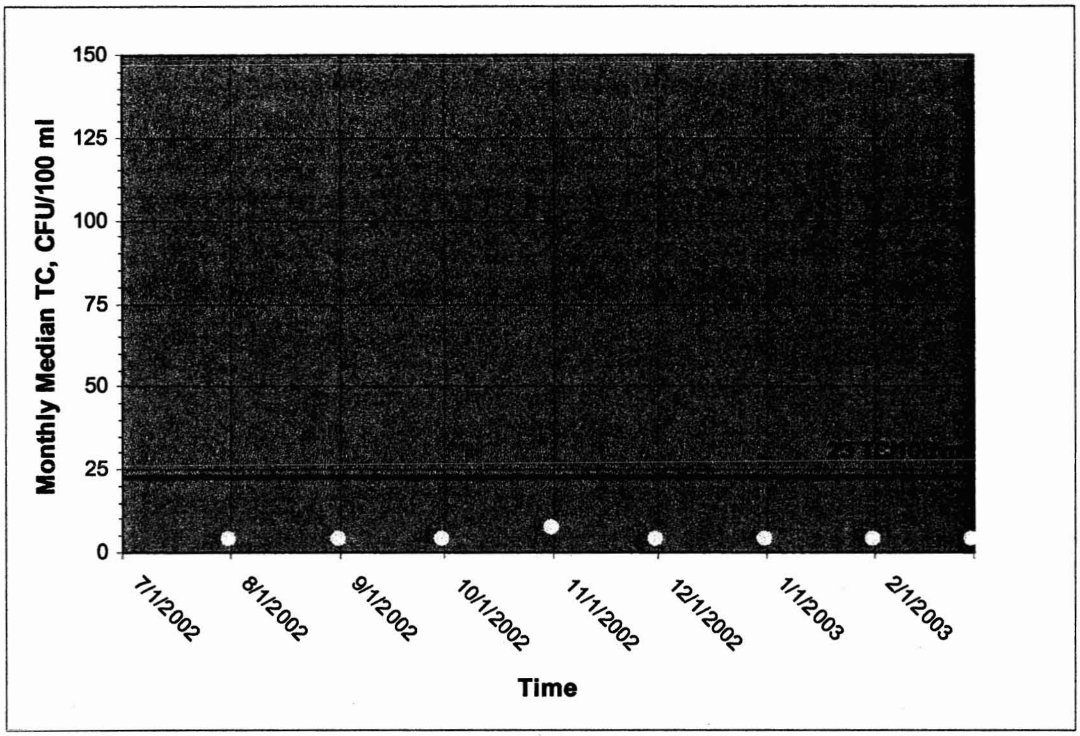

Figure 29 - Phase II Monthly Median TC/100 ml (July 1, 2002 to February 28, 2003)

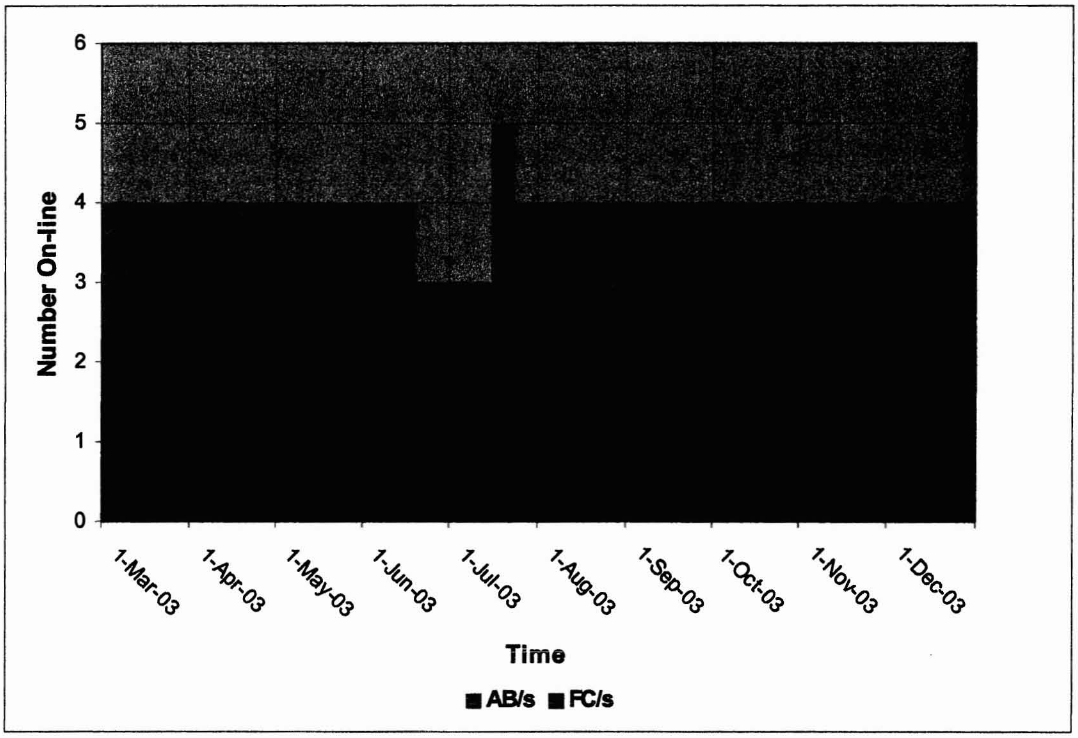

Figure 30 - Phase III On-line Tanks (March 1, 2001 to December 31, 2003)

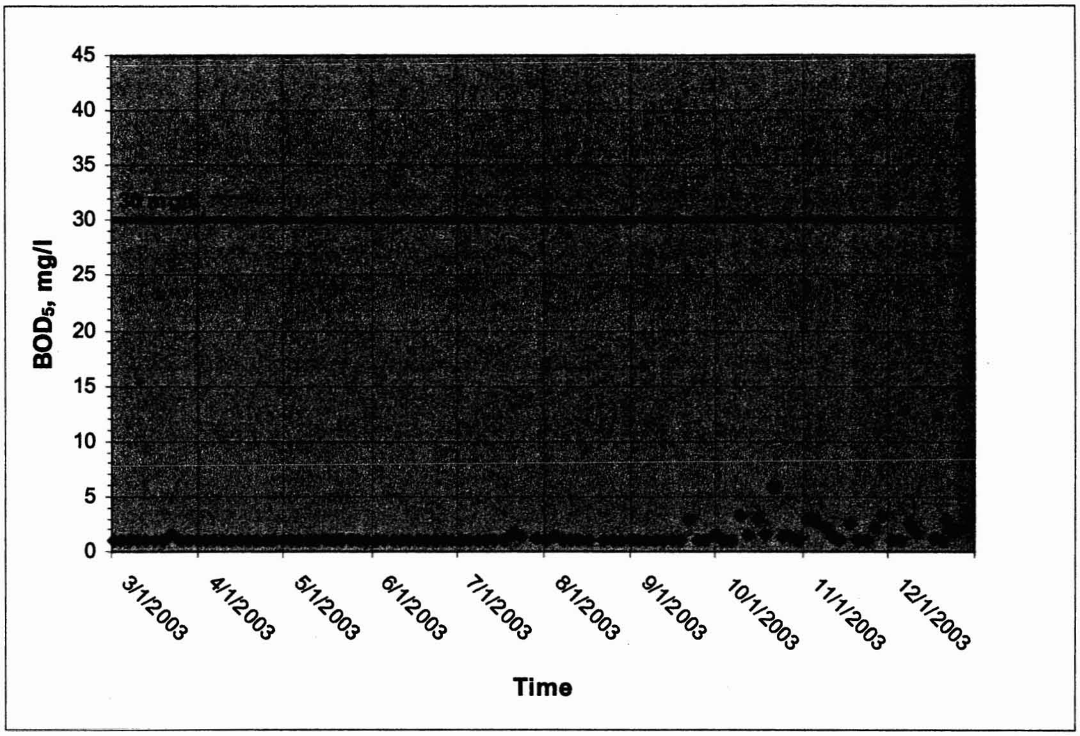

Figure 31 - Phase III Effluent BOD$_5$ Concentrations (March 1, 2001 to December 31, 2003)

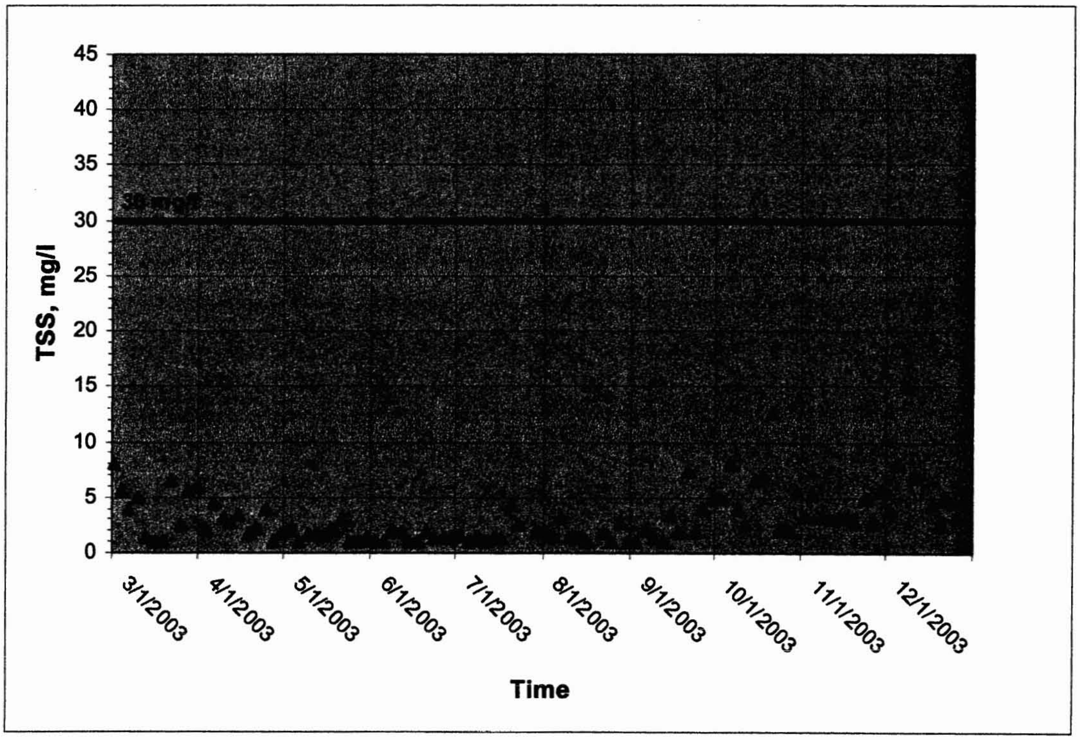

Figure 32 - Phase III Effluent TSS Concentrations (March 1, 2001 to December 31, 2003)

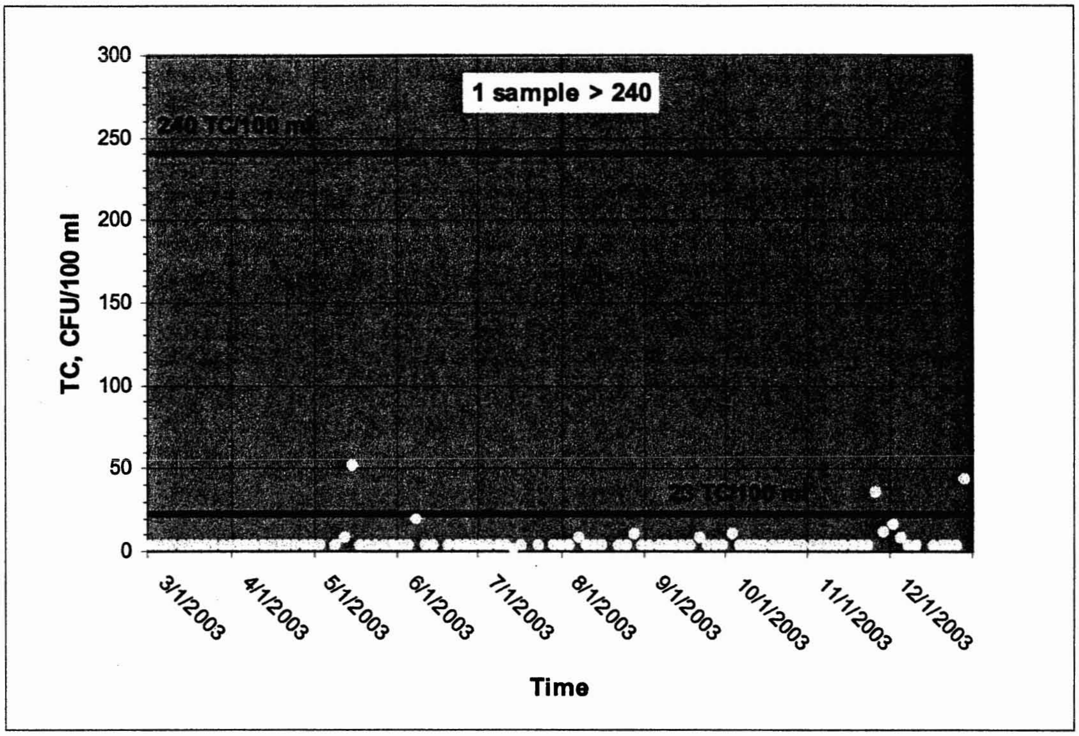

Figure 33 - Phase III Effluent Total Coliform Densities (March 1, 2001 to December 31, 2003)

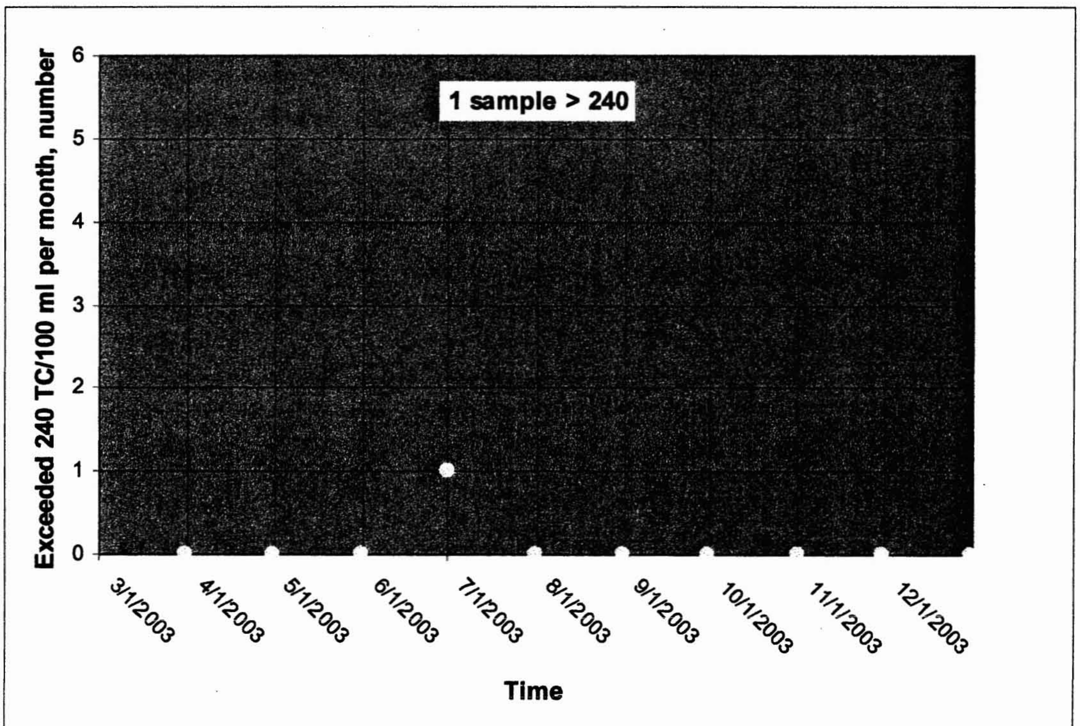

Figure 34 - Phase III Times Exceeded 240 TC/100 ml (March 1, 2001 to December 31, 2003)

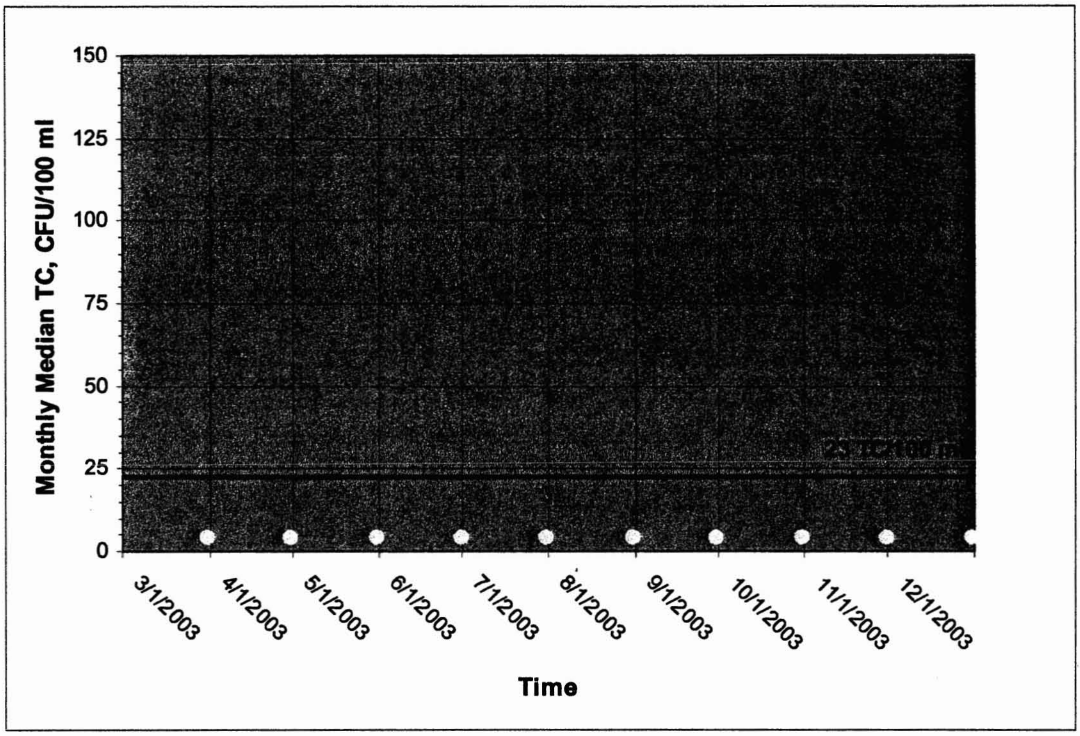

Figure 35 - Phase III Monthly Median TC/100 ml (March 1, 2001 to December 31, 2003)

APPENDIX A

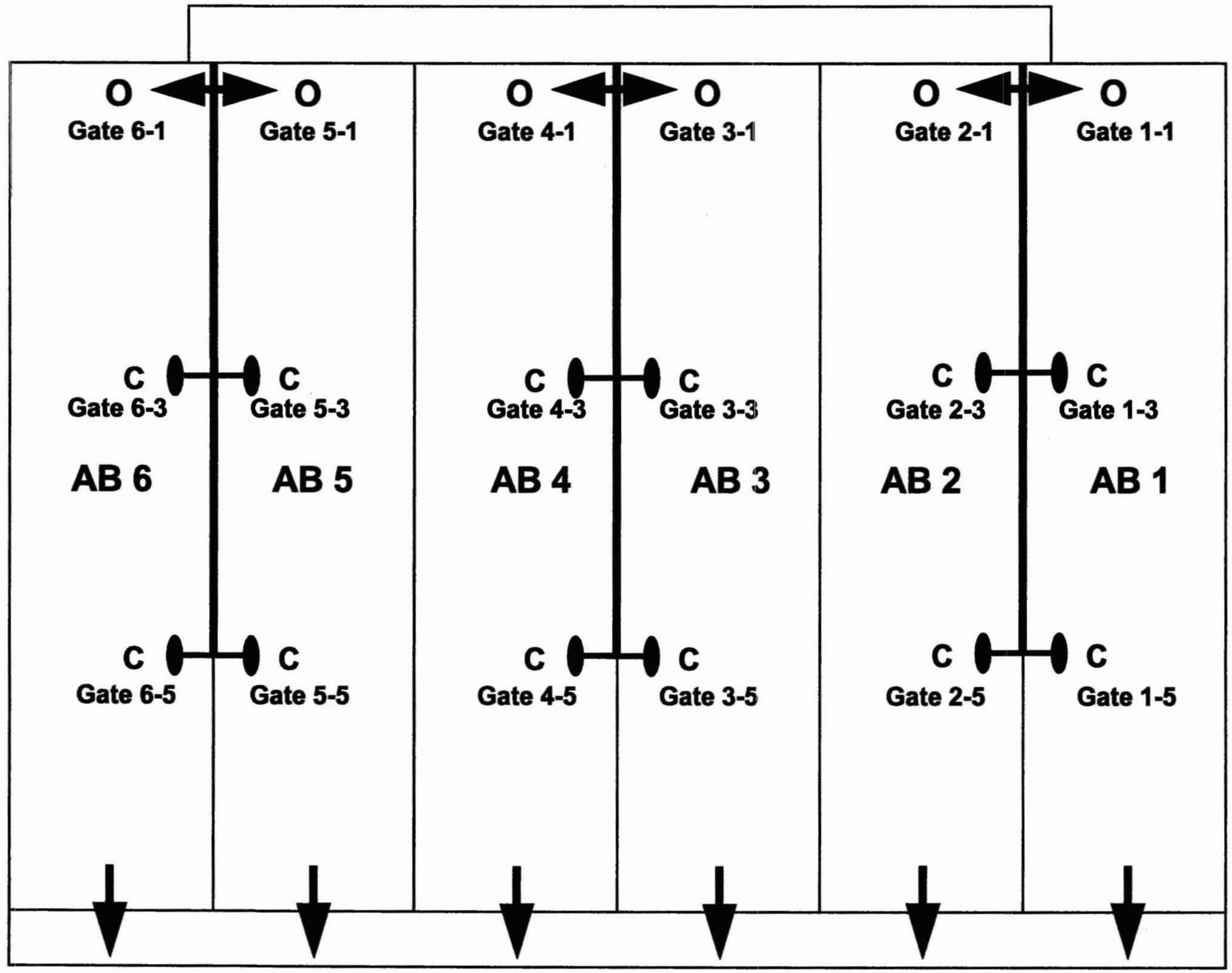

Figure A1 - Pre-Grant Aeration Basin and Gate Configuration

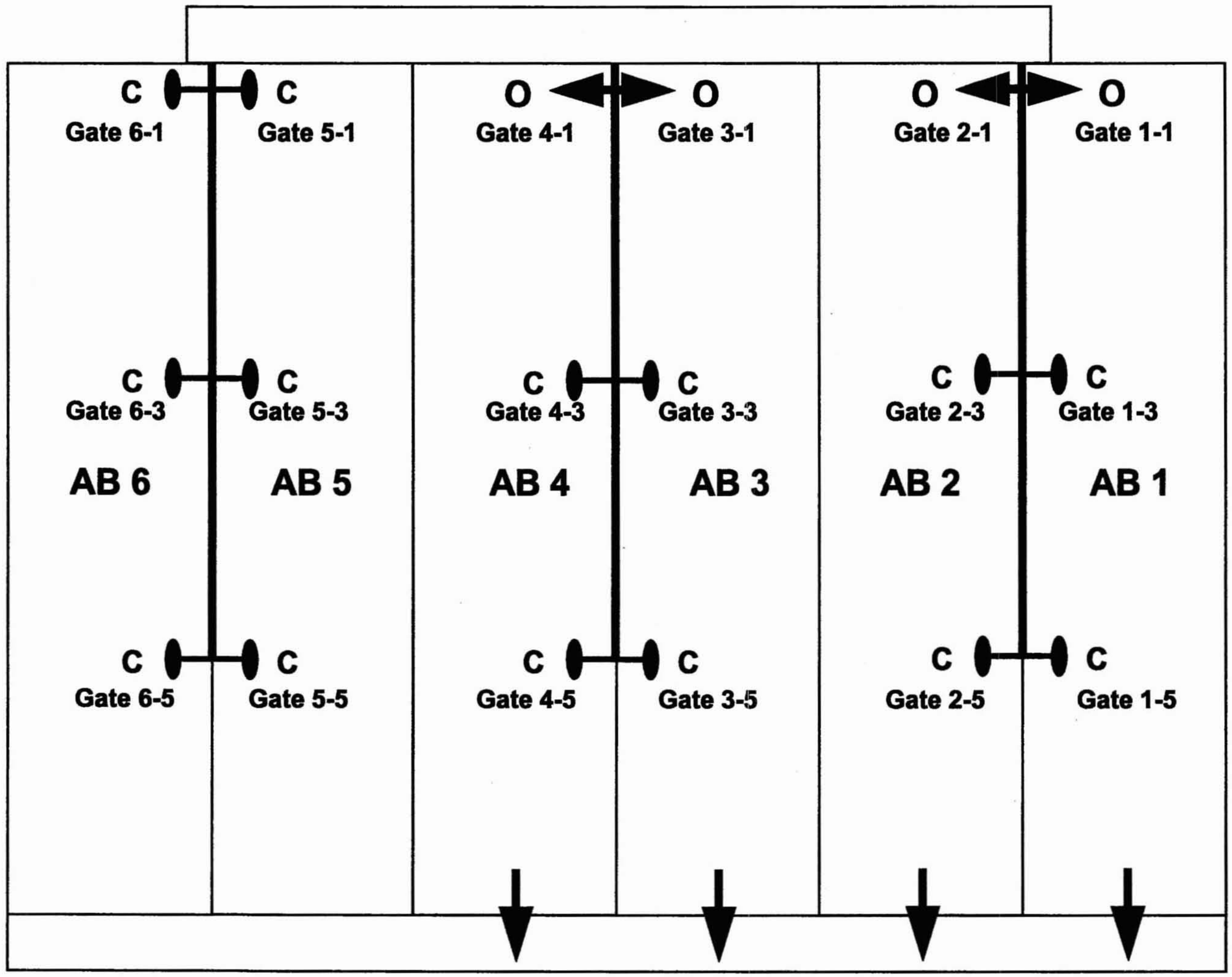

Figure A2 - Phase I Aeration Basin and Gate Configuration

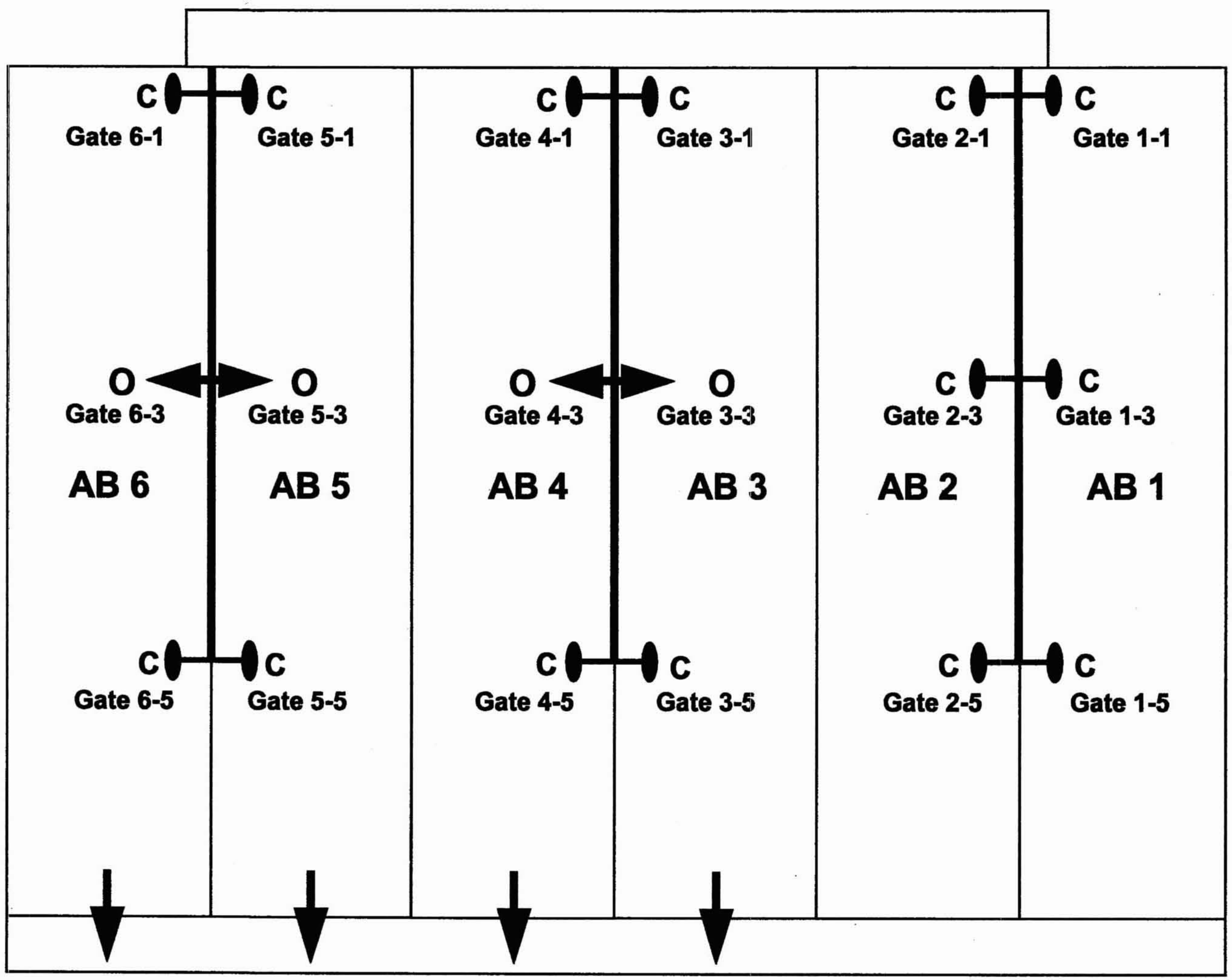

Figure A3 - Phase II Aeration Basin and Gate Configuration

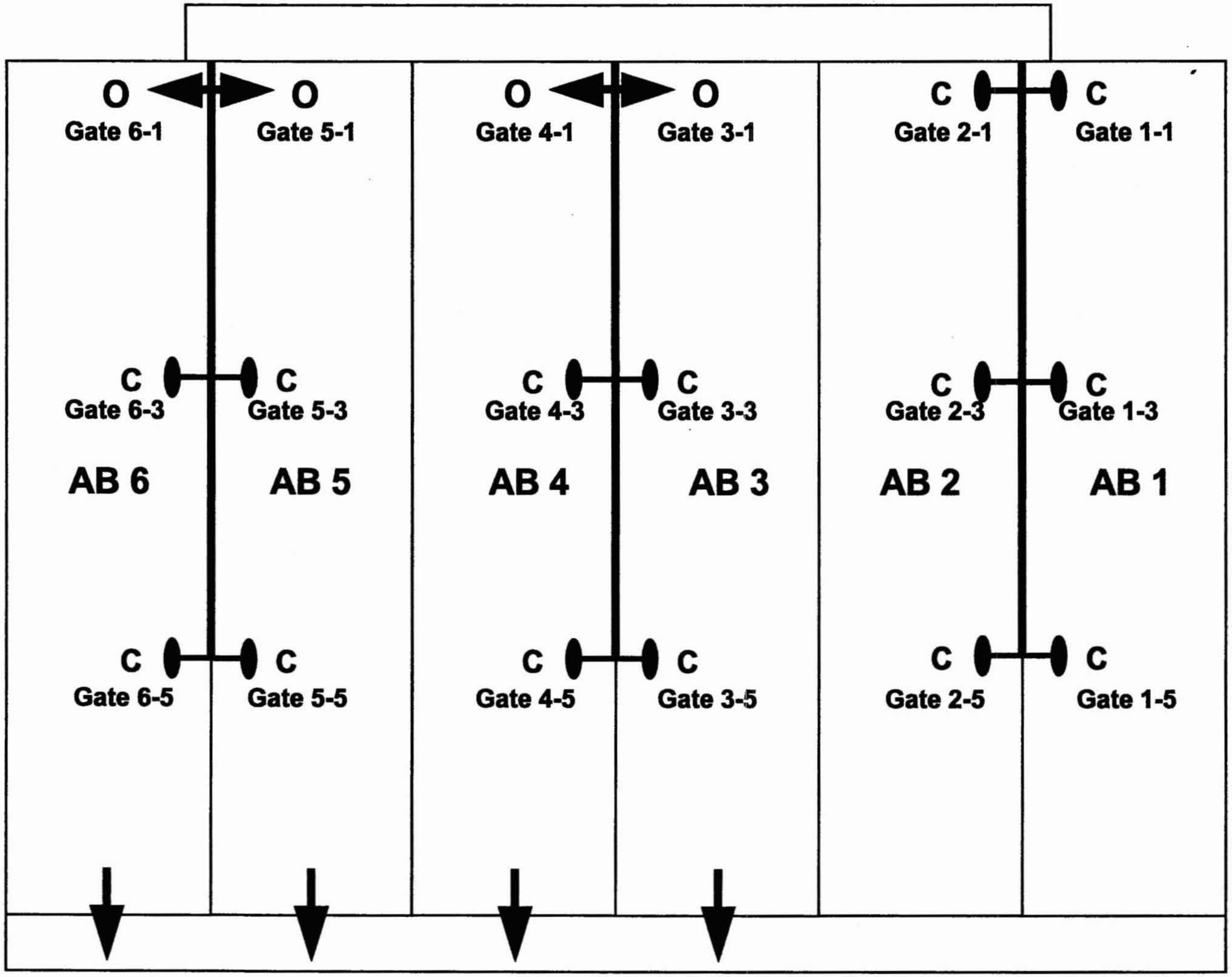

Figure A4 - Phase III Aeration Basin and Gate Configuration

APPENDIX B

Table B1
Schofield Barracks Wastewater Treatment Plant
Phase II Low DO Operational Guidelines

Aeration Supply

Condition	Zone 1	Zone 2	Zone 3
Air header valve position	Full open	Full open	Full open

Process Parameters

Condition	Flow, mgd	Feed, gate	AB's on-line	MLSS, mg/l	Total Mass, Lbs	HRT[1], hr	RAS, gpm	WAS, gpm	DO, mg/l	SVI, ml/g
Normal (Weekday)	≥1.9									
Stable SVI		**3**	4	1,200 - 1,400	14,000 - 16,000	≥3.7	**1,000 - 1,300**	**25 - 35**	**0.2 - 0.3 (0.25)**	≥175 - 250
Increasing SVI		**1**	4	1,200 - 1,400	8,000 - 10,000	≥5.6	**1,000 - 1,200**	**25 - 40**	**1.0 - 3.0 (2.0)**	> 350
Decreasing SVI		**3**	4	1,200 - 1,400	14,000 - 16,000	≥3.7	**1,000 - 1,300**	**20 - 30**	**0.05 - 0.15 (0.1)**	< 125
Normal (Weekend)	< 1.9									
Stable SVI		**3**	4	1,200 - 1,400	14,000 - 16,000	< 3.7	**1,000 - 1,300**	**20 - 30**	**0.2 - 0.3 (0.25)**	≥175 - 250
Increasing SVI		**1**	4	1,200 - 1,400	8,000 - 10,000	< 5.6	**1,000 - 1,200**	**20 - 35**	**1.0 - 3.0 (2.0)**	> 350
Decreasing SVI		**3**	4	1,200 - 1,400	14,000 - 16,000	< 3.7	**1,000 - 1,300**	**15 - 25**	**0.05 - 0.15 (0.1)**	< 125
Toxic Episode	?									
Stable SVI		**1**	4	1,300 - 1,500	9,000 - 11,000	≥3.7	**1,000 - 1,300**	**0**	**1.0 - 3.0 (2.0)**	≥175 - 250
Increasing SVI		**1**	4	1,300 - 1,500	9,000 - 11,000	≥5.6	**1,000 - 1,200**	**0**	**1.0 - 3.0 (2.0)**	> 350
Decreasing SVI		**1**	4	1,300 - 1,500	9,000 - 11,000	≥3.7	**1,000 - 1,300**	**0**	**1.0 - 3.0 (2.0)**	< 125
Storm Event	> 4.0									
Stable SVI		**3**	4					**25 - 35**	**0.2 - 0.3 (0.25)**	≥175 - 250
Increasing SVI		**1**	4					**25 - 40**	**1.0 - 3.0 (2.0)**	> 350
Decreasing SVI		**3**	4					**20 - 30**	**0.05 - 0.15 (0.1)**	< 125

1 - HRT = under aeration based on Q + R flow rates, Process parameter changes are generally made based on a 5 or 10 percent maximum increase or decrease, **BOLDED** parameters are those which we control to make process changes (effluent water-quality and SVI).

Table B2
Schofield Barracks Wastewater Treatment Plant
Phase III Anoxic Operational Guidelines

Aeration Supply

Condition	Zone 1	Zone 2	Zone 3
Air header valve position	Slightly open	Full open	Full open

Process Parameters

Condition	Flow, mgd	Feed, gate	AB's on-line	MLSS, mg/l	Total Mass, Lbs	HRT[1], hr	RAS, gpm	WAS, gpm	DO, mg/l	SVI, ml/g
Normal (Weekday)	≥1.9									
Stable SVI		**1**	4	1,300 - 1,500	9,000 - 11,000	≥5.6	**1,000 - 1,300**	**25 - 35**	**0.6 - 0.9 (0.8)**	≥175 - 250
Increasing SVI		**1**	4	1,300 - 1,500	9,000 - 11,000	≥5.6	**1,000 - 1,200**	**25 - 40**	**0.9 - 1.1 (1.0)**	> 350
Decreasing SVI		**1**	4	1,300 - 1,500	9,000 - 11,000	≥5.6	**1,000 - 1,300**	**20 - 30**	**0.5 - 0.8 (0.7)**	< 125
Normal (Weekend)	< 1.9									
Stable SVI		**1**	4	1,300 - 1,500	9,000 - 11,000	< 5.6	**1,000 - 1,300**	**20 - 30**	**0.6 - 0.9 (0.8)**	≥175 - 250
Increasing SVI		**1**	4	1,300 - 1,500	9,000 - 11,000	< 5.6	**1,000 - 1,200**	**20 - 35**	**0.9 - 1.1 (1.0)**	> 350
Decreasing SVI		**1**	4	1,300 - 1,500	9,000 - 11,000	< 5.6	**1,000 - 1,300**	**15 - 25**	**0.5 - 0.8 (0.7)**	< 125
Toxic Episode	?									
Stable SVI		**1**	4	1,400 - 1,600	9,500 - 11,500	≥5.6	**1,000 - 1,300**	**0**	**1.0 - 3.0 (2.0)**	≥175 - 250
Increasing SVI		**1**	4	1,400 - 1,600	9,500 - 11,500	≥5.6	**1,000 - 1,200**	**0**	**1.0 - 3.0 (2.0)**	> 350
Decreasing SVI		**1**	4	1,400 - 1,600	9,500 - 11,500	≥5.6	**1,000 - 1,300**	**0**	**1.0 - 3.0 (2.0)**	< 125
Storm Event	> 4.0									
Stable SVI		**1**	4					**25 - 35**	**0.6 - 0.9 (0.8)**	≥175 - 250
Increasing SVI		**1**	4					**25 - 40**	**0.9 - 1.1 (1.0)**	> 350
Decreasing SVI		**1**	4					**20 - 30**	**0.5 - 0.8 (0.7)**	< 125

1 - HRT = under aeration based on Q + R flow rates, Process parameter changes are generally made based on a 5 or 10 percent maximum increase or decrease, **BOLDED** parameters are those which we control to make process changes (effluent water-quality and SVI).