# WASTE WATER TREATMENT AND ODOR CONTROL
# A SIX-YEAR PROGRAM

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## INTRODUCTION

Not long ago, vile industrial odors were dismissed with the coarse phrase "That's the smell of prosperity." Long before any governmental agency became involved, the local citizenry across the beet belts generally endured the unpleasant vapors emanating from the sugar factories as a part of life. Since many of these folks also worked at the factory, their interest was vested and they voiced an opinion only in jest, if at all.

The chemical processes by which sugar is coaxed from the beet have changed but slightly throughout this century which we are soon to close. Transport of the beets at the factory is still largely by water fluming followed by washing. The soil and organics which find their way into the waste waters possess compelling fragrances, and for many years they were sent back to the river or stream for "purification" before the next downstream user. And there was another catch phrase of the time: "Water will clean itself after five miles.."

With each spring came the runoff with its cleansing waters rushing to the ocean, removing all vestiges of any odors "south of town" which had visited the populace, especially when borne by chinook winds. To this factory assault might also be added the pulp pit drainage. One has not experienced a solid number 4 odor until taking a whiff of that concoction when fully aged. However, one powerful source remained: lime sewer. It could not be flushed away; it simply accumulated and emitted its trademark scent throughout the year, awaiting a fresh inoculation in the fall. If the sugar loss in waste lime was a bit higher than usual leaving the vacuum filters, then also the summer nights reflected that accountable - or unaccountable - loss.

This scene had to change, and the advent of pulp dryers heralded the first big step. Pulp pits were history. With direct discharge into the waterways now forbidden, came the need for ponding of flume water, its reuse and all of the problems which attend this "solution." Odors now stayed where they were made. Accordingly, a pressing need arose for technology to address these new odors as well as the old ones. And the need for money, of course, came with it.

In the early eighties, Monitor Sugar, like most sugar beet processors, realized that the salad days were over and that nothing would cause the problem to drift away. Federal and state mandates made it crystal clear that strict odor control legislation was just over the horizon and that not season nor weather nor influence nor any quick fix would cause it to wash away with the spring flood. Even without a push from governments, Monitor was determined to make its presence "unknown" in the community.

Follows are the rudiments of six years' efforts leading to 1993, during which period the Company successfully implemented a plan for large scale reduction of odors coming from the storage of waste water, mud and spent lime. Our work will doubtless continue into the 21st century and as long as there is a sugar beet industry. We are heartened by the progress being made by our industry in odor control and are anxious to share with all of you any of our successes.

## EFFECT ON WASTE WATER SYSTEM AS FACTORY DOUBLES SLICE CAPACITY

After the 1983 campaign, Monitor Sugar began a three-year program to bring its capacity to 8,000 short tons, saying farewell to the comfortable but unrealistic 4500 ton per day arrangement. The more stringent environmental standards addressed not only smoke and water, but odors, too. It was obvious that success in one area could not be achieved on the back of another area left neglected. So was born the plan to spend heavily on the first phase to control waste water and reduce odors.

The decision was made that only non-contact cooling water would be returned to the Saginaw Bay. All process waste water would be treated on site and sent to the West Bay County Wastewater Treatment Plant. Prior to this, all process waste water could be discharged into the bay. Two problems existed: WBC was not of a capacity to accept our wastewater, and our wastewater carried too high a strength for them to treat all of it. Both had to be solved by the time the factory came up to 8,000 tons, planned for the 1987 campaign.

A.C. Biotechnics, a Swedish company, was chosen to build an anaerobic treatment system which could handle 800,000 gallons per day. Contracts for the Anamet digester and for Monitor's financial help to increase WBC's facilities were executed. Two problems were headed for solution, but the program was only begun.

## BRIEF DESCRIPTION OF THE ANAMET SYSTEM

From the primary settling pond the water is sent through heat exchangers where barometric condenser water yields its heat to bring the waste water to 98° F. Pumped into the 1.5 million gallon reactor, the organics in the water are converted into methane and carbon dioxide. These gases leave the top of the vessel and are flared. Plans to burn them in the pulp dryer are being considered. The effluent then overflows via a weir and travels by gravity to a flocculation/degassification tank. The material is agitated with a lightnin' mixer to release any remaining biogas. From here it flows by gravity to a Lamella clarifier where the flocs of bacteria are settled and returned to the digester by sludge pumps. The clarified water overflows the top of the Lamella clarifier and goes on to the ponding system.

As the campaign continues, the strength of the waste water increases. Whereas early COD strength entering the Anamet might be in the range of 1,500 mg/l, by December it may hit 16,000. The system can handle 68,000 pounds of COD per day on a routine basis, as well as 3,300 pounds of suspended solids. This digester was designed with a narrower diameter and more height, presumably to increase its capacity through greater shearing forces. Figure #1 shows the dimensions and operating parameters for the Anamet system in use at Monitor Sugar.

## AFTER THE ANAMET

As seen in Figure #2, effluent from the Anamet system flows to the east and west ponds for aeration. When more water arrives for Anamet treatment than the system can take, a 16-inch bypass line can carry that excess flow into the east pond. Abstinence from such bypassing is the watchword, since the untreated water is unwelcome on the west side of the Columbia Drain where each horsepower of treatment is expensive.

East and west ponds are treated with a 110hp aeration in the east pond and a 60hp in the west. The overflow from the west pond into the main 6.2 acre-pond is treated further by 7 aerators with a combined force of 315hp. The final pond has a polishing aeration of 60hp. All this done, yet in 1988 the so-called "spring turnover" intruded the vernal air with a stronger than acceptable odor. When April temperatures warm the surface of the ponds, the colder waters rise from the 10 foot depths, and upon reaching the surface, expel any odors which they hold. If that water be anaerobic, then the atmosphere in and around the ponds will absorb it and carry it wherever it may. Neighbors were not pleased. Complaints were lodged with the Department of Natural Resources. Figure #3 illustrates the near total elimination of future complaints as our program progressed.

If the cold lower waters could be aerated, then the spring turnover would be a non-event. Accordingly, in 1989 four 7.5hp "down draft" mixers were launched in the main pond with the mission of maintaining a more uniform mix of the waters, top to bottom. When the spring of '90 arrived, there *were* no foul odors to bring to the top. An unpleasant condition which a *fleet* of aerators may not have righted was cleared with these down draft mixers.

Just before the water is sent to the West Bay County system, it is further polished in the "final pond" with a 60hp aerator. Early on, this water typically has a BOD of 175 mg/l, but it could reach 1,500 by campaign's end. The agreement with the county allows Monitor to discharge a maximum of 1.5 million gallons per day, 4,000 pounds of total solids, 4,000 pounds of BOD - both solids and BOD not to exceed 1500 mg/l. Combining the effects of the Anamet, the aeration, and the down draft mixing, Monitor has been able to hold the volume below 250,000 gallons per day, with solids and the strength proportionately reduced.

But more was needed to insure that the Anamet would perform to its designed capacity. To delight the bacteria with early sustenance, five drums of molasses were added to the digester just before the start of campaign. Then, to further enhance the biological activity in the Anamet, the Mazer people provided Monitor with a product they market called "Bio-Act." The role of this product in maintaining healthy bacteria has become accepted by many operators of wastewater systems. We expected a BOD reduction of about 30% using Bio-Act. The results showed a 43% reduction. After further trials, we determined that Bio-Act also works well with aerobic micro organisms, and therefore we can add it with equal effectiveness *after* the digester and before the aeration ponds.

## MUD DREDGING AND ATTENDANT ODORS

With the ponding of mud comes dredging, and dredging propagates another set of pungencies. The organics trapped within the mud may lie dormant during the colder months, but with the agitation of spring and summer dredging they quickly ripen and come to full bloom. As good luck would have it, a German Company by the name of Bammann and Schreiber (Technoligik) of Zeven, have recently perfected a "screen" or filter that can actually remove fiber from mud while allowing the water and other material to pass through. While somewhat dubious, Monitor elected to try such a device early in the campaign of 1991.

Expecting a few pounds of fiber from the B&S filter, operators quickly found that much more was dropping off the end of the vibrating machine. *Much* more. So successful was the installation that a second filter was purchased and installed for the 1992 campaign. Tests taken from both filters in December of '92 while the factory was slicing 340 tons per hour showed that the filters were delivering a combined 222 pounds of fiber mass per minute.

The fiber mass was very wet - 87%. On a dry basis similar to dried pulp, the fiber mass contained 5% fiber and 9% protein. Monitor decided from these analyses and the relative insignificance of the fiber compared with the wet pulp, to wash the fiber mass, screen it and add it to the exhausted tower diffuser pulp. It is always gratifying to convert a problem into an asset.

Prior to the 1991 campaign, two major problems yet remained which, left unchecked, would nullify much of the good work done toward eliminating pond odors. The larger problem was waste lime ponding and the certain warm weather odors. The other was the disposition of aromatic sand taken from the flume water. Monitor decided to take on the lime waste in 1991 and the sand problem in the summer of 1992. If these projects proved successful, the normal sugar plant odors which had become anathema could be eliminated virtually overnight.

## GOING TO A DRY SYSTEM

Since 1901 waste lime had been slurried to the pond north of the factory. By 1991 that "pond" had gained altitude to become one of the more prominent geographical features in this state not known for its "fourteener" peaks. However, just *reducing* odors from that source would not be sufficient - they had to be *eliminated* for all intents and purposes. Membrane filters have been around for a few years; they insure low sugar retention and high cake solids. As these were the exact qualities we sought to address our problem, we asked Putsch GMBH of Hagen, Germany to give us a hand in sizing the filters and some engineering help in installing a proper station. They were happy to oblige.

With the start of the 1991 campaign, three Putsch filters, PKF 100's (frames 100cm x 100cm) were in place. Commissioning was quite painless, proceeding more uneventfully than we had expected. (The standby readiness of the old rotary vacuum filters proved totally unnecessary.) Performance of the new filters delighted us, doing all and more than the Putsch people had warranted. The sugar loss was reduced to 0.07% on beets; lime cake moisture was less than 30%. Movement of the cake by belt and truck was not so simple as the old slurry method, but the air was now free of offensive odors, and a new by-product was born: _dry_ waste lime. Demand for the material has caught on, to the point that even the "old" lime from the now capped lime pond also is finding users.

Without wet transport of the waste lime, the annual drainage and run-off from the pond to the lower Anamet and aeration system were canceled. The BOD loadings from the lime pond had been of a magnitude of 15,000 mg/l. Cessation of this infusion helped the lower water system remain within its designed parameters. Dense growth of Kochia (sometimes called fireweed) on top of the lime "plateau" kept down any dust which otherwise would be a bane to the neighborhood on windy days. (Remember, Monitor Sugar once was in the country, but now is surrounded by homes with people who, rightfully, expect the Company to control dust and odor.)

Now it was time to move on to the sand problem.

## DEODORIZING SAND

In the web of the thumb of Michigan the soil contains a good percentage of sand. When the beets are pulled from the ground, this sand does not readily slough off as it does out West. The reason is simple. The soil normally is wet in Michigan, almost guaranteed when it is time to harvest sugar beets. This unique mixture of sand and dirt turns into an amalgam of troublesome mud which would find its way into the mud ponds if the sand were not allowed first to settle out. The sand is separated because experience has shown that its gritty nature will wear out most centrifugal pumps and pipe elbows long before their time.

Monitor Sugar uses a beet pump to elevate the beets from the flume to the beet washer. Beet pumps have their good points and bad ones. Since the pump takes beets, flume water, remaining rocks and all, and throws it to the top floor of the factory, it negates the need for a beet wheel and a beet elevator. There the beets are dewatered and discharged into the beet washer. The downside of any beet pump is the damage it does to the beets with its rough handling. The chips it creates pass through the grating of the beet washer and, with the rest of the water and washings, find their way to the screen house. Here *was* the problem: the chips and tailings of different sizes commingled with the mud and the sand. Until 1991 this vegetable material remained, in part, *with* the sand and was the source of odor when spring arrived. So pervasive was it, that the Company was obliged by agreement to move the sand from the property within 60 days of the end of campaign.

Now, in addition to the fiber screens discussed earlier, the Technologik people also provided a screened rotary desanding drum (3.85m diameter x 3.11m depth) for removing tailings and chips from the waste water. Replacing six vibrating screens (5½' x 12') with 1/8" openings, a single new screen with a rating of 9,000 gpm was installed to receive the water from the new desanding drum. Sixteen feet wide and seven feet of working depth, with slotted openings of 1.7mm x 10mm, this endless belt dewaters the mass and sends chips and tailings onto the separation belt just below. This separation belt travels counter to the dewatering belt, thereby allowing the larger beet chips to fall into a scroll while the smaller pieces carry on up with the belt to the macerator (disintegrater) and pulp presses. Instead of being macerated to serve as feed for beet pulp pellets, the chips are transported with clean water, dewatered and fed into the slicers. Maintaining a sugar-in-pellet level of well under 8% is assured by this separation, while increasing sugar extraction. While contributing to odor abatement, the new installation added about 100 tons per day of chips to the slicers, proving once again that we often can find revenue in an environmental project.

## REDUCING POND AREA
## A WASTEWATER CLARIFIER REQUIRED

Since 1936 Monitor separated the sand from the mud because the sand could be removed by settling chambers and drags. Left unseparated, the sand would quickly plug pipelines and mud pumps. When considering the installation of the clarifier, the engineers had to add a sand drag to their plans. The fact that most clarifiers in Western U.S. factories are not preceded with sand drags was a powerful argument for the engineers, but with their intimate knowledge of Michigan sand, the Company decision makers did not waver in the requirement that a drag be included. Figure #4 reflects the settling profile for Monitor's flume water.

From visits to German factories, Company personnel observed the relative shallowness of clarifiers over there as compared with those installed in the U.S. A properly sized clarifier must consider detention time, surface settling rate, solid loadings, launder overflow, temperatures and even short circuiting. The formula for detention time may be found in figure #5. Monitor elected to go with a very broad dish of 200 feet, a shallow outside depth of six feet sloping to a center of 12 feet. Other specifications included:

| | |
|---|---|
| Manufacturer | Envirex of Milwaukee |
| Holding capacity | 2.0 million gallons |
| Maximum hydraulic load | 10,000 gpm |
| Surface settling rate | 500-800 gpd/ft$^2$ |
| Detention time | 100 minutes |
| Maximum influent solids | 450 tpd |
| Effluent solids | 50 tpd |
| TSS* of influent | 8,000 mg/l |
| TSS of effluent | 1,000 mg/l |
| Maximum TSS of underflow mud | 100,000 mg/l |

*(TSS - Total Suspended Solids - See Figures #5 and #6 for in and out loadings).

With a turnkey contract in place, the clarifier construction progressed quite well despite heavy late summer rains. The sand classifier contract was also let to the same contractor. Painfully we learned that the plastic chain on the classifier drag, although highly touted, proved no match for the Michigan sand. The chain lasted less than ten days, and the conversion to steel would take two months! Now the clarifier *would* have to perform *without* the classifier, or the operations of the factory would be in jeopardy.

Key would be the unfaltering performance of the underflow pump: Could it handle not only the mud but also the additional 225 tons of sand per day? The pump is a 40hp, submersible from GPM Inc. of Duluth. We decided to, in part, protect the pump by reducing the solids, but in so doing, had to add to the mud pond volume. Something we did not want to do. Until the "iron" change over for the classifier could be installed in early December, the clarifier *must* be able to fulfill every parameter for which it was designed. Well, it performed like a champion! It was with profound relief, nevertheless, that the now steel classifier was restarted in mid December and the underflow loading was returned to its designed setting. Figure #7 demonstrates the extraordinary ability of the new clarifier to remove as high as 78% of the influent suspended solid. No flocculant was used during the entire 1992/93 campaign.

## SUMMARY

No conclusion may be reached in this chronology, since a constantly changing and insistent society will continue to press for more and more reduction of odors - from wherever the source - to the end that beet processing when viewed may appear a sterile and bland operation. On the immediate horizon is the need to remove even that fragrance of roasting pulp which many heretofore welcomed as a pleasant sign of the fall season.

In the six year span discussed, Monitor Sugar has spent millions of dollars to bring sugar processing odors down to a level where they are either gone or are no longer offensive even to the most delicate and discerning passerby. These atmospheric conditions should now allow for complete enjoyment of other essences, whatever their nature and wherever their origin.

Monitor Sugar has not intended to use this forum to vaunt its efforts in achieving goals which the Company itself set, but rather to share in brief our program which came to fruition even in advance of our hopes.

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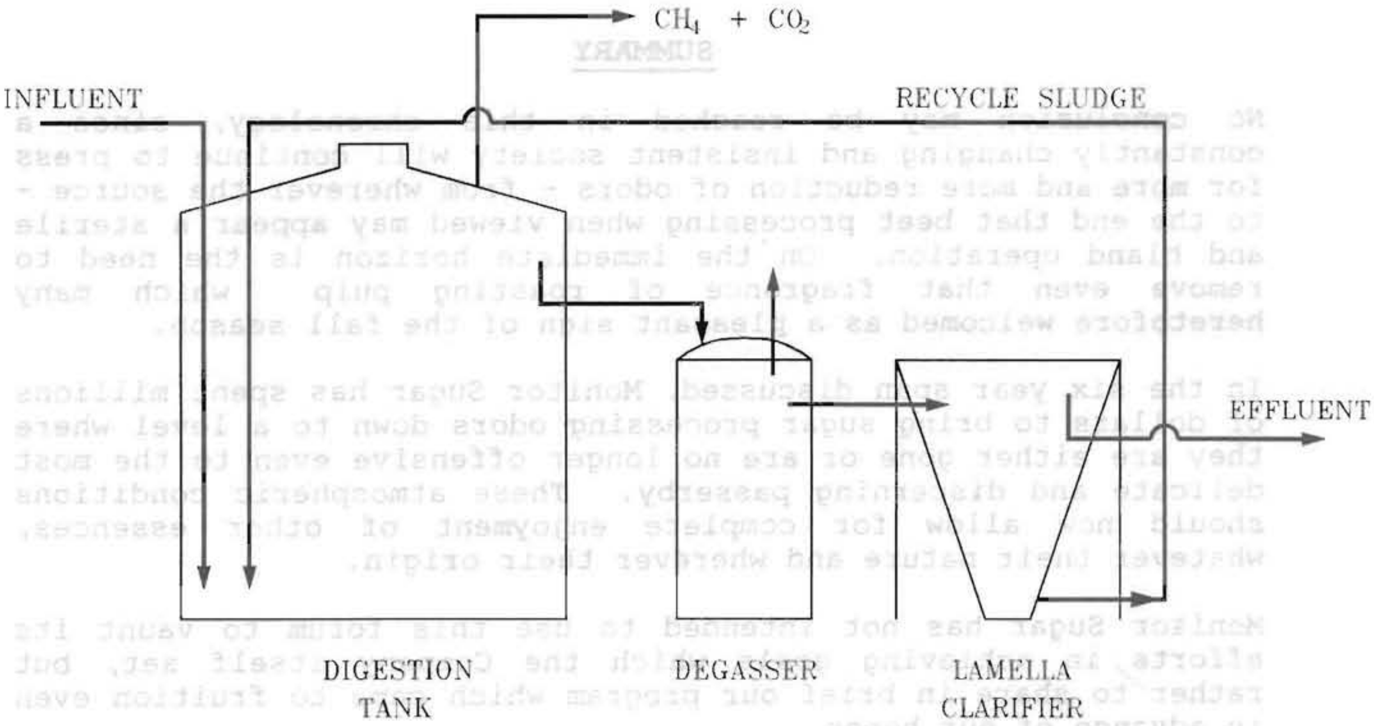



OPERATION PARAMETERS FOR ANAMET:

| | |
|---|---|
| DIGESTER TANK CAPACITY (g) | 1,600,000 |
| HYDRAULIC FLOW (gpd) | 800,000 |
| RETENTION TIME (h) | 12 |
| COD LOAD IN (lb/d) | 68,000 |
| TSS LOAD IN (lb/d) | 3,800 |
| COD LOAD OUT (lb/d) | 9,500 |
| DEGRADATION RATE (%) | 86.0 |

$$\text{DEGRADATION RATE} = \frac{(\text{COD IN} - \text{COD OUT})}{\text{COD IN}} \times 100$$

FIG: 1 ANAMET SYSTEM & ITS OPERATION PARAMETERS

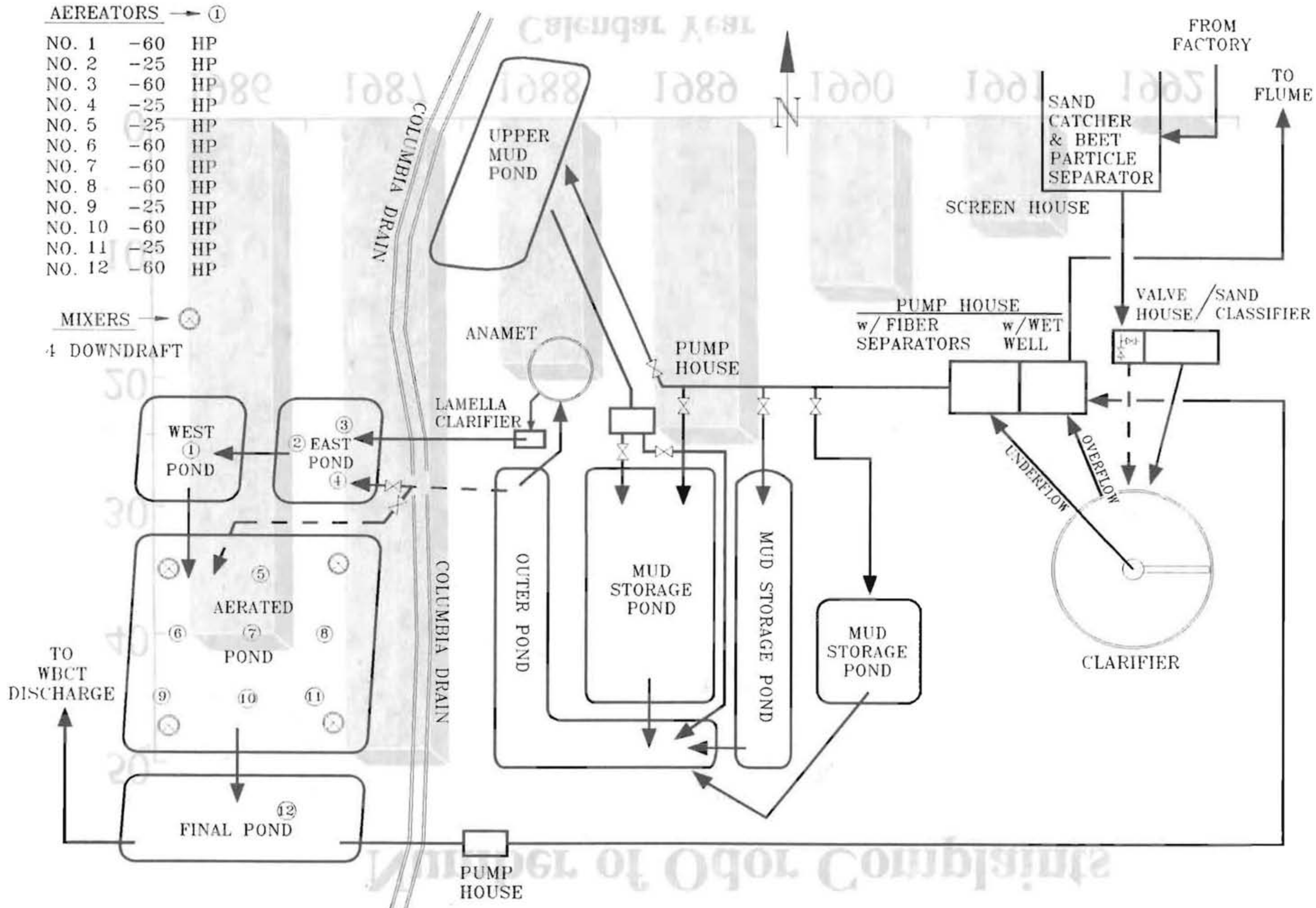



FIG: 2 WASTE WATER TREATMENT FLOW DIAGRAM

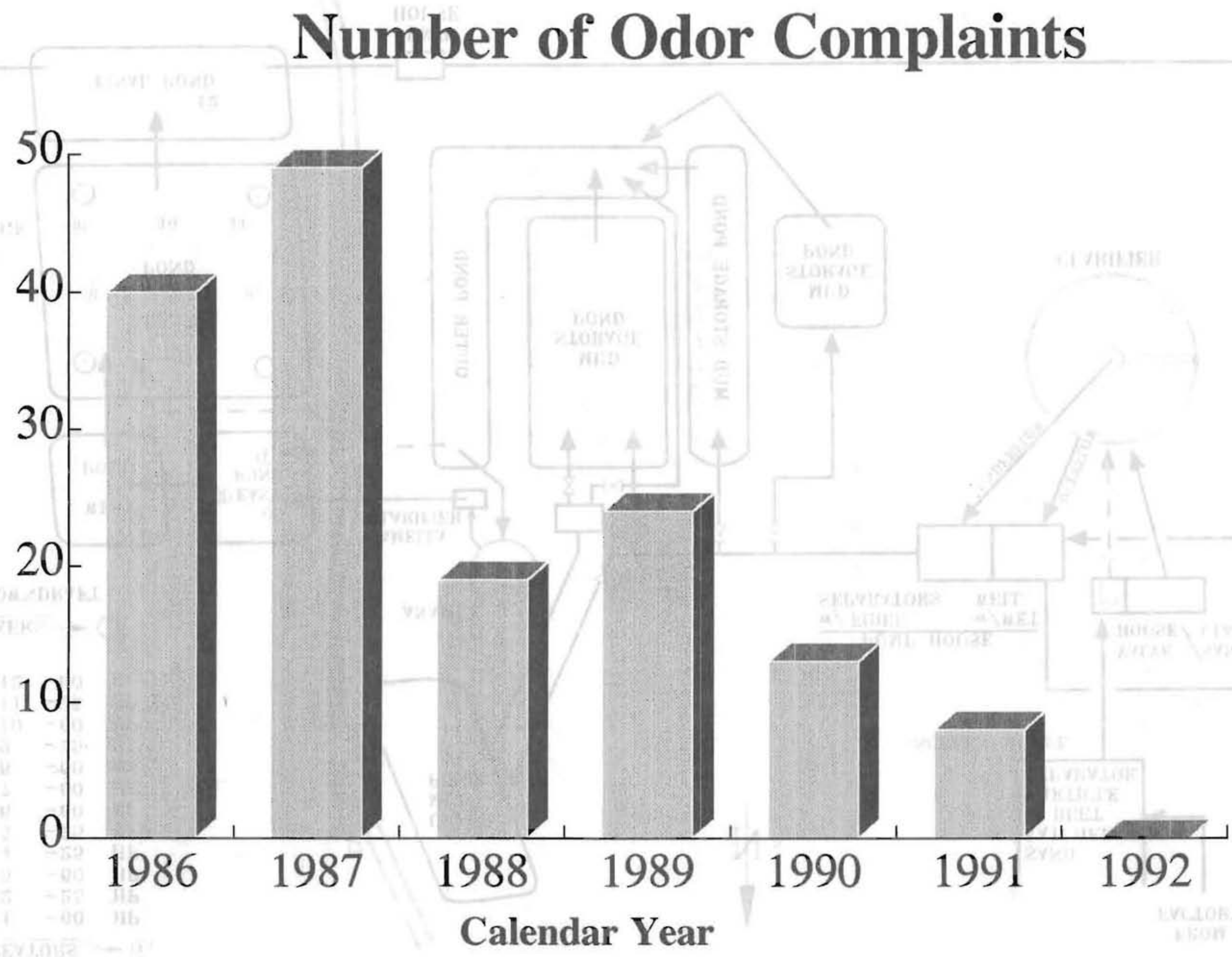



**Figure 3. Number of Odor Complaints**

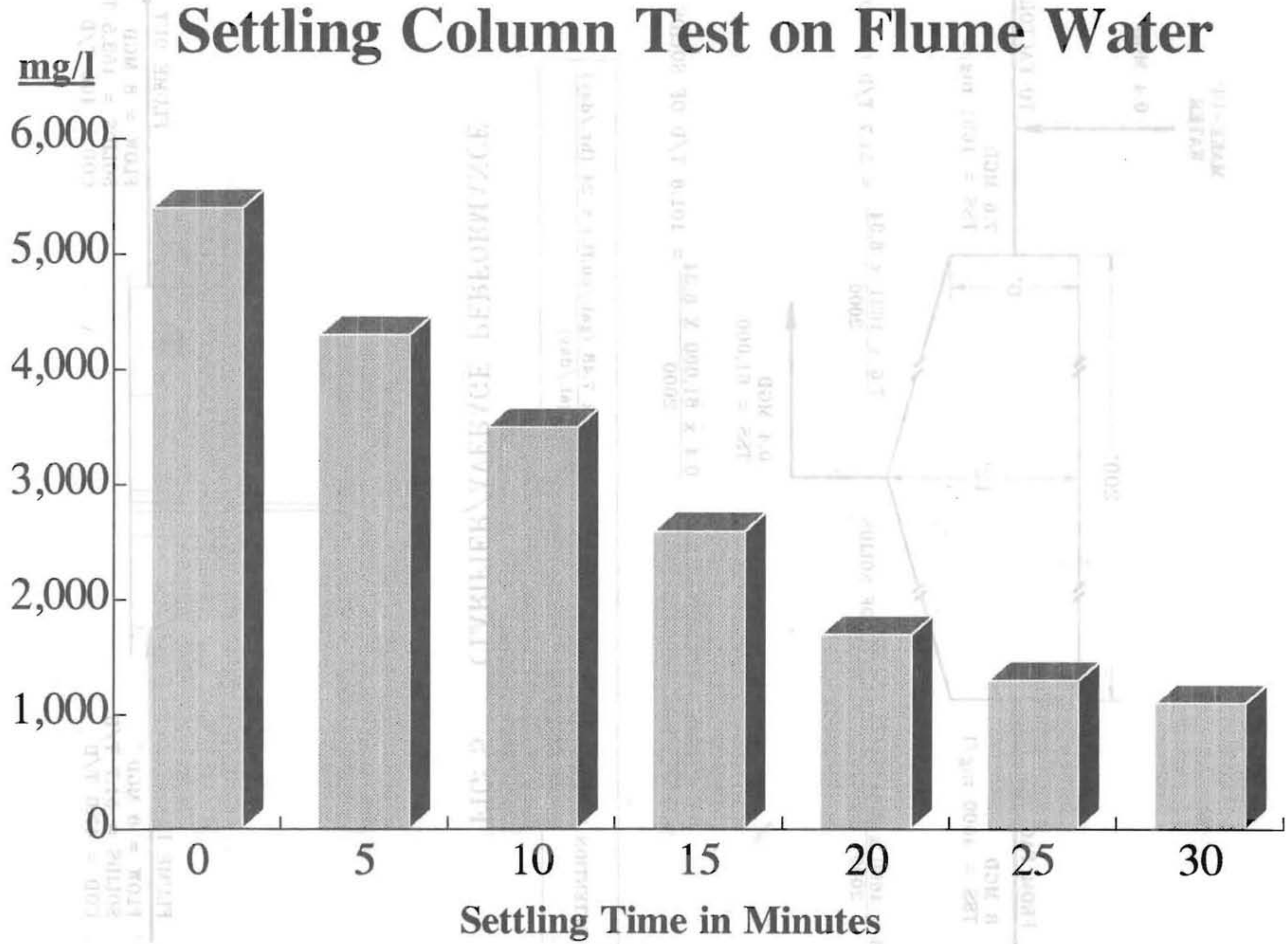
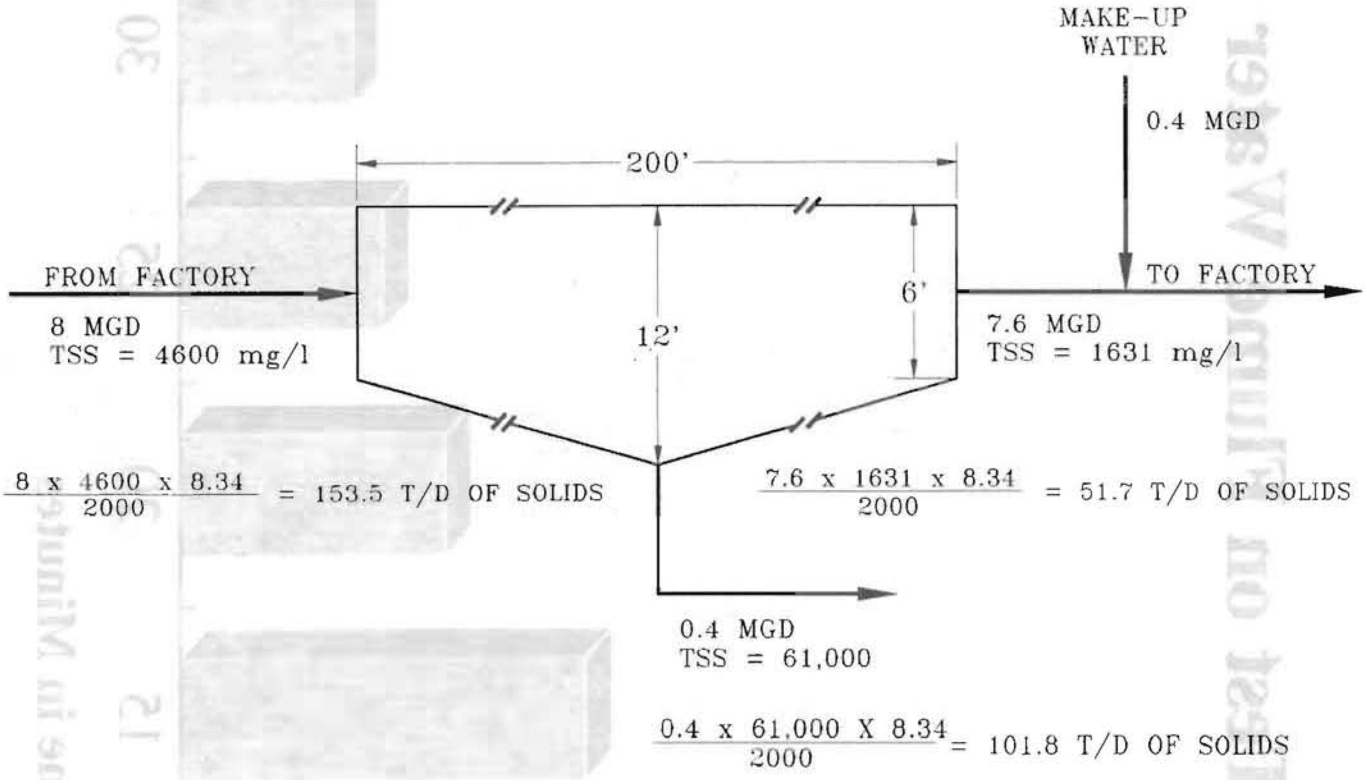



**Figure 4. Settling Column Test on Flume Water**




$$\text{DETENTION TIME (HOUR)} = \frac{\text{Clarifier Volume (cu. ft.)} \times 7.48\ \text{(gal./cu.ft.)} \times 24\ \text{(hr./day)}}{\text{Flow (gal./day)}}$$

FIG: 5 CLARIFIER/AVERAGE PERFORMANCE

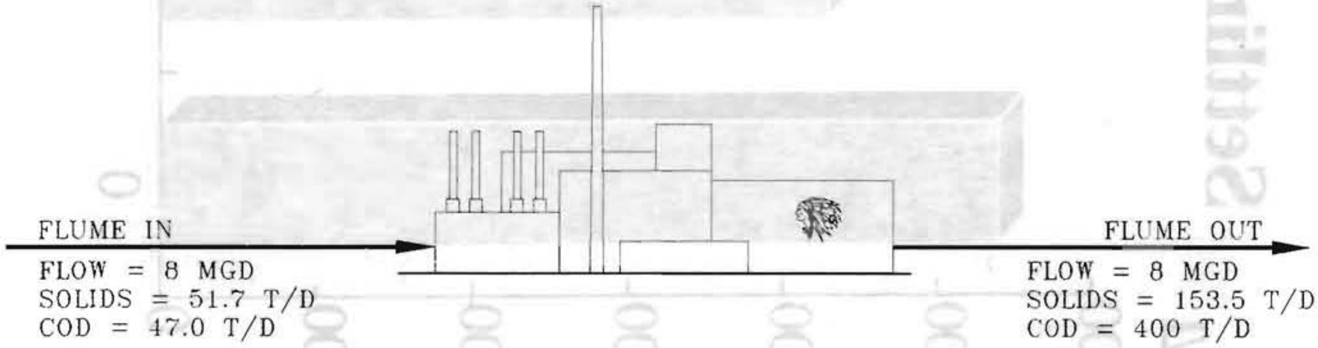



FIG: 6 FLUME WATER COD AND SOLIDS

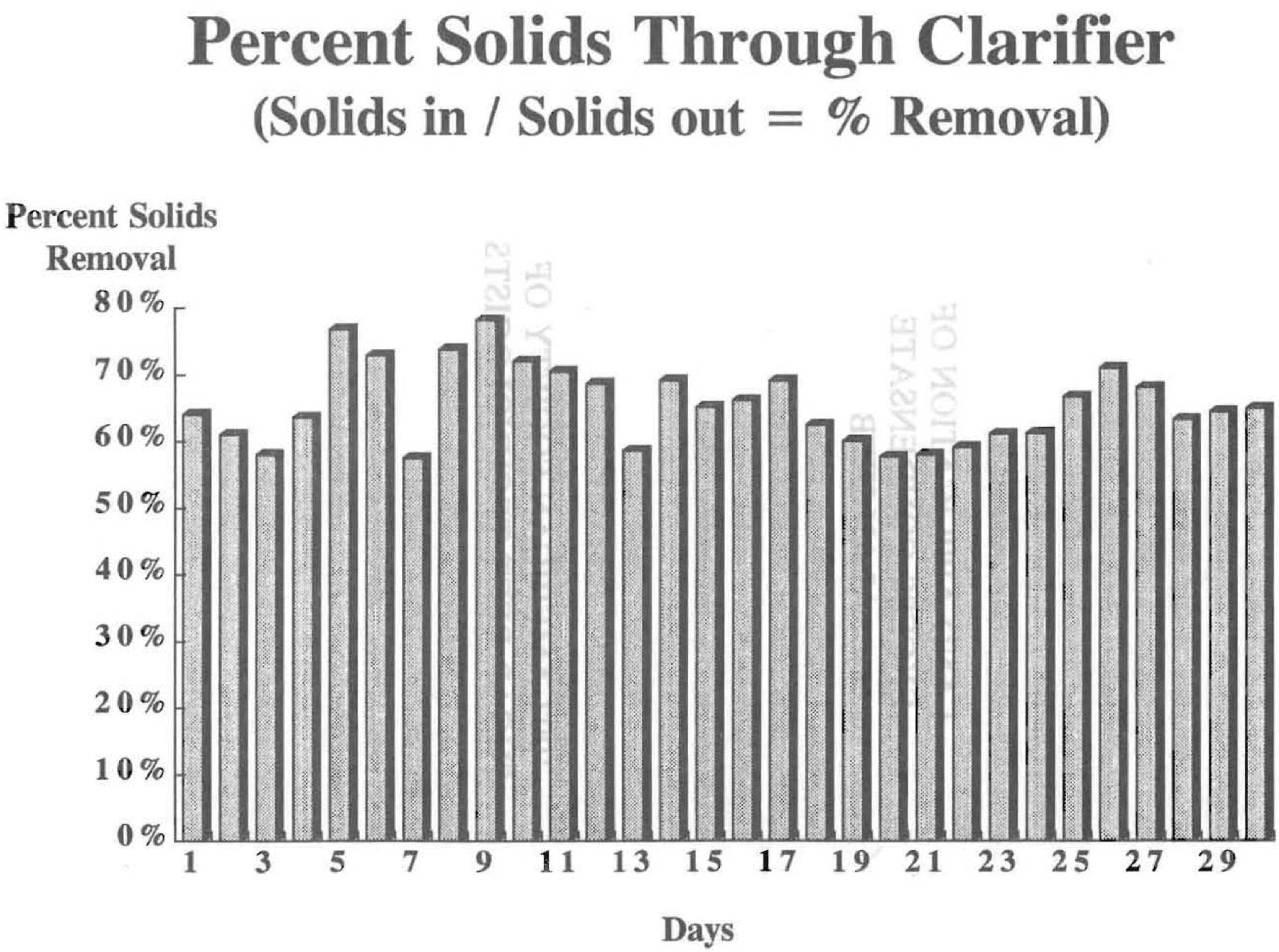



Figure 7. Percent Solids Through Clarifier