PATERSON REPORT
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PERS/GD STATUS

A REPORT TO MESA COUNTY ON

THE PERSIGO WASTEWATER TREATMENT PLANT

AND COLLECTION SERVICE AREA

JIM PATTERSON

MARCH 1985

INTRODUCTION

Over the past ten years as the City of Grand Junction Utilities Director, I have been involved in the construction of the joint City-County Wastewater Treatment Plant. Mesa County authorized and designated the City of Grand Junction Utilities Director to act on the County's behalf in the grant and construction administration. In addition to City-County coordination, I also worked with several sanitation districts in an effort to maintain a regional sewerage system.

Before leaving the employment of the City, I think it is appropriate that I give the County a detailed status report on the sewage system. There were several construction projects associated with the Persigo Wastewater Treatment Plant. The plant construction contract will be closed soon and there is still one major interceptor to be built. A final audit has been made on all but one EPA grant. A preliminary audit has been made on the remaining grant. The final EPA reimbursement request will be made and the final audit will be conducted after the construction contract is closed. Three studies dealing with rates, infiltration/inflow, and the 201 service area are nearing completion. The plant is nearing the end of the first twelve months of operation after which an update of the operation and maintenance manual will be produced. The sewer fund budget is prepared as a part of the total City budget. Revenue estimates are made and compared to operation and maintenance costs including debt reduction costs.

This report will give information on each of the subjects mentioned above and will include my recommendation for the continued operation of the system.

STATUS OF CONSTRUCTION PROJECTS

There were several construction projects funded by separate EPA construction grants and built under separate contracts that together make up the combined City-County Sewage System. Those projects are as follows:

A. Paradise Hills Interceptor - Phase I

B. Flow Equilization Basins (Interim Treatment Plant)
C. Paradise Hills Phase II/River Road Interceptor
D. Independent Avenue Interceptor
E. Tiara Rado Interceptor
F. Goat Wash Interceptor
G. Persigo Treatment Plant
H. Scenic Interceptor

Projects A through F have been constructed and accepted for operation by the City. All of those except D are in operation. The Independent Avenue Interceptor is in use in that there are some service connections on that line. The main diversion of flow from the old line has not been completed, however. The City is now in the process of getting cost estimates to divert the flow and seal the old line. If the contract cost estimates are acceptable the work will be done by a contractor, otherwise the City will complete the work with City forces. In any event the work should be completed early in 1985.

The construction of the Persigo Treatment Plant has been completed and the plant has been in operation for about a year. The total cost of the project including the interim plant, the plant and all of the related interceptors was approximately $28 million. Funding came from $19 million in EPA grants, $1.5 million in state grants, and $8 million in revenue bonds issued by Mesa County. There are still some construction items to be finished therefore, the plant has not been accepted and the project has not been closed. An interim construction inspection was made by Richard Bowman, District Engineer with the Colorado Department of Health on December 19, 1984. His report lists four recommendations that must be addressed. They are as follows:

(1). The problems of sealing the cracks in the floor of the raw sewage pump station must be addressed.
(2). Seepage of ground water into the an aerobic digester pipe gallery must be elimated.
(3). There is some problem with the mixers in the aeration basin drawing too much amperage.

(4). There is fluxuation of the influent flow measuring device to the aeration basin.

These four items are included in a list of at least nine "punch list" items that the City has identified as needing correction or completion prior to acceptance of the plant. The four items listed in Bowman's report are the more important items and are the only requirements that need to be addressed before final inspection and acceptance by EPA and the state. The City will require, however, that all punch list items be addressed satisfactorily prior to acceptance of the plant and closing of the project. The contractor, City Staff, and the Design Engineers are all aware of the punch list items, are working together, and have made good progress toward resolving the items. Some of the items require action from equipment suppliers under warranties and will take some time to complete. In one instance where we thought it was a good idea, we requested and received an additional performance bond from one of the equipment suppliers. I am not aware of any problem at this time that may not be resolved satisfactorily.

Nothing has been done on the Scenic Interceptor. The construction of the other two interceptors to the Redlands resulted in the immediate connection of many users to the system. This, of course, resulted in the collection of a significant amount of money from plant investment fees. Plant investment fees are used specifically to pay the capital construction costs of the project. The Scenic Interceptor will not, at the present time, result in a large number of users connecting to the system. The only immediate user would be Scenic School. The school has a package treatment plant which is apparently operating satisfactorily at the present time. There has been little interest expressed in the area to connect to the sewerage system. Construction of the interceptor now could result in a large capital expenditure with a slow return on plant investment fees. Although, if the line is constructed it may generate some interest in connecting to it.

The reason the three interceptors to the Redlands were included in the project to construct a new sewer plant was because they were eligible for EPA grants

to design and build and because it makes it possible for 2,500 + residential units on the Redlands to use and help pay for the new plant. Because the interceptors were included in the project the estimated 25% local share cost was included in the calculation of the current plant investment fee schedule. Although the Scenic Interceptor is still eligible for EPA grant funding the prospects for getting a grant are very slim. There is a commitment, in a sense, by the City and County to build the interceptor in that 25% of the estimated cost is built into the current fee schedule; however, there is no provision currently to cover the 75% share that would have been covered by EPA grants, as was also the case with the Tiara Rado and Goat Wash Interceptors.

These are the only projects that were intended to be constructed by the City and County as capital improvement projects. All other collection lines are to be constructed by property owners, developers, or by local improvement districts with the costs to be assessed to the property owners. The City has an established procedure for improvement districts within the City limits. The County is currently in the process of establishing a procedure for establishing local improvement districts to construct local sewage collection systems. This procedure will be set forth in a manual being written by Mesa County.

STATUS OF EPA GRANTS

The City and County have received fourteen EPA grants throughout the project. The first grant was to prepare the 201 facilities plan. After that, separate design and construction grants were awarded for each conctruction project. All of the grants except five have been closed. The five that have not been closed are the construction grants on projects C through G. A final audit has been made on four of the remaining five and preliminary audit has been made on the fifth, which is the Persigo Plant.

When the preliminary audit report was made on the five remaining grants, some costs were determined to be ineligible, some costs were questioned and some costs were set aside for verification. The total amount of the grants questioned at that time was about $280,000. We responded to the preliminary audit report with additional information about the questioned items. When

the draft final audit report was prepared the questioned costs had been reduced to $113,022. We met with EPA officicals in Denver after receiving the draft final report because we still believed that some of the questioned costs should be accepted. The EPA Staff in Denver indicated that some of our arguments were probably valid and asked us to submit a written summary. We are now waiting for a response which should be the final audit report of the four grants which are ready to be closed the questioned costs involve only two. Everyone is in agreement to close the other two as they are.

The fifth grant which is for the construction of the Persigo Plant can not be closed until the construction contract is closed and until the plant is accepted. The EPA officials in Denver, however, did also say that the preliminary audit might also serve as the final audit when the project is closed.

STATE, FEDERAL, AND FINANCIAL REQUIREMENTS

NPDES PERMIT

There are many standards established by the discharge permit for the Persigo Plant. The main two of concern and prime indicators of how well the plant is operating are BOD and suspended solids. The limit for each of these is 30 milligrams per liter of plant effluent.

The initial plant start up was in January 1984 with temperatures near or below zero degress farenheight. It is difficult to get an activated sludge plant started under ideal conditions; yet the Persigo plant reached compliance limitations within a week of start up under these extreme temperature conditions. The start up went so well that we immediately shut the old plant down. We had originally anticipated running both plants for one to three months in case we had difficulties with the new plant.

Included in this report is a report from Paul Trout of Henningson, Durham, and Richardson, Inc. to Ralph Sterry. Among other things, the report from Trout contains information about the plant start up and the quality of the plant effluent. There are several charts that compare the plant effluent with the discharge permit requirements. It can be seen that the BOD averages about 10 milligrams per liter and that suspended solids average about 15 milligrams

per liter. These are well within the limits. While it is conceivable that a lower BOD and suspended solids level could be produced with more effort and expense it would produce no additional benefit to the environment to do so. The plant has operated well on a consistant basis. While any activated sludge plant can easily be upset by toxic material or any adverse conditions, there is no reason to believe that the Persigo Plant will not continue to operate within the permit limitations until it reaches capacity. Of course, all users and influent sewage must be monitored to prevent any material from entering the plant that would be harmful to plant personnel or plant operations.

INDUSTRIAL PRETREATMENT PROGRAM

The industrial pretreatment program for the Persigo service area has been approved. Public meetings were held and businesses were notified so that those effected would be aware of and participate in the formation of the program. Initially there will be five permits issued to local industrial users. A high BOD appears to be the primary area of concern from the five industries.

All heavy commerical and industrial users should continue to be monitered. It is important that no material be allowed to enter the plant which would be harmful to the plant operation or the plant personnel. The community has a major investment in the plant. A single user or group of users should not be allowed to interfere with proper plant operations for which the City and County would be legally responsible and all users of the system would have to share financially in correcting.

An annual report describing the pretreatment program, any violations, and the results of the program must be submitted to EPA. The first report is due in June 1985.

SLUDGE DISPOSAL PROGRAM

Two types of sludge dewatering systems were designed and constructed in the Persigo treatment plant. This not only gives flexibility and back up

support in the plant operation, but it also gives two different types of dried sludge for greater disposal flexibility. Plant personnel have investigated and visited other plants to observe and gain information about various methods of sludge disposal. Disposal other than landfill is desired because of limited landfill capacity in Mesa County and because of potential benefit to generally poor soil conditions in the area. A draft copy of "Sludge to Land Management Plan" has been prepared by the plant staff. A Copy of the plan (minus the appendix) is attached to this report. The plan appears to be comprehensive and well thought out. The original time tables set in the plan can no longer be met, but the steps identified should be followed to establish a sludge disposal program.

The discontinuance of disposal of digested sewage from the treatment plant at the landfill should not lend to confusion regarding the acceptence of harmful substances at the treatment plant. Toxic sludges or septic pumpings containing large amounts of oil and grease can not be accepted at the plant. Also, screenings and grease removal at the plant will still have to be disposed of by landfill. There are continuing monitoring requirements for all parcels of land on which sludge is disposed.

BOND REQUIREMENTS

Both EPA and our bonding commitments require that fee and rate structures be established that will produce adequate revenue to cover operating, debt retirement, and replacement costs. At the time the bonds were sold a cash flow projection was made that estimated revenue from tap fees and showed annual monthly service charge increases to provide the needed revenue. By following the cash flow projections and making annual adjustment in the monthly service fee, the sewer fund has been self supporting for the last five years. No monies are currently being accumulated for a plant expansion which may be needed around 1995.

It was agreed in the bonding commitments that the City would hire an independent engineer once each five years to conduct a rate study to determine if rate revenues are adequate and to make recommendations regarding fees

and service charges. The EPA requires that all fees and service charges be fair and equitable in that each user pays a proportionate share of the cost of construction and operation according to the proportionate share of the plant capacity that is required for that user. As a result, a uniform user fee system has been established according to class of user. The single family home has been established as a class of user. The single family home is used as the base unit, or one equivalent unit. All other users are grouped into classes and a formula is used to determine the number of equivalent units assigned to each user. For example, motels are one class of use and 0.36 equivalent units are assigned for each room in the motel. Other examples of classes of users are restaurants, laundrymats, office buildings, churches, etc.

The formula used to calculate the number of equivalent units for each user was taken from EPA quidelines and modified to apply to Grand Junction area users.

The philosophy under which the current tap fee structure was set up is that users in existance at the time the new plant was constructed should share in the capital construction debt retirement as well as new users. The reason for this is because the existing users would have faced a capital cost to continue to use the old plant even if there had been no new users. The old plant, which was constructed in 1938, needed major replacements and upgrading in order to meet discharge standards established in 1972. Rather than make the improvements to the old plant plus construct a second plant for additional growth, it was more economical to operate one new plant large enough to accomodate the existing users plus new users for a ten year growth period. Since there was a benefit to existing users in building a new plant some debt retirement is calculated into the monthly service fee. About one-half of the debt retirement costs are collected from tap fees from new users and the remainder is collected through monthly service charges paid by both old and new users. Throughout this report where the term "tap fee" is used it refers only to the plant investment fee portion or the total tap fee set by the City of Grand Junction. An additional capital improvement charge is added to the tap fee in the City where the City has constructed the local

sewage collection system without an assessment to the property owner.

STATUS OF STUDIES

RATE STUDY

ARIX, Inc. has been hired to do the first rate study by an independent engineer. ARIX has developed computer models which the City can use annually to update the rate structures. Each year the annual costs and user information can be put into the model to determine what rates are required to balance the budget. In the future the models may be modified or new methods developed to reflect the philosophy of the City and County at that time. Generally EPA and bonding commitments require that rates be fair and equitable and that they generate enough revenue to cover the cost of operating the system.

The 1985 budget information is just now being put into the model. Information should be available soon regarding rate recommendations for 1985 or 1986.

I & I STUDY

As part of the EPA grant conditions and as part of the discharge permit conditions the City was required to perform a study on the quantity of infiltration and inflow into the system. Projects must be identified and priorities established for separation of storm sewers and the elimination of as much inflow and infiltration as is economically feasible. Nichols and Associates Inc., was hired to do this study. The study has been completed and currently is being printed. The recommendations should be evaluated and incorporated into the five year capital improvement plans and annual budgets as soon as it is feasible to do so. In the future all connector districts should be required to establish and implement programs to identify and eliminate excessive infiltration and in flow. If this is not done by a District then that District should pay an additional proportionate share of the cost of the plant expansion when it is needed. The City and each District should bear the cost of the projects for the elimination of excessive infiltration and inflow independent of the sewer fund unless the project mutually benefits all users of the system.

201 UPDATE STUDY

The EPA has required the City to perform an analysis of current conditions relating to population growth and land uses so that a comparison can be made to the original assumptions that were made in these areas. The original assumptions and information generated from those assumptions determined the size of the plant and interceptors that were built.

In addition to the EPA requirements, Mesa County wanted to know the effects of changing the 201 service area boundry. An analysis was made of each drainage basin area and the size of interceptor required to serve that basin based on the current population projections and land uses. It can be calculated what the additional sewage flows and/or alternate land uses will do to the interceptor size requirements. It can also be determined what effect additional sewage flows will have on the ultimate plant capacity.

ARIX, Inc., was also selected to do this study. Although work has begun on the study a higher priority was given to the rate study and the 201 update is not yet complete. It should be finished in the near future. ARIX and the City are currently trying to determine what population growth (or decline) assumptions should be made.

CURRENT OPERATION AND MAINTENANCE

The Persigo plant is fully staffed with professional personnel as was outlined in the original operations plan. The plant came into required operations compliance within a week of start up and has continued to operate well with very few permit violations.

The report from Paul Trout, which is attached, gives information about the start up period and the current operations and management. There have been a few personnel problems such as may be experienced in any organization, but in general the personnel work with pride and with a very professional attitude and skill. A heavy emphasis is given to preventative maintenance. This is very important at a wastewater treatment plant because of the very

corrosive nature of atmosphere. The plant is a major investment of the community and its protection must receive the highest priority.

In addition to maintaining the plant equipment, the plant must be operated to avoid discharge permit violations. Activated sludge plants are sensitive to extreme weather conditions and the introduction of toxic or harmful materials will cause occasional permit violations. These cannot be avoided but they will be kept to a minimum by carefully monitoring and controlling the material that enters the plant. The industrial pretreatment program will help do this. It should not be assumed that just any waste material can be put into a wastewater treatment plant. Some industrial wastes, toxic material, grease etc. cannot be accepted by the plant. These conditions are outlined in the current sewer use ordinances.

In addition to plant maintenance, the City maintains it's own collection system as well as the collection system of most of the districts. The City has agreed to contract with the districts for maintenance of the collection systems in an effort to avoid duplication of services. This should be continued where it is shown to be cost effective. The City should also be careful to recognize it's obligation to provide a reasonable level of preventative maintenance effort. The City has not added equipment and personnel at the same rate that the system has grown and the level of preventative maintenance efforts has decreased over the years.

STATUS OF SEWER FUND

The sewer fund has received about $20 million in EPA grants and about $2 million in state grants during the last ten years. The grants along with the revenue generated from tap fees and monthly service charges and $8.2 million in revenue bonds has made the sewer fund self supporting. In 1984 there was a carryover of $4 million in the sewer fund. Grant reimbursement payments are still being received and some residual from bond proceeds still exists. This along with higher than expected revenues from tap fees has made the carryovers possible. The carryover is being used up however, due to completion

of construction and engineering services as well as some capital construction that was not included in the plant construction contract.

The City Council has made annual adjustments in monthly service fees in an effort to meet increased costs of operation and to reduce the need to depend on carryover revenue. There has not been a rate increase for 1985. The City reviews operating costs and the fees necessary to generate needed revenue as part of the annual budgeting process. The budget and fee recommendations are then presented to Mesa County for review and approval prior to enactment by City Ordinance.

In 1984 the operating expenses were $2.9 million and revenue was $3 million. In 1985 the operating expenses will be about $2.6 million and revenue will be about $2.7 million. With other capital expenses added, however, the total cost of the sewer system in 1985 will be $4 million which means $1.3 million in carryover will be used. There is enough carryover revenue so that a reduction in carryover is possible, however, it should be acknowledged that if the current level of expenditures continues that additional revenue will be needed.

The EPA requires that the system be self supporting and that the sewer fund be kept separate from all other funds. It is also important that fees be fair and equitable and that all users pay a proportionate share of the cost based on the proportionate share of system capacity needed by that user. An arbitrary fee reduction or waiver for a single user or group of users should not be offset by contributions from other users of the system. This would circumvent the fair and equitable user fee system and would be a violation of the EPA grant agreements. If a user or group of users brought such a violation to the attention of EPA it is possible that EPA would demand a refund of all grant monies received by the City and County.

RECOMMENDATIONS

It is my recommendation that the following actions be taken or completed.

(1). The Scenic Interceptor should be designed as soon as possible

Construction can be scheduled to coinside with the demand and need for the interceptor to serve the drainage basin on the Redlands that drains by Scenic School.

(2). The Independent Avenue interceptor should be fully activated as soon as possible.

(3). The EPA grant should be closed and final payment requested.

(4). The industrial pretreatment program should be fully implemented and the first permits issued. The first annual report is due to EPA in June 1985. No industrial wastes that are detrimental to the plant operations should be allowed to be discharged into the system.

(5). The sludge disposal program should be formally adopted and implemented as soon as possible.

(6). Rates and fees should be reviewed and adjusted annually to keep the system self supporting.

(7). The sewer separation program should be adopted and implemented as soon as it is economically feasible. Districts should also implement programs or prepare to pay for the additional needed plant capacity.

(8). The plant should continue to be operated under the current priorities and with the current level of staff.

HDR

To Ralph Sterry, Utilities Supervisor
City of Grand Junction, Colorado

From Paul Trout, Senior Operations Specialist
Henningson, Durham & Richardson, Inc.

Subject Persigo Wastewater Treatment Facility

Date February 8, 1985

Per your request, I am forwarding my comments related to your items of concern discussed during our meeting of 1/24/85.

I would like to preface my specific comments with the following items:

1. Following comments are based upon personal observations made during visits to the facility during the start-up and performance demonstration phases of the project. My personal perspective on activities and conditions at the facility are basically a comparison of the Grand Junction facility with some 20 other O & M related projects I have been involved with over the past 10 years.

2. Overall, the management, operations and maintenance staff of the Persigo Facility, as well as the people served by the treatment system, have reason to be proud of what has been accomplished by the staff over the past year's operation.

3. As I indicated during our discussion, we anticipate preparing a report that summarizes actual process performance data for the first year's operation. Included in this report will be a comparison of actual loadings and performance with the design values established. The goal of the report will be to assess the ability of the system to perform as designed. The report will summarize operation and maintenance activities over the past year and list recommendations for future operation. We anticipate completing this report by the end of April, 1985.

1. MANAGEMENT

I believe the management staff has done an excellent job of accomplishing the primary goal of producing an effluent that meets the NPDES requirements of the facility. It is my impression that the management (most specifically Jerry O'Brien) has the ability to identify and utilize those individuals on the staff that are most competent, in terms of applying their understanding of process control theory to the operation of their specific facility. One instance where this has made a particular difference is in the operation of the anaerobic digesters where a change in personnel made by management was a key factor in successfully bringing the system on-line.

In our dealings with the management staff, we have received what I consider to be above average cooperation. Management and lead personnel have not been reluctant to ask advice or express concerns and have been open to discussions and suggestions. To me, this is

indicative of a healthy situation where the staff rightly relies on their own in-house expertise but is willing to seek and accept advice when conditions arise that they may be unfamiliar with.

2. TRAINING

Since I am not presently aware of all in-house training activities that exist at the Persigo Facility I can only address comments to two areas: 1) operator competence at start-up and 2) operations staff ability to successfully operate facility.

As you are aware, I was involved in formal operator training beginning approximately one month prior to actual start-up. Based upon my experience during these training sessions, the operators were one of the best prepared groups I have had the opportunity to work with. They had a good understanding of the physical plant, the direct process controls available and major flow routings. It's important to note that this is not a common situation. I would not hesitate to say that the reason this group was well prepared was because of the thought and effort given by management to the development of an in-house training program far in advance of facility start-up.

The ability of the staff to successfully operate the facility with the training received is evidenced by the fact that the effluent quality has continually bettered NPDES requirements during this first year of operation.

3. PROCESS PERFORMANCE/EFFLUENT QUALITY

You have indicated that some personnel have voiced the opinion that the effluent quality is not as good as it could be due to management and/or design.

When considering effluent quality the prime consideration is whether or not it meets the specified requirements of the discharge permit. Persigo's does; there is no question about that.

Going beyond this prime consideration, it can be said that presently, the facility may not be producing the "best" effluent that it is capable of. Attached you will find trend charts that show process loadings and performance for the operation period from start-up to date.

The trend charts included and a description of the information presented by each is as follows:

Figure	Description
1	Total Wastewater Treated
2	Reported Average Daily Influent Flow vs. Design Average
3	Reported Maximum Day Influent Flow vs. Design Dry & Wet Weather Design
4	Influent vs. Effluent BOD Concentration, & Removal & NPDES Month Average Discharge Limit

5 BOD Loadings, Reported vs. Design for Influent & Effluent; NPDES Month Average Discharge Limit
6 BOD Mass Removal, Reported vs. Design
7 Influent vs. Effluent TSS Concentration, % Removal & NPDES Month Average Discharge Limit
8 TSS Loadings, Reported vs. Design for Influent & Effluent, NPDES Month Average Discharge Limit
9 TSS Mass Removal, Reported vs. Design
10 Anaerobic Digester Volatile Solids Loading - Lbs/Day
11 Anaerobic Digester Volatile Solids Loading - Lbs/Ft^3/Day
12 Primary Digester Volatile Acids vs. Alkalinity
13 Primary Digester Volatile Acid/Alkalinity Ratio
14 Primary Digester pH
15 Raw Sludge % Volatile Solids vs. Digested Sludge % Volatile Solids
16 Digester Gas - % CO_2 vs. % CH_4
17 Digester Gas Production

Referring to Figures 4 & 7 it can be seen that effluent BOD has been as low as 6 mg/l but generally averages around 10 mg/l (1/3 the permitted level). TSS concentrations have followed the same general trend. It is commendable that the operations staff would like to be able to point to the effluent from their facility and say it consistently achieves this high level of treatment. However, almost invariably, increasing the level of treatment from say 20 mg/l BOD and TSS to 5 mg/l BOD and TSS is going to cost more in terms of additional manhours for close process control and added power/chemical costs. It just makes good business sense to treat to the level required to protect the receiving stream and maintain permit compliance while not maintaining a degree of treatment that places an unnecessary burden on the facility's operating budget and ultimately the rate-payer.

My personal observation has been that management is actively and successfully working to maintain the required level of treatment while initiating changes in operation and equipment that will provide the most cost-effective operation.

Regarding the actual capabilities of the facility versus design, I would once again refer to the attached trend charts. Please note that we are comparing reported loadings with 1/2 the particular design value to be consistent with the portion of the facility utilized to date. For the major process parameters (flow, BOD & TSS), the average facility influent loadings have been near or exceeded the design criteria for the portion of the facility being utilized for the past several months. Facility effluent loadings have been less than design and, as can be seen from Figures 6 & 9, the treatment system has consistently provided greater than design mass removals for BOD & TSS. Based on these trends, it would be safe to say that the liquid stream portion treatment facility will provide at least the capacity that it was designed for. I have also included process trend charts for the anaerobic digestion system. Due to present solids loading levels, it is not possible to verify actual performance at full design loading.

The process trends do indicate that once the digestion process stabilized within acceptable ranges (beginning approx. July 1; 84) ongoing process control has resulted in a stable, efficient operation.

Once again, these items will be addressed in greater detail for individual treatment processes in the report I mentioned earlier.

4. TASK ASSIGNMENTS

You have indicated that some personnel have complained that they are only allowed to monitor treatment processes and are not allowed to "operate". I'm not sure what they mean by this but I suspect they mean that they are not allowed to make independent process control decisions and changes. Based on this assumption, I would offer the following comments.

First of all, the NPDES permit issued for the facility requires that one person be named as being responsible for meeting the permit conditions. Consequently the facility superintendent, Jerry O'Brien, is responsible for seeing that the facility consistently meets specified treatment levels; and his certification and reputation are "on-the-line" if it doesn't. Based on this, it becomes necessary for the superintendent to set process control goals based upon his knowledge and experience along with input from key personnel charged with the responsibility of monitoring and operating individual processes within the facility. Once a goal has been established and a set of process control criteria established, that program must be adhered to in order to determine whether or not the program will allow the established goal to be reached. Any actions that deviate from the established process control program can delay the desired final result and make it more difficult to determine whether or not the process control program is appropriate for a given set of conditions.

What this all boils down to is that it becomes difficult if not impossible to properly operate a complex facility such as Persigo if everyone is running around making independent process control decisions and changes. There has to be one person who has overall responsibility and works as a team with key people in the various process areas to allow the facility to operate successfully as a single system. It has been my impression that this is happening at Persigo.

5. START-UP AND CONTINUING OPERATION

As mentioned previously, in our judgement the operations staff was well prepared for start-up due to their own initiative as well as that of management personnel. Overall the actual start-up of the facility which included establishing flow through the plant, verifying operation of equipment, bringing individual unit processes on-line and establishing and maintaining a process control program was and continues to be quite successful. Recalling the first 3-months of operation, problems normally associated with this shakedown period were less than we would normally anticipate for a facility such as Persigo. At no time did any situation occur that prevented the facility from meeting permit conditions.

Continuing operation of the facility appears to be good to excellent based on a review of operating data. Visits to the site during the past several months indicate that the staff is continuing to actively control the processes.

A good example of this is the discussions we had with Jerry, Emily and Michael Drake during our visit last week. During the past several months, heavy, greasy foam has been prevalent on the aeration basins and the final clarifiers. Also, the activated sludge process has consistently been removing almost all the applied ammonia nitrogen. Both these conditions are typical of a high sludge age. Consistent with good application of process control theory, the staff has taken steps to reduce sludge age through increased wasting. Presently, all calculations indicate that the sludge age is approximately 5 days, aeration basin/clarifier appearance has improved and ammonia removal has been reduced. However, some greasy foam is still evident and effluent turbidity is somewhat higher than what we have seen in the past. Review of process data indicates that while the raw influent organic loading is close to the design value for the amount of plant being utilized, the aeration basin organic loading has been approximately 1/2 the design loading for 2 basins. This results in an F:M ratio of approximately 0.2 which we believe is resulting in the physical appearance of the process not being consistent with a 5-day sludge age. It is our understanding that further adjustments in process control will be made to verify whether or not this is the case.

The important point that I see in all this is that all the staff-related elements are present to allow continuing successful operation.

1. Staff has identified an undesirable situation and taken proper steps to correct it.

2. Monitoring, both by observation and data manipulation, has continued throughout changes in the control program to verify if program is appropriate.

3. Staff realizes that results of changes to the process control program are not immediately obvious due to slow changes in biological systems.

4. No single process control parameter has been relied upon to tell the total story on the condition of the process.

5. When monitoring results do not show a clearcut problem, personnel are willing to seek outside advice.

Given that these skills and approaches continue to be present at the Persigo facility, the system should continue to provide the good results that it has to date.

MAINTENANCE

From routine observations around the plant during the past several months, my impression has been that the buildings and equipment are

being well maintained. All areas are clean and it appears that equipment lubrication is being kept up.

From discussions with the maintenance staff during the time we were setting up the computerized maintenance management system I know that good preventive maintenance is a high priority with them. Implementation of the maintenance management system by the staff has been very good, they have maintained the necessary records to keep the system curent and continue to work on new and better ways to utilize the system.

SUMMARY & RECOMMENDATIONS

When comparing the Persigo Wastewater Treatment Facility with other projects I have been involved with, I would personally rate the overall operation above-average to excellent. I believe that someone visiting the facility for the first time would have the impression that this is a well operated and maintained operation. From our standpoint, there are several people on staff that are to be especially commended for the effort they have put fortn during this first year's operation. Those individuals include Jerry O'Brien, Emily Wittum, John Evans, Terry Franklin and his staff, Sandy Warner, Michael Drake, Mickey Drake, Jay Vancil and Neal Tripp and his staff. Their effort and cooperation has greatly enhanced our ability to fulfill contractual obligations related to startup, performance demonstration and development of the process data and maintenance management systems.

I have not yet worked with a facility where everyone is completely satisfied with how they are treated or how the organization and plant are managed. Evidently, this condition also exists at Persigo based on the operators complaints that you have related to us. Putting these complaints into perspective, I have heard a city administrator for a facility say he wasn't in favor of spending money for operator training because "they would probably be training the operator to get a job somewhere else and they would probably have to raise his salary from $5.00/hr." I have also seen facilities where operators were fired on the spot without appeal, for relatively small infractions. It has been obvious that attitudes of this type toward operating personnel are not present at Persigo.

Often times, morale can be improved and facility operation enhanced by developing a system where all personnel have the opportunity to upgrade their knowledge of the facility while making a positive contribution to it's overall operation. This has been accomplished in some plants through improved communications in conjunction with regularly scheduled workshop sessions that include all operators and concentrate on individual process areas. This type of training can be more cost-effective than more general outside training since it allows operators to 1) understand and have input into establishing process control goals and 2) understand the response of their specific facility to process control changes. In order for these sessions to be successful, personnel must be willing to participate and make a positive contribution.

I hope the preceding comments will be of assistance to you. If you have questions on any of my comments or we can be of further assistance, please don't hesitate to contact me.

PERSIGO WASTEWATER TREATMENT FACILITY

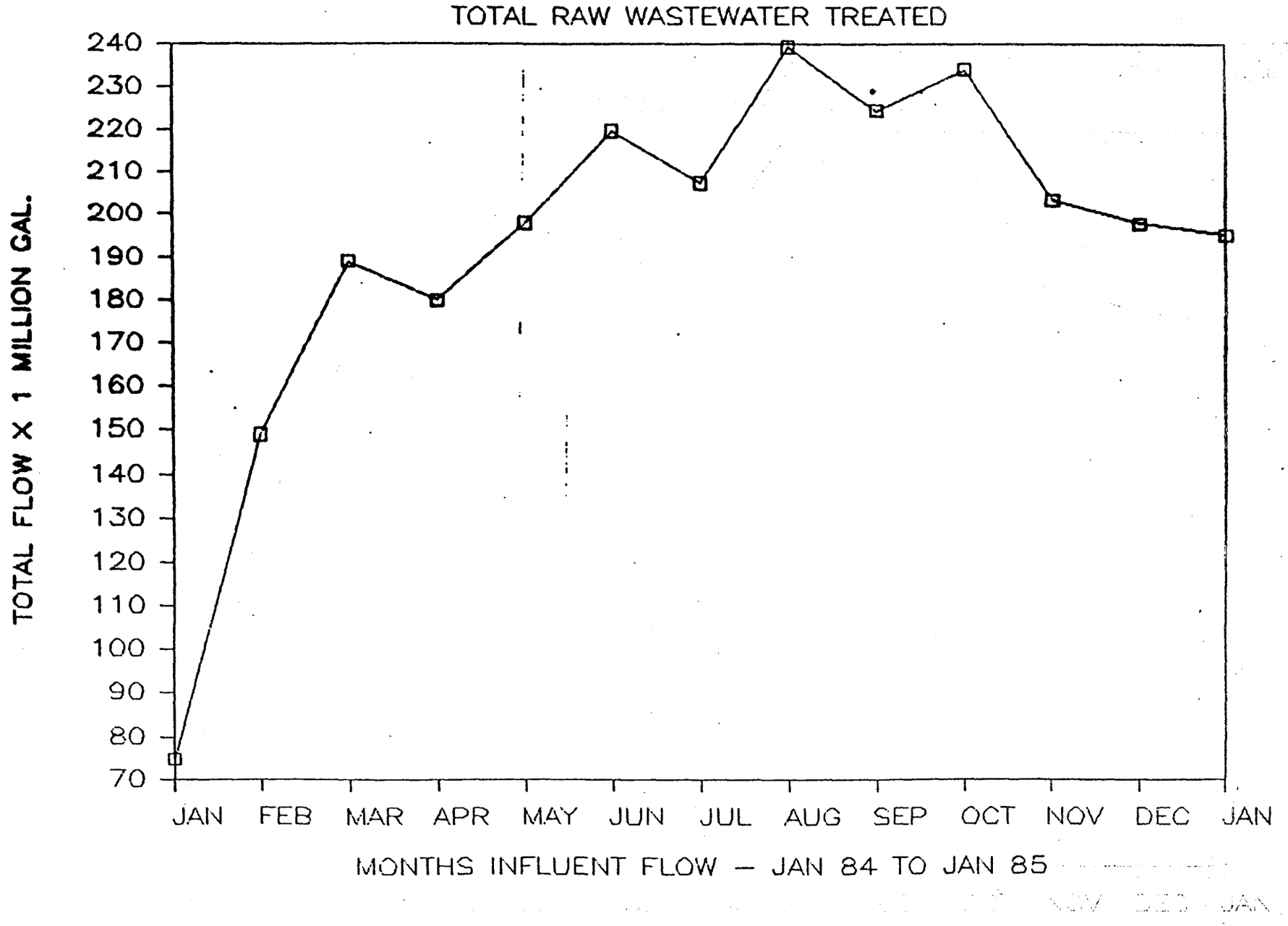


FIGURE 1

PERSIGO WASTEWATER TREATMENT FACILITY

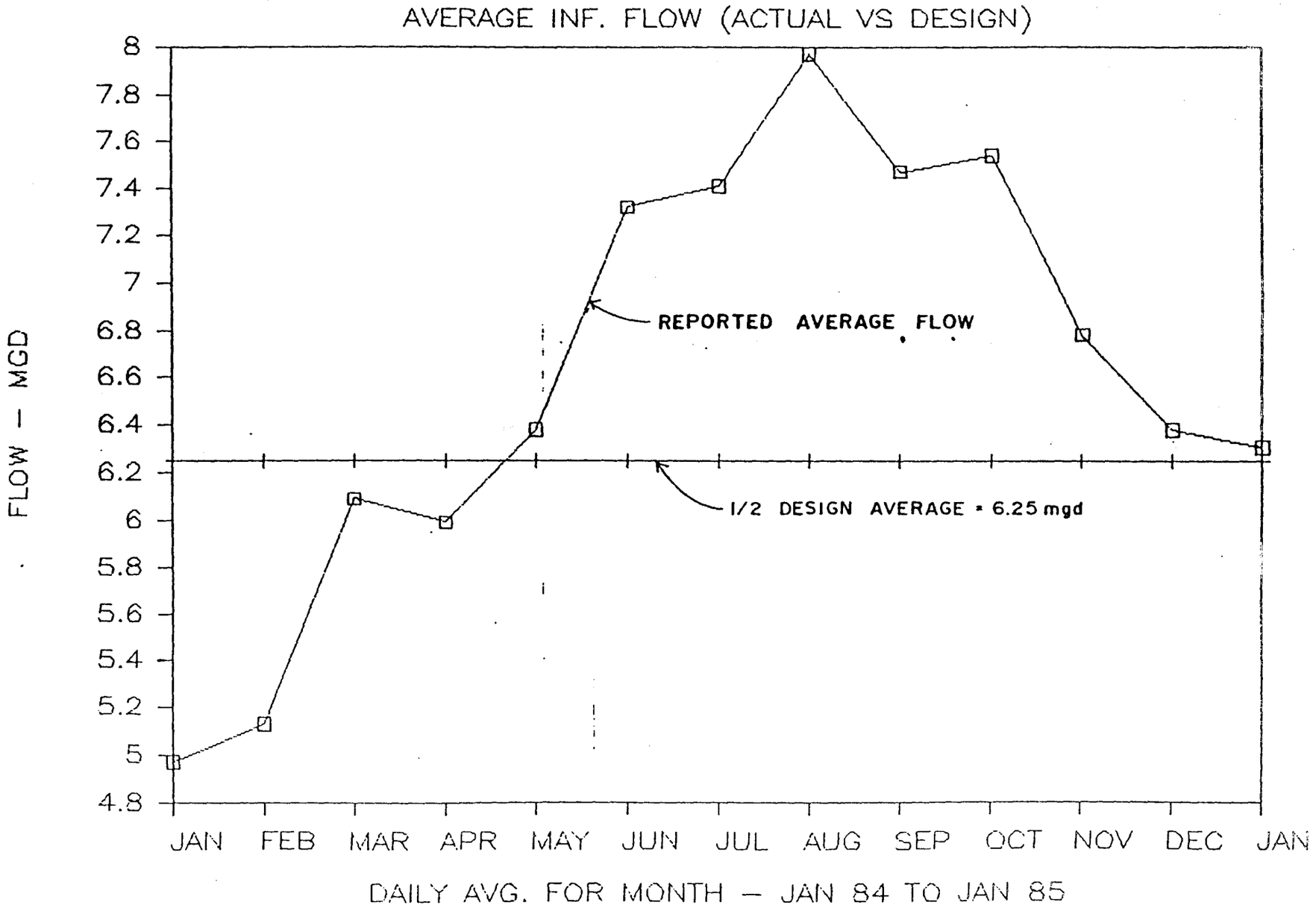


FIGURE 2

PERSIGO WASTEWATER TREATMENT FACILITY

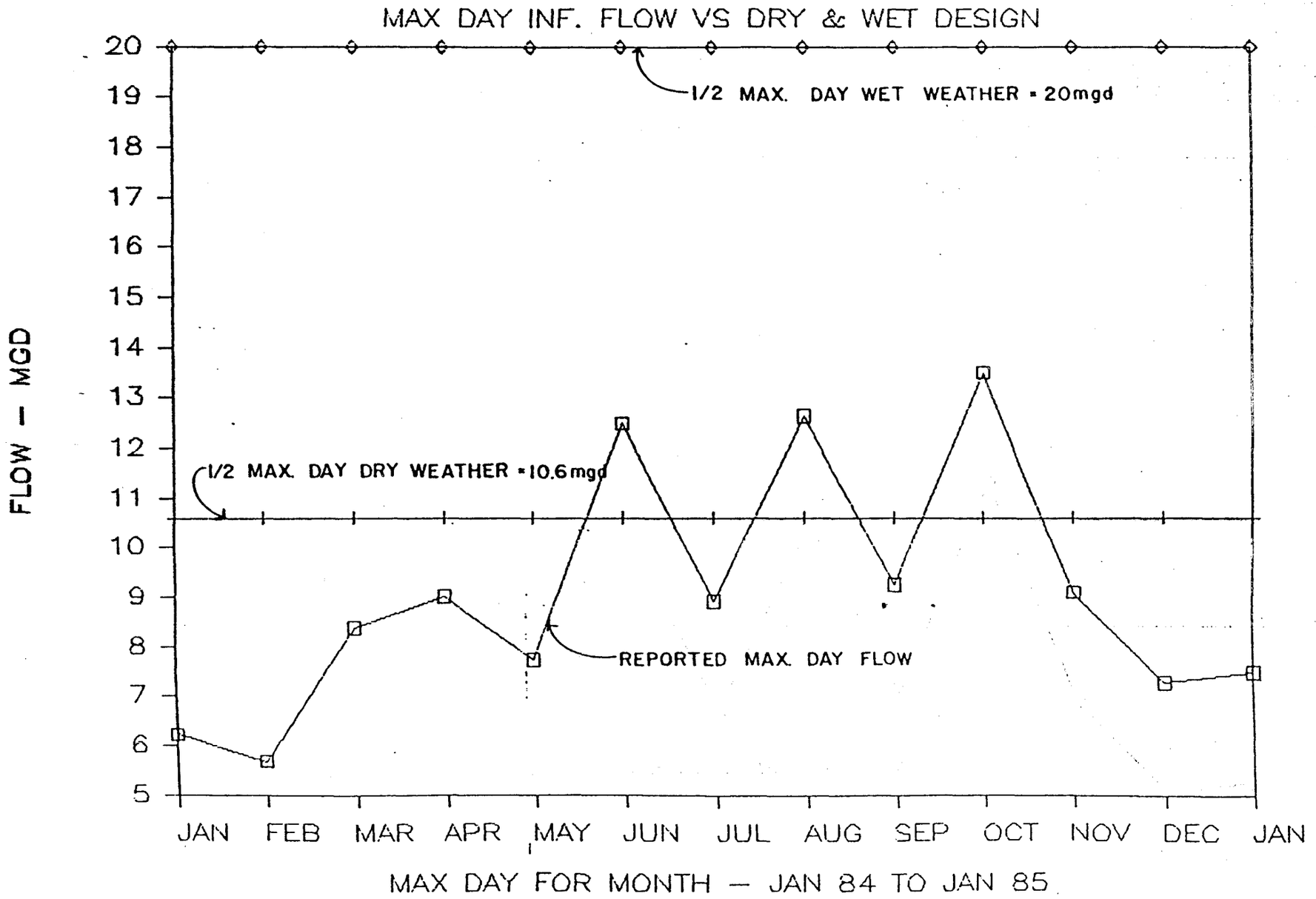


FIGURE 3

PERSIGO WASTEWATER TREATMENT FACILITY

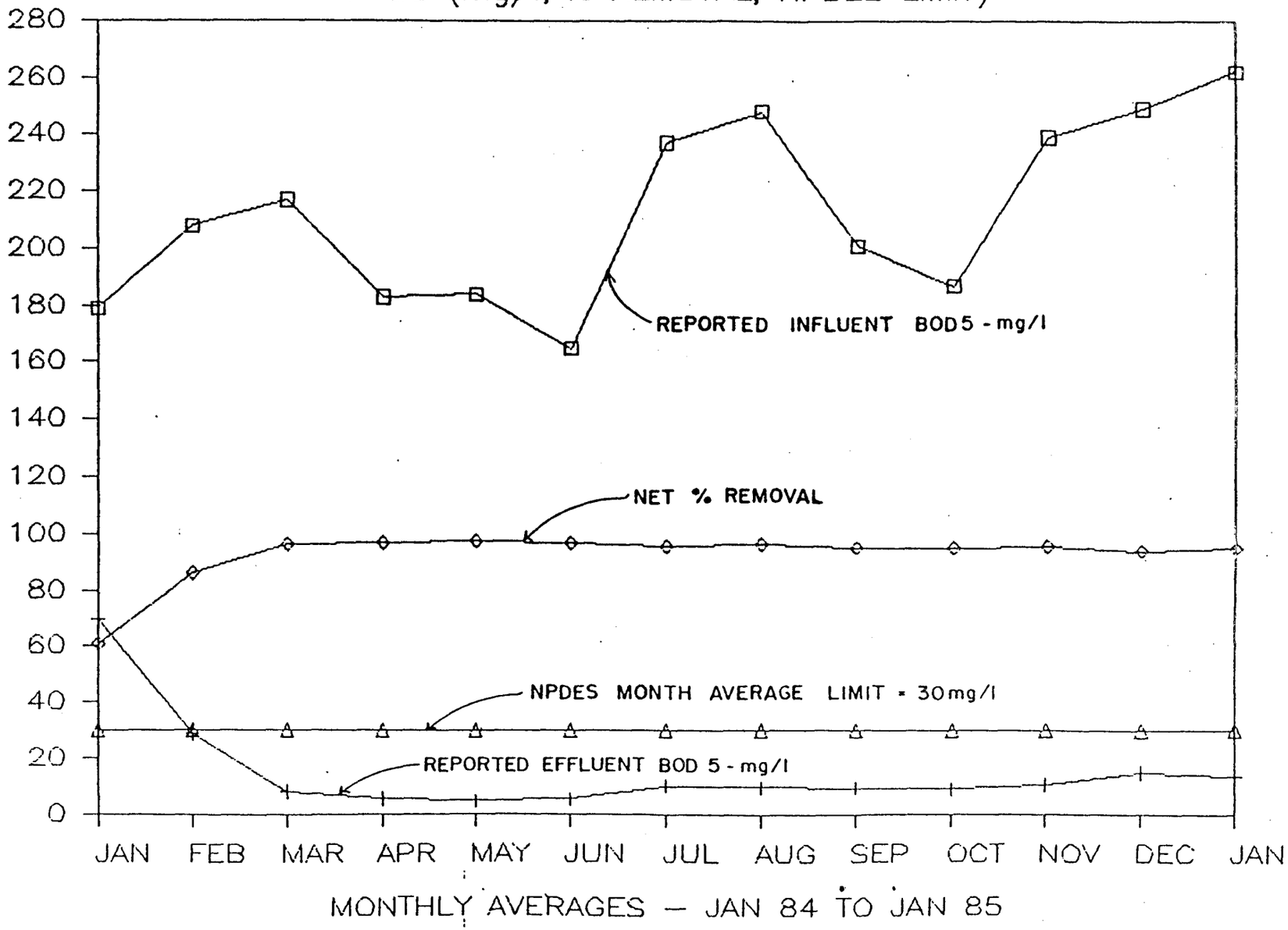
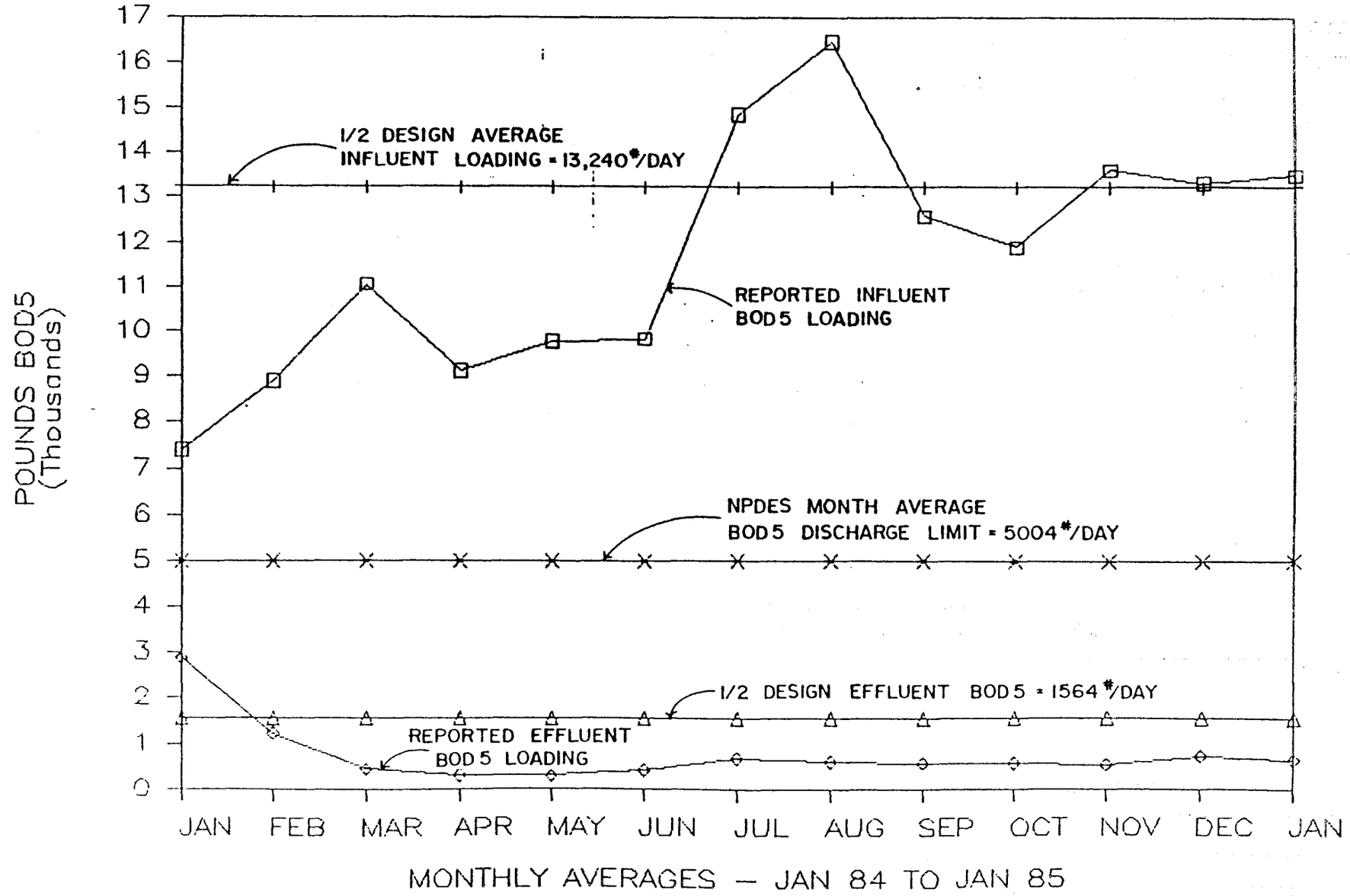


FIGURE 4

PERSIGO WASTEWATER TREATMENT FACILITY

BOD5 LOADINGS — INFLUENT VS EFFLUENT



MONTHLY AVERAGES — JAN 84 TO JAN 85

FIGURE 5

PERSIGO WASTEWATER TREATMENT FACILITY

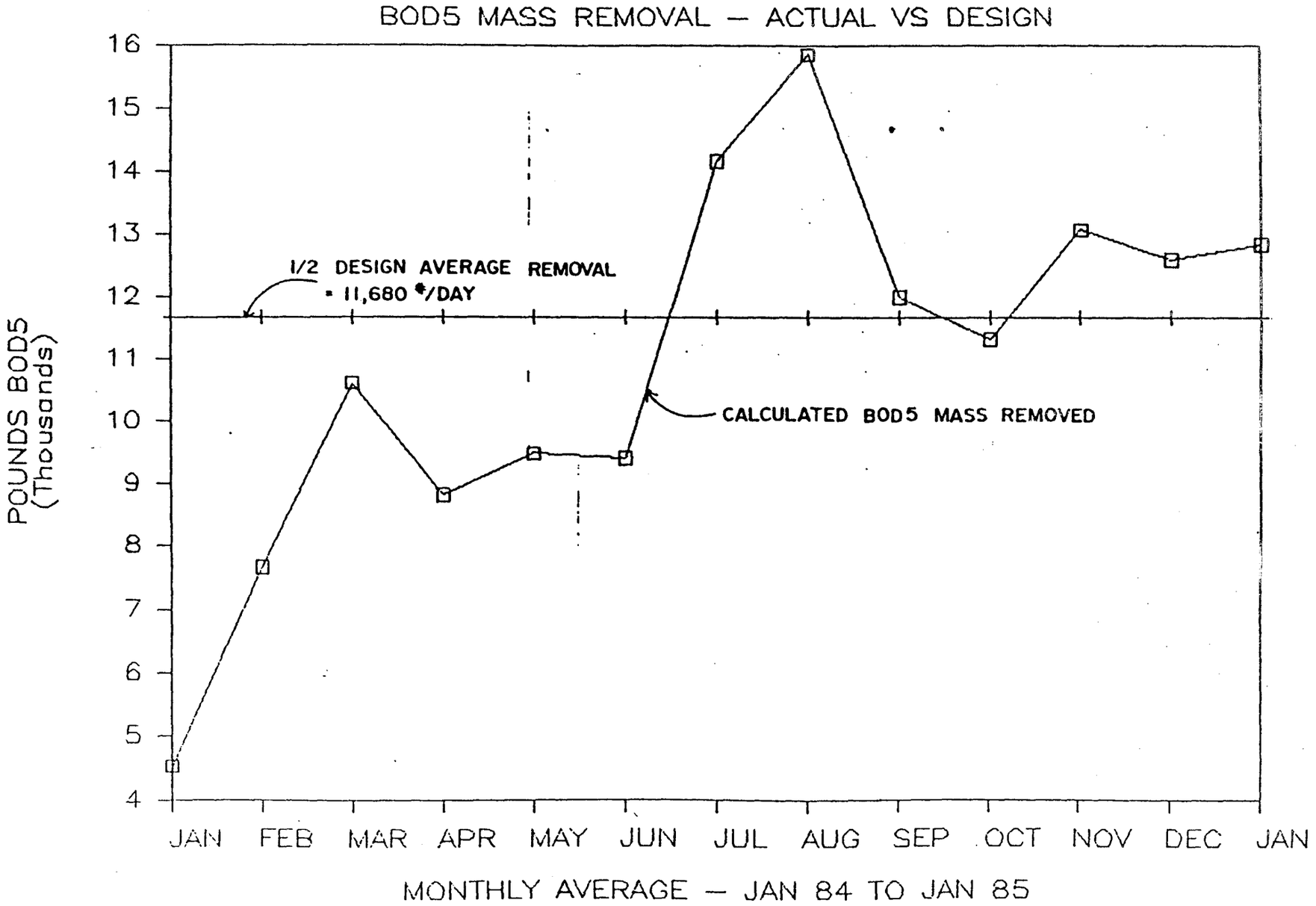


FIGURE 6

PERSIGO WASTEWATER TREATMENT FACILITY

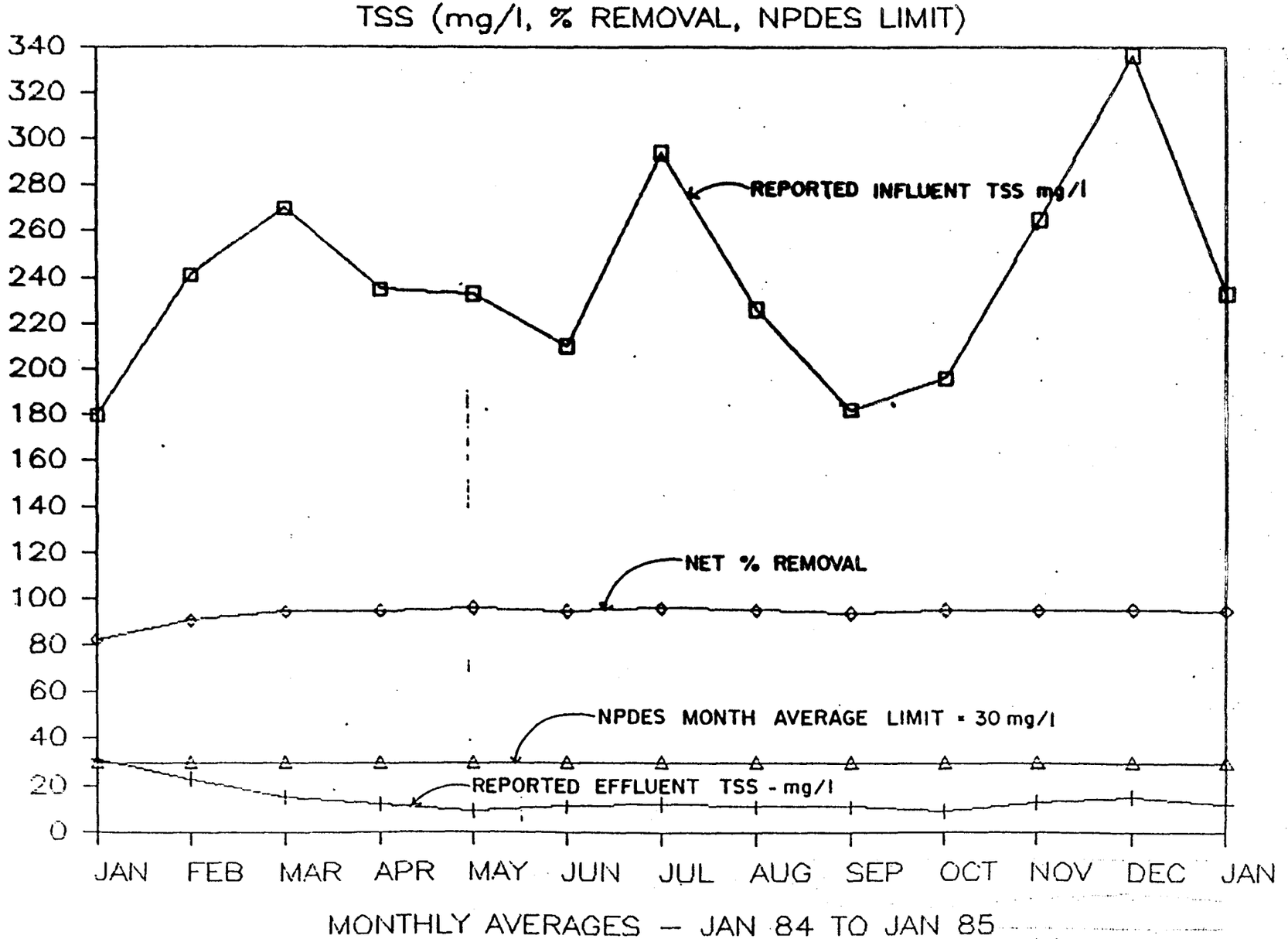


FIGURE 7

PERSIGO WASTEWATER TREATMENT FACILIT

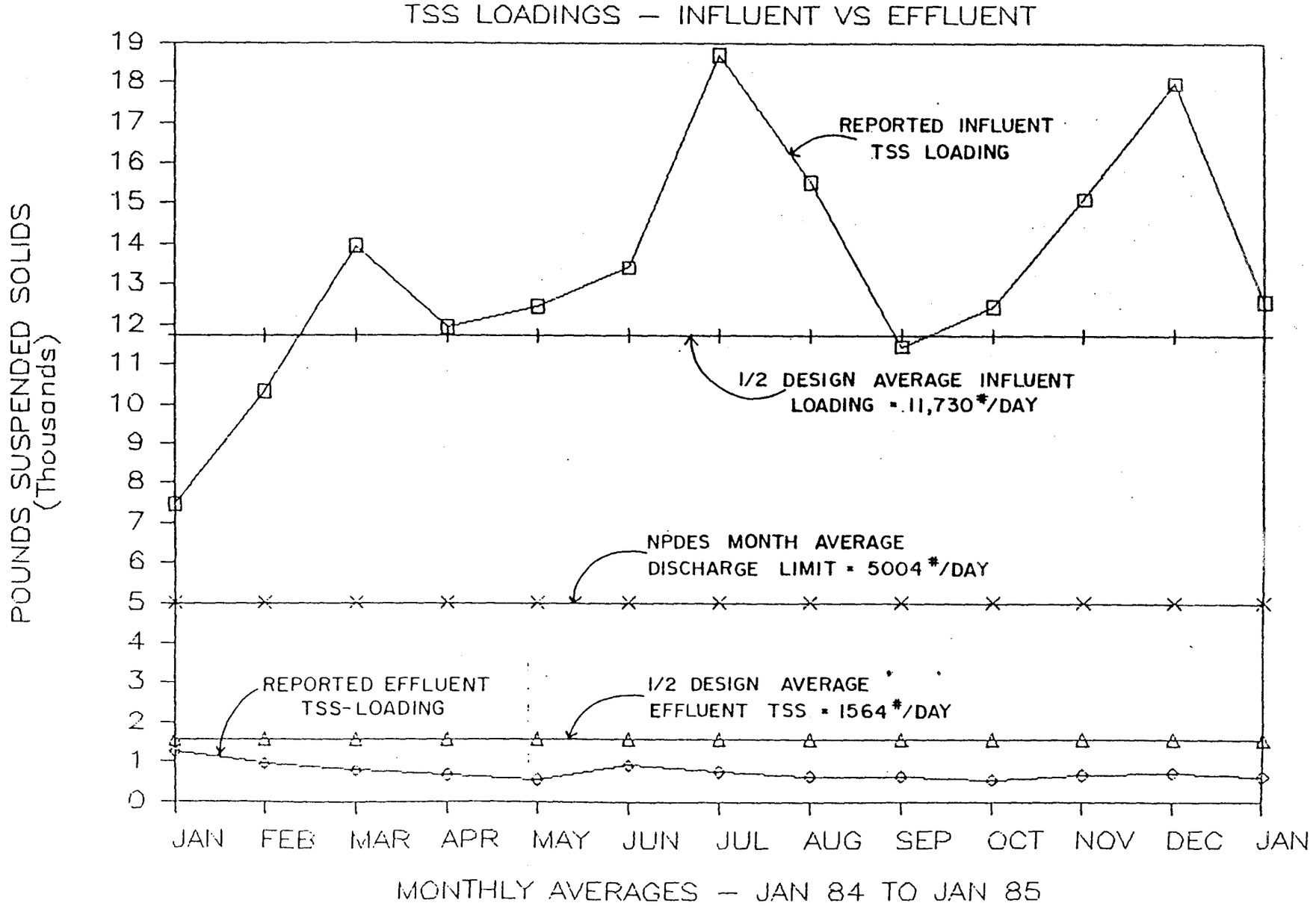


FIGURE 8

PERSIGO WASTEWATER TREATMENT FACILITY

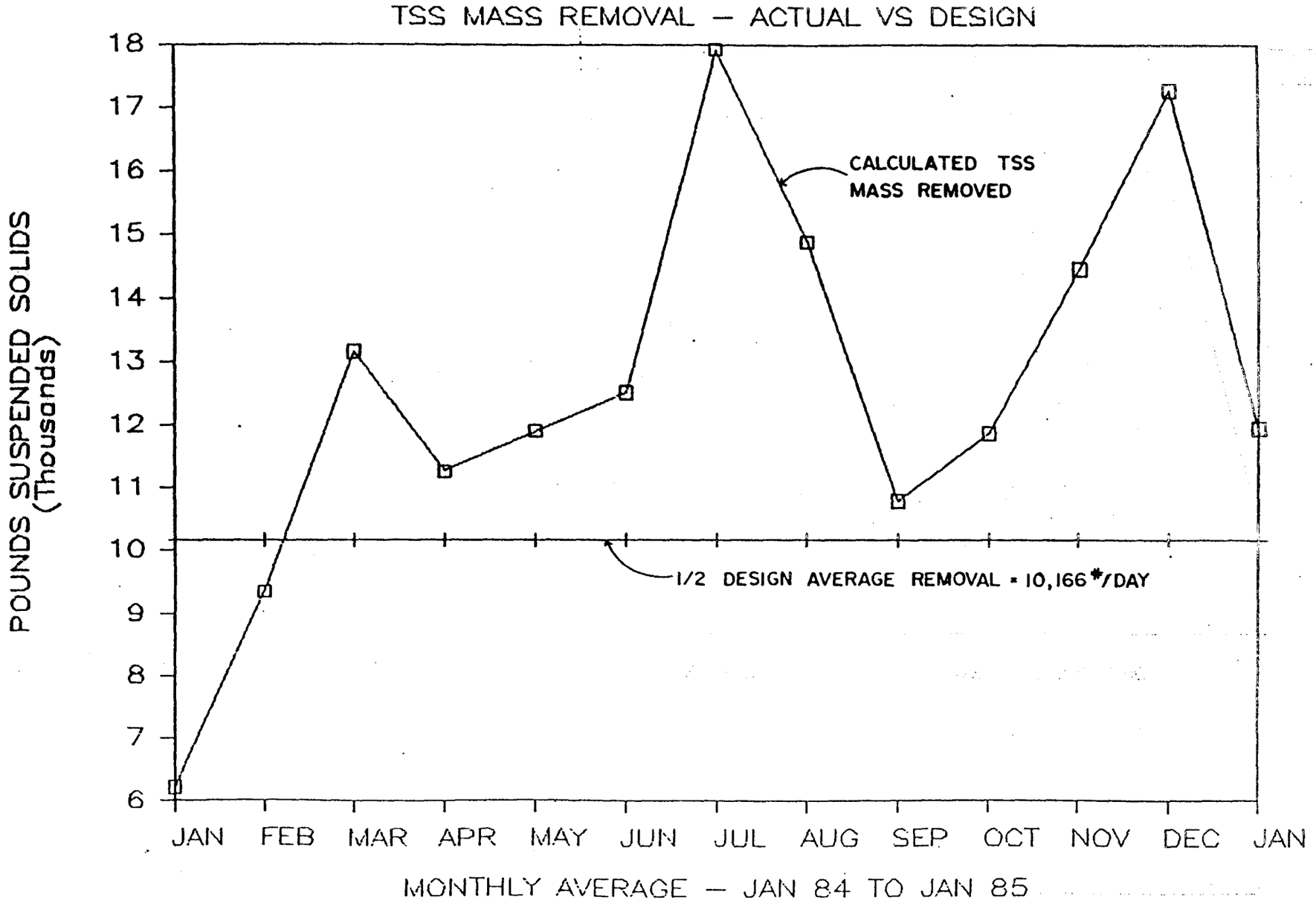


FIGURE 9

ERSIGO WASTEWATER TREATMENT FACILIT

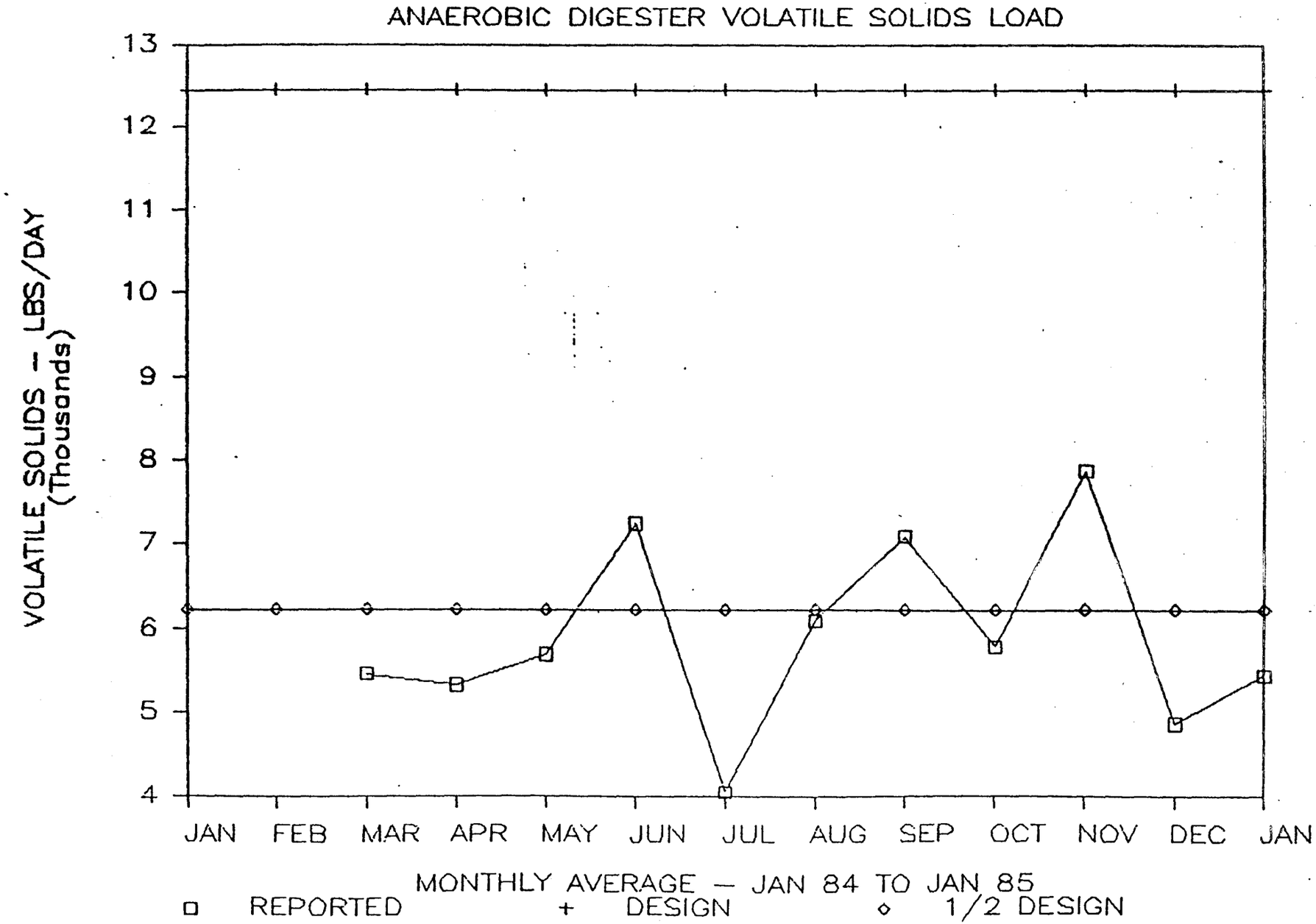


FIGURE 10

PERSIGO WASTEWATER TREATMENT FACILITY

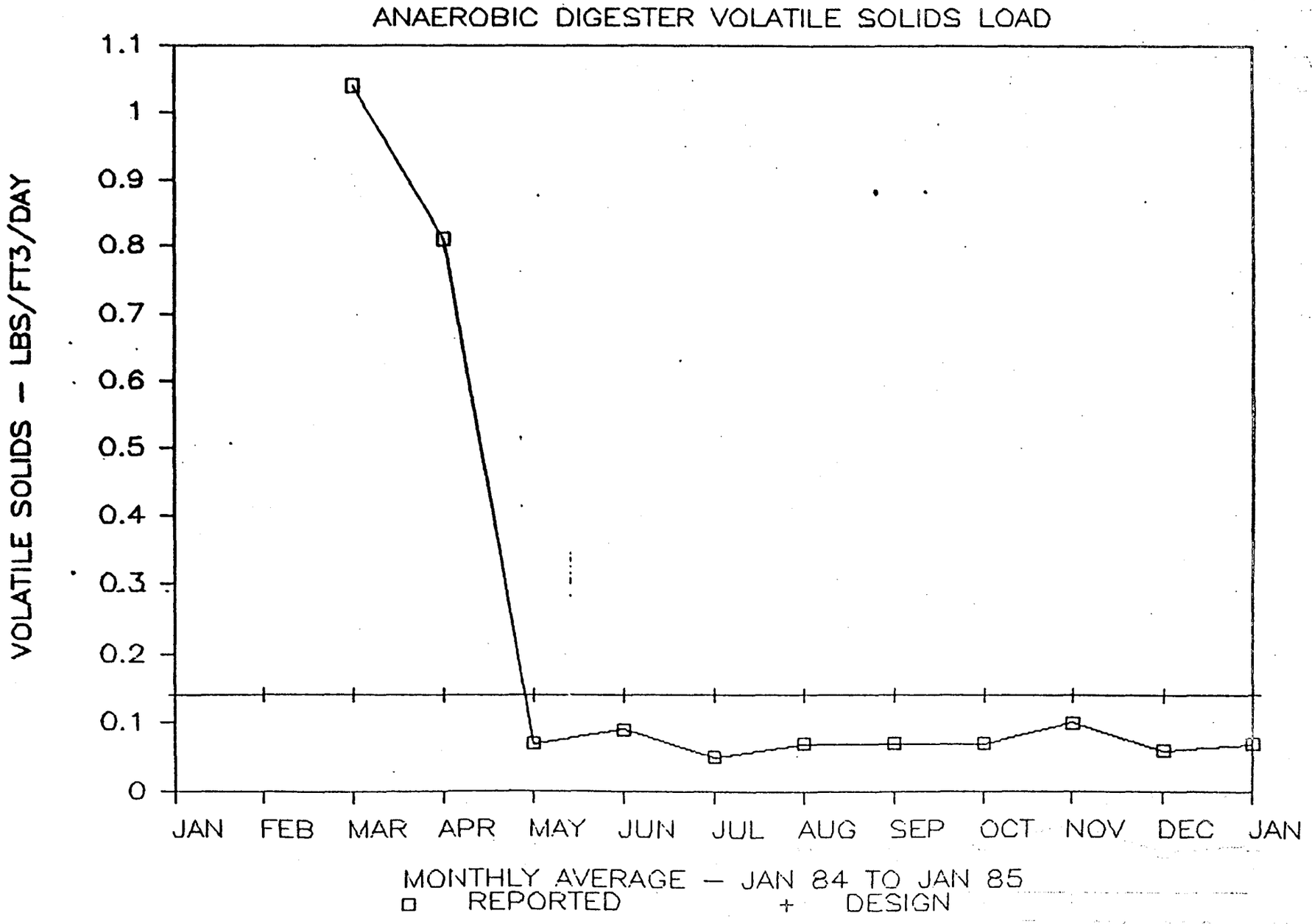


FIGURE II

ERSIGO WASTEWATER TREATMENT FACILITY

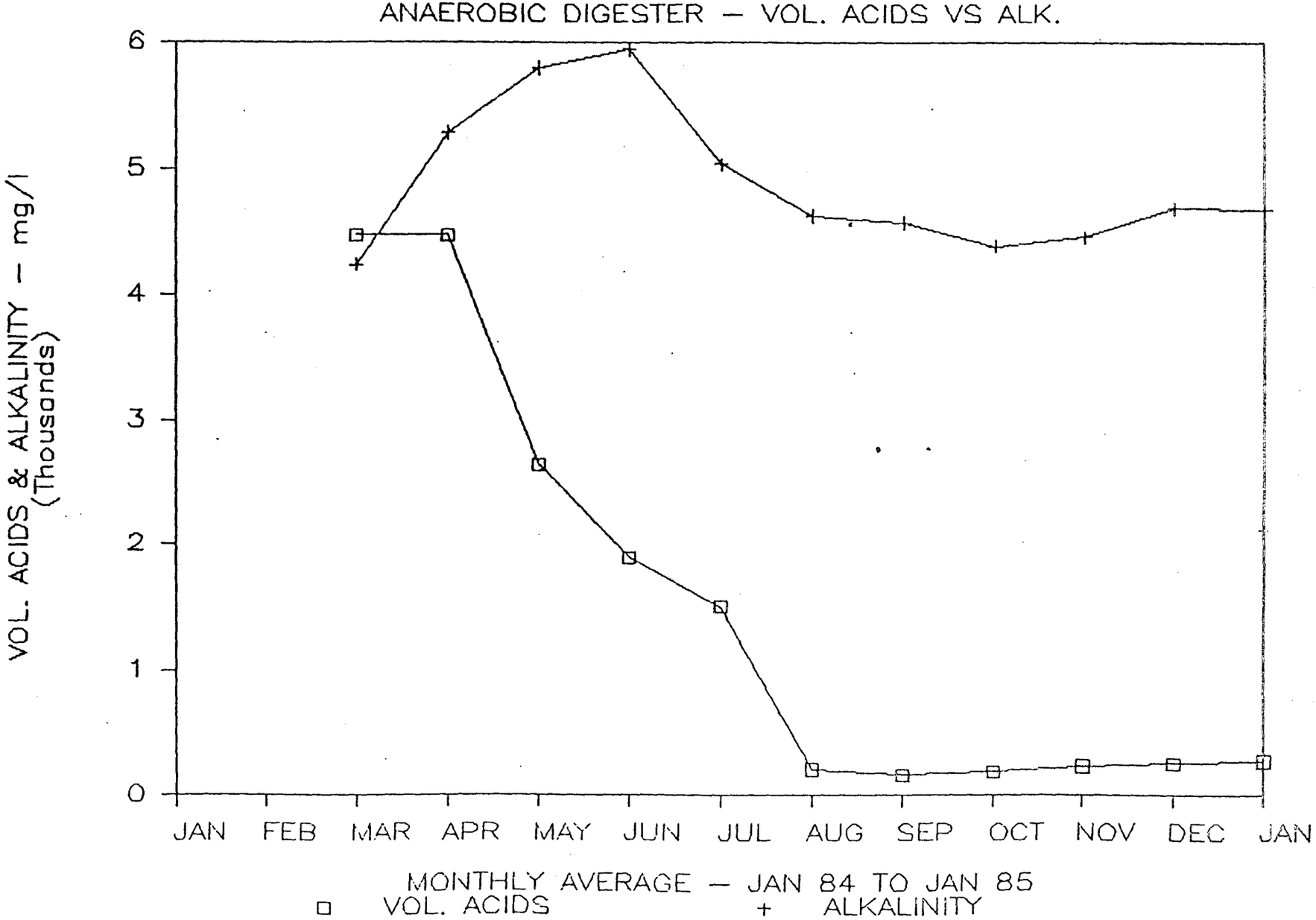


FIGURE 12

PERSIGO WASTEWATER TREATMENT FACILITY

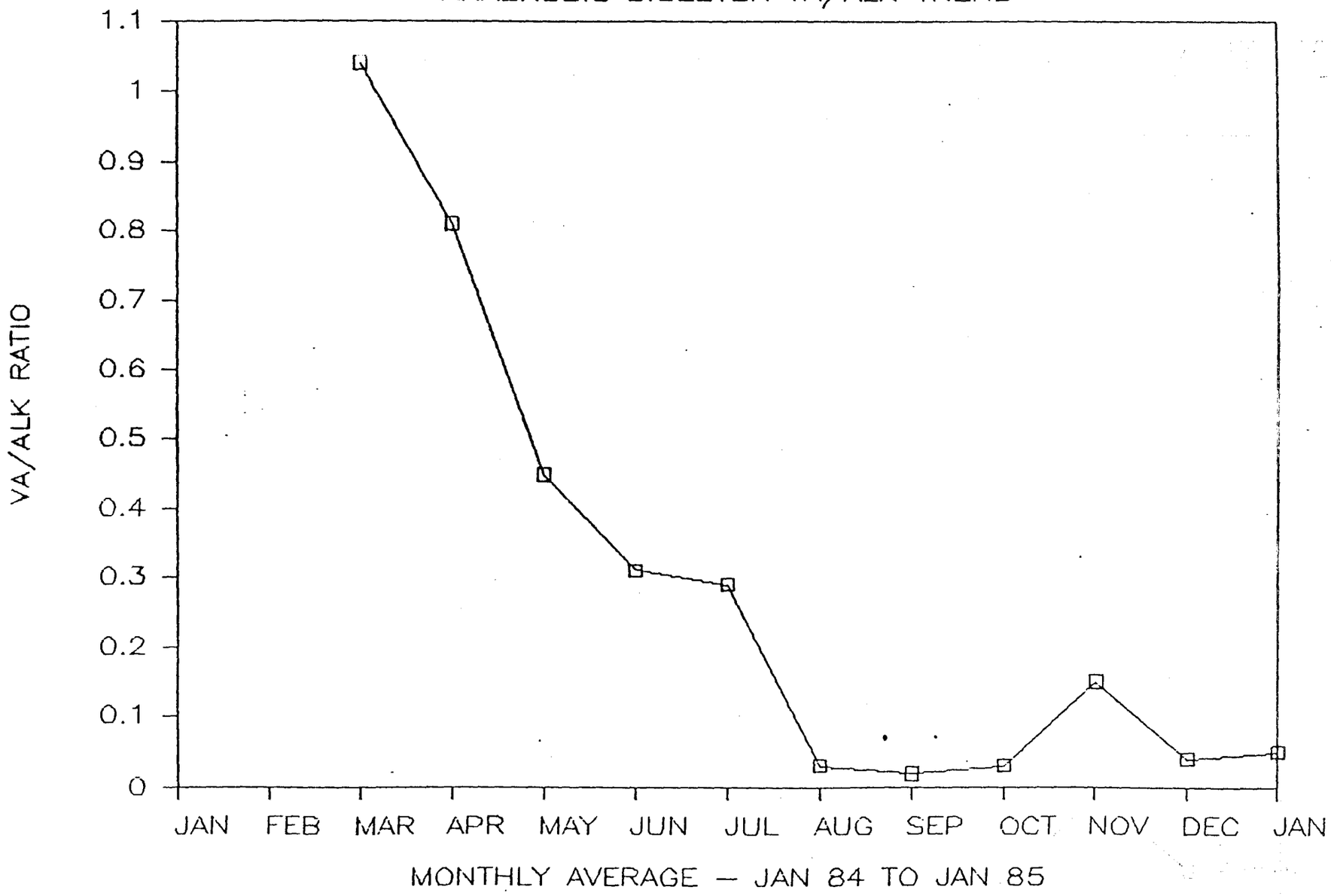


FIGURE 13

PERSIGO WASTEWATER TREATMENT FACILITY

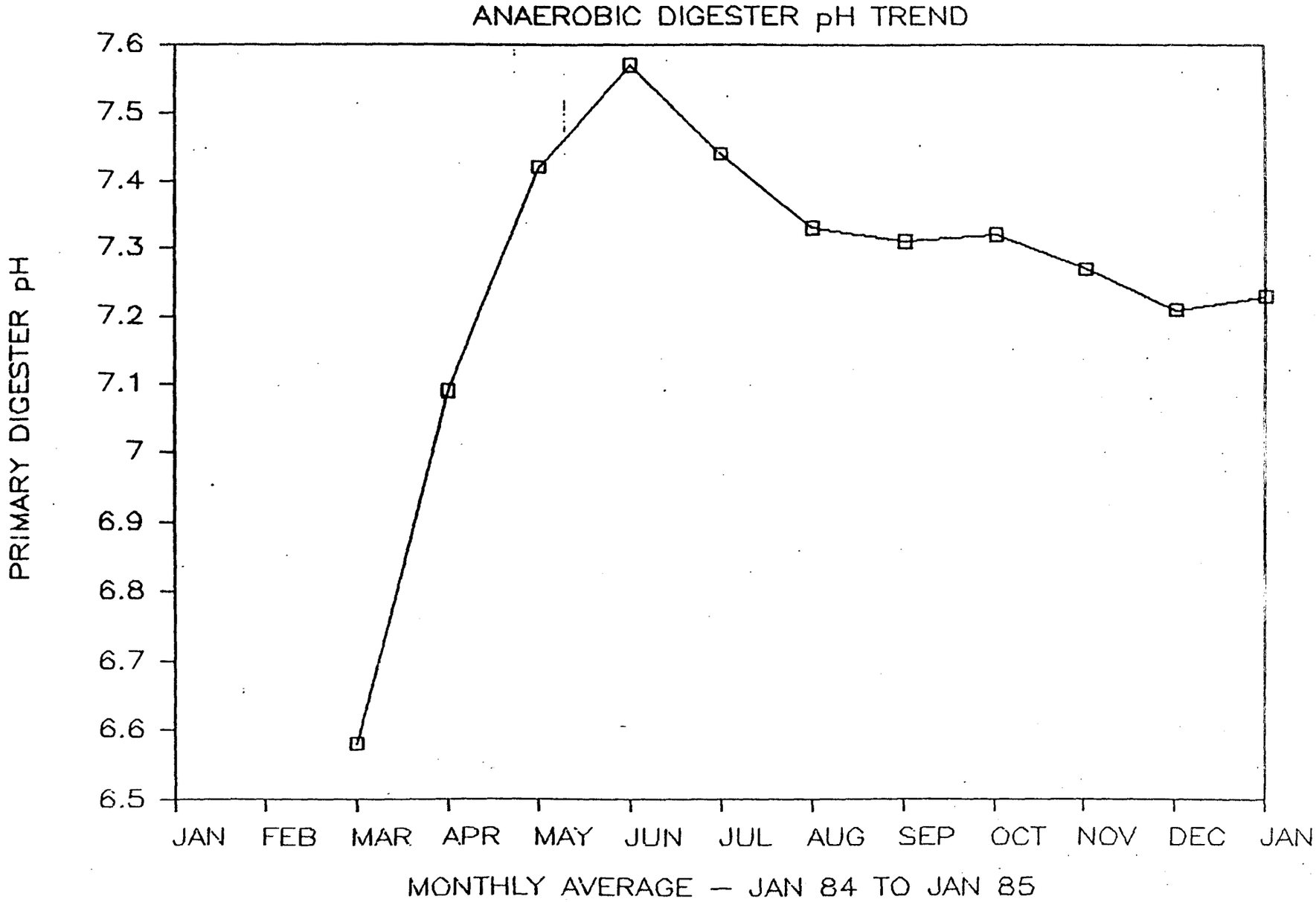


FIGURE 14

PERSIGO WASTEWATER TREATMENT FACILITY

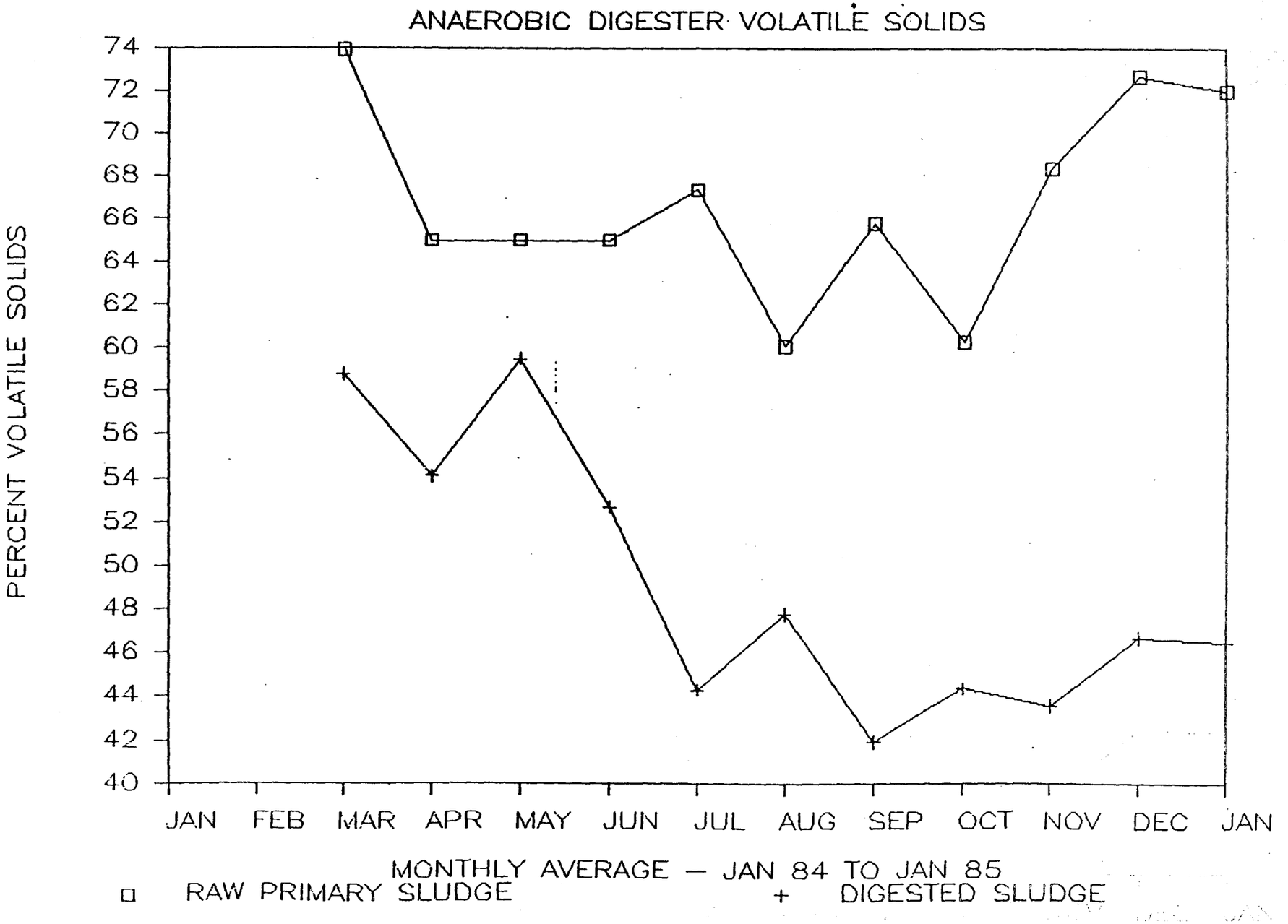


FIGURE 15

PERSIGO WASTEWATER TREATMENT FACILITY

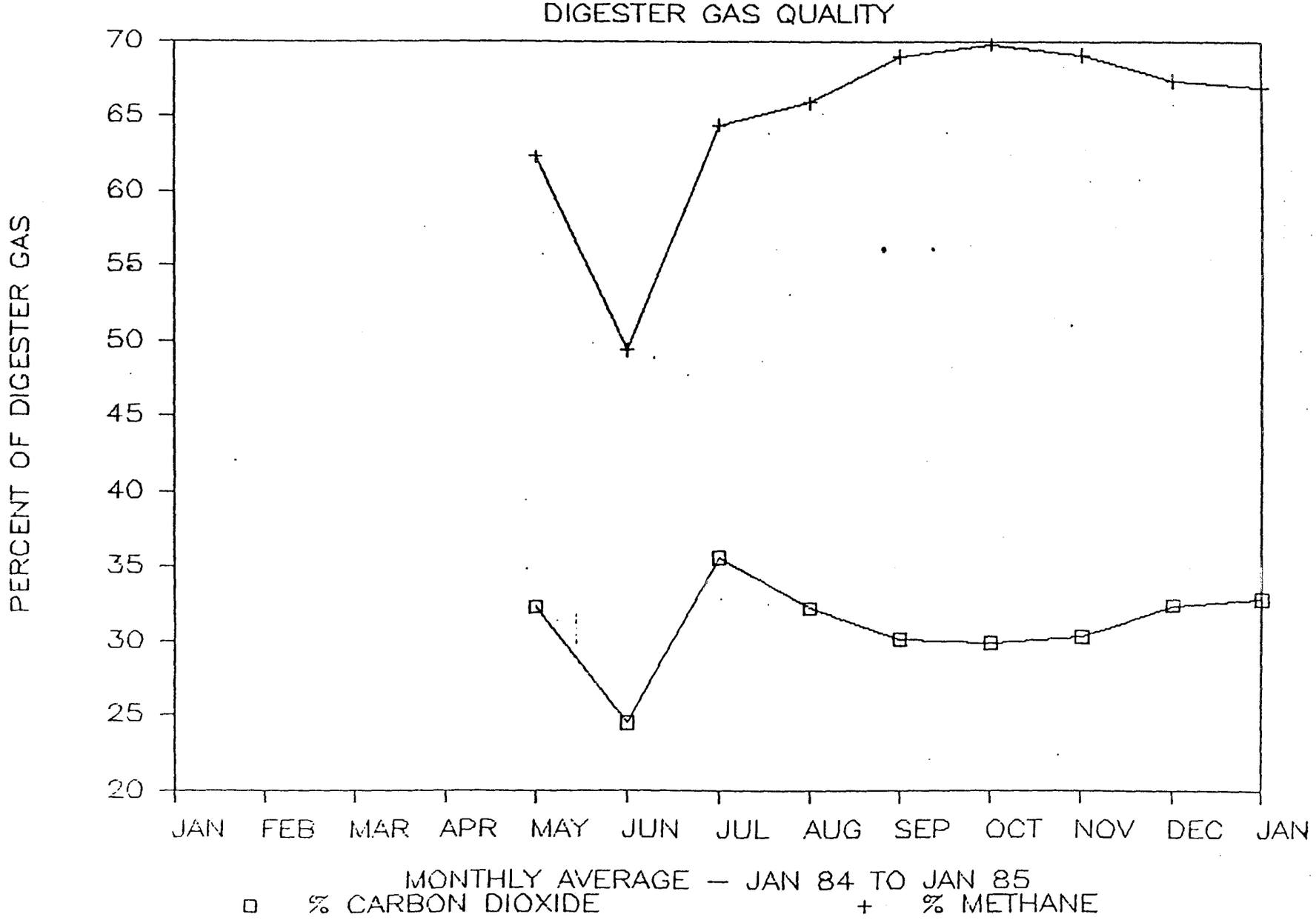


FIGURE 16

PERSIGO WASTEWATER TREATMENT FACILITY

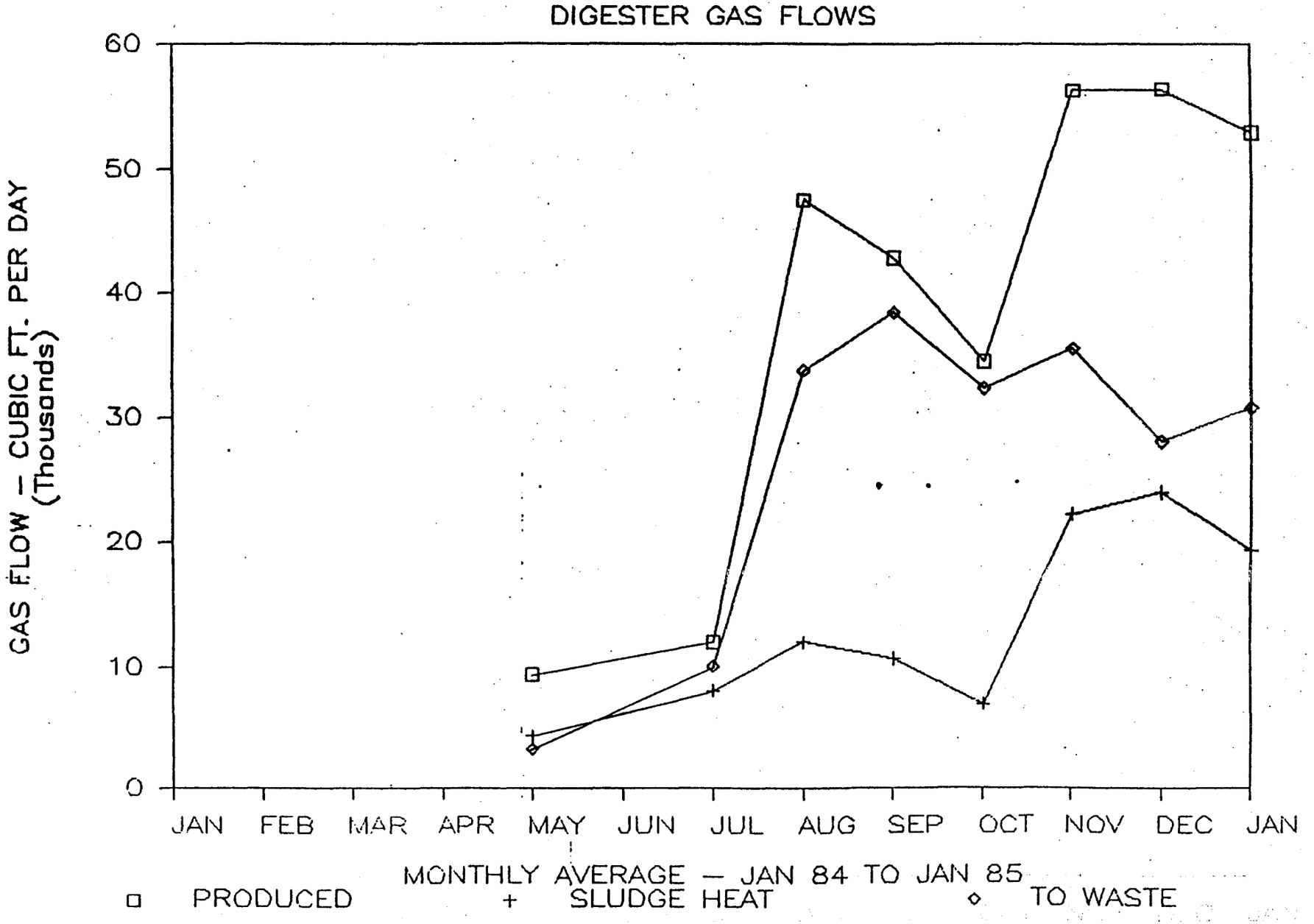


FIGURE 17

City of Grand Junction, Colorado 81501
250 North Fifth St.,
(303)244-1687

September 13, 1984

TO WHOM IT MAY CONCERN:

Re: Persigo Plant's Proposed Sludge to Land Management Plan

Following is a 1st draft Sludge to Land Management Plan proposed by the supervisory and operation's staff at the Persigo Plant.

To date, the State Regulations on Domestic Sewage Sludge have not met final approval. A final date for approval is estimated to be granted by mid-October 1984. After approval of these regulations, should the City decide to proceed with a Sludge to Land Management Plan, this plan or a similar plan must be sent to the State for approval. The procedures described herewith would be added to the Plant's CPDS permit.

It is with pride and warmest regards that we now submit this proposal for your consideration.

Sincerely,

Jerry O'Brien
Wastewater Facility Supervisor
Persigo Wastewater Plant

JO:skw

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APPENDIX

I. INTRODUCTION

A. GENERAL

Wastewater treatment generates considerable quantities of sludge. The sludge consists of suspended solids collected from both the raw wastewater and biological processes utilized in treating the wastewater. The make-up of the solids is primarily organic material. Wastewater sludge contains nutrients beneficial for both crop growth and improving soil conditions.

The City wastewater system collects waste from various sources, including residences, commercial establishments and industries. Therefore, stabilization is required before wastewater sludge is acceptable for disposal using land application practices. The City of Grand Junction Wastewater Treatment Facility has the sludge treatment facilities and monitoring capabilities necessary to assure a stabilized product for land application.

This report outlines the sludge management plan recommended by the operational staff at the Persigo Plant as being the most economical and efficient means of disposing of stabilized sludge.

The management of final disposal of wastewater sludge can have a significant impact on public acceptance of the disposal process. A well-planned, carefully managed program will aid the Persigo Plant in establishing and maintaining a "good-neighbor" image, thereby promoting public acceptance. This report is intended to provide information to the City of Grand Junction, the Colorado Department of Health and private individuals interested in the development of a sludge management program.

Summaries of alternative sludge disposal mentods, past sludge analysis, availabe sites for land application, recommended application rates, sampling and monitoring programs and environmental rules and regulations have been investigated.

B. WASTE TREATMENT PLANT

In January of 1982 construction began on the Persigo Wastewater Treatment Plant and this facility was put in service in January of 1984.

The plant is designed for an average flow of 12.5 MGD and a population of approximately 125,000. The plant was designed to be expanded to a 25 MGD plant.

The sludge processing systems for the plant include anaerobic digesters which provide biological treatment to decompose organic solids in an environment which is heated and operated in a state lacking oxygen. The process decomposes the organic solids and produces methane gas and carbon dioxide as byproducts along with a stable digested sludge product. The methane gas produced is used to heat the contents of the digesters and for building heat in the anaerobic digester complex.

The waste solids from the activated sludge system are pumped to aerobic digestion which is an extention or continuation of the activated sludge process. The waste solids are aerated for an extended period of time with similar microorganic activity as the activated sludge system. The process results in a stable microbal sludge mass relatively free of organic matter.

Two systems are provided for disposal of digested sludge; one includes four belt presses for dewatering the sludge to dry cake using the pressure principal of "squeezing" the water out of the sludge, the second system is a series of sludge drying beds that utilize a vacuum to pull water out of the sludge. The dewatered sludge removed from the plant can then be applied to the land as a soil conditioner.

In addition, the plant also has laboratory facilities required for the daily operation of the plant. The laboratory contains the necessary technology for the monitoring required in the sludge management program.

II. SLUDGE ANALYSIS-Process Control

A. SLUDGE QUANTITIES

Characterization of sludge quantities is required prior to establishing sludge disposal procedures. Current and future sludge generation quantities are needed to determine land requirements.

The amount of sludge generated at the Persigo Plant is outlined in Table 1 - Quantities of Wastewater Sludge.

TABLE 1

AVERAGE QUANTITIES OF WASTEWATER SLUDGE PRODUCED

PARAMETER	UNITS	1984 START-UP	DESIGN
Flow	MGD	6.0	12.5
Dewatered Sludge	gal/day	48,635	100,000
Wet Cake Produced	yd^3/day	33	70
Dry Weight Solids	tons	9	20

B. SLUDGE CHARACTERISTICS

Proper disposal requires a knowledge of the physical, chemical and biological properties of the sludge.

1. Physical Properties of Wastewater Sludge

Characterization of the physical properties of wastewater sludge will influence transportation and application methods. In addition, volatile solids (organics) are important in determining odors.

During the digestion process organic solids are reduced to water, methane gas and carbon dioxide. Also, small amounts of nitrogen gas, hydrogen sulfide and oxygen are produced. following digestion, the sludge will be composed of smaller solids, relatively uniform in size with a sludge age of approximately 30 days. The sludge will be characterized by a deep black color.

Digested wastewater sludge, disposed of by land application, can be dewatered and spread on the surface. Digested sludge is less odorous than non-digested sludge; however, organic matter remains in digested sludge. In any sludge management plan, consideration should be given to minimize odors.

2. Chemical Properties of Wastewater Sludge

A knowledge of the nitrogen, phosphorus and potassium content of wastewater sludge is necessary to determine the fertilizer value of sludge. Also, heavy metal quantities (principally cadmium, copper, nickel, lead and zinc) and organic compounds are necessary to determine yearly or total allowable application quantities.

While municipal wastewater sludge contains all essential nutrients, normally, nitrogen is the limiting factor in determining application rates.

The amount of nitrogen requiring disposal per working day is as outlined in Table 2 Total Kjeldahl Nitrogen (TKN) represents the total nitrogen in the digested wastewater sludge (includes total organic and ammonia nitrogen).

TABLE 2

TOTAL KJELDAHL NITROGEN QUANTITIES

WASTEWATER SLUDGE

	Start-up		Design	
	(lb/wkng day)	(ton/yr)	(lb/wkng day)	(ton/yr)
Digested Sludge	*(No laboratory data at this time)*			
Dewatered Sludge				

Almost all wastewater contains heavy metals which accumulate in sludge during waste treatment. The most significant metals are lead, zinc, nickel, copper and cadmium. It is important to monitor heavy metals in wastewater sludge used for land application.

Most crops themselves tend to be effective barriers against the transfer of metals from soil to the edible tissue, especially in the case of lead, copper and nickel. Plant uptake of these metals has generally been low.

Zinc can be transmitted from soil to plant foliage, and though this metal is beneficial to plant growth, it can be harmful in excessive concentrations. Cadmium, like zinc, can be transmitted from soil to plant foliage.

Wastewater sludge differs from community to community with respect to heavy metals. In addition, these metals are common in most soils. When organizing a sludge management plan the metal content of the sludge and the receiving soil must be considered. The Persigo Plant wastewater sludge has been analyzed and is presented in Table 3 - Concentrations of Heavy Metals.

TABLE 3

CONCENTRATION OF HEAVY METALS

WASTEWATER SLUDGE

Parameter	Unit	Detection Limit	Blended** Sludge	Aerobic Digested Sludge
Antimony	mg/kg	0.8	ND*	ND
Arsenic	mg/kg	0.04	0.65	0.20
Beryllium	mg/kg	0.02	0.02	ND
Cadmium	mg/kg	0.04	0.26	ND
Chromium	mg/kg	0.1	1.4	0.32
Copper	mg/kg	0.04	24	6.0
Lead	mg/kg	0.5	12	2.7
Mercury	mg/kg	0.002	0.058	0.038
Nickel	mg/kg	0.2	2.6	0.66
Selenium	mg/kg	0.4	ND	ND
Silver	mg/kg	0.06	2.4	0.73
Thallium	mg/kg	0.04	ND	ND
Vanadium	mg/kg	0.04	1.5	0.29
Zinc	mg/kg		33.0	6.2

**Blended Sludges represents a mixture of raw primary sludge and anaerobic sludge. On May 24, 1984 when these results were analyized by RMA in Denver the plant was not producing a complete mixed anaerobic sludge. The above results in this table will be replaced with an updated list of results from sludge samples recently submitted to RMA. New results will include results of anaerobic digested sludge and Barium and Strontium.

*ND = not detected

3. Biological Properties of Wastewater Sludge

The fundamental responsibility of wastewater treatment and wastewater sludge disposal is protection of the public's health.

Wastewater sludge does contain various forms of bacteria, viruses, protoza and worms, some of which are pathogenic.

The digestion process used at the Persigo Plant substantially reduces disease causing organisms. However, some of these organisms can be found in digested sludge. These organisms do exist, therefore, the use of sludge conditioned soil for growth of vegetables to be directly consumed by humans is not recommended.

III. LAND APPLICATION

A. REVIEW OF METHODS FOR SLUDGE DISPOSAL

The following is a summary of the evaluation of alternatives available to the City of Grand Junction for sludge disposal. The alternatives evaluated include landfilling, land application using wet and dry hauling, composting and a combination of these alternatives.

1. Landfilling

Landfilling would be practiced as a co-disposal system where dewatered sludge would be mixed with City refuse and buried. The EPA Design Manual for Municipal Waste Sludges recommends that wastewater sludge be dried 20 percent solids or greater for co-disposal. The dewatered sludge would be hauled to landfill by 6 yard shuttle trucks and/or two (2) 12 yard dump trucks.

Landfilling charges (fees) from the Persigo Plant to the Mesa County Landfill is $1.90 for a cubic yard of sludge buried, or $22.50 per each 12 yard truck of dewatered sludge. In addition to the cost outlined, other factors which are difficult to assess need to be considered when evaluating landfilling. Some of these include: the shortened life of the municipal landfill, the loss of beneficial nutrients contained in wastewater sludge and the loss of soil conditioning capabilities when applied to agricultural land.

2. Land Application of Dewatered Sludge

Land application of stabilized dewatered sludge as proposed by the Persigo Plant would consist of surface application. Sludge would be hauled to the application site using two (2) 12 yard diesel trucks equiped with spreader beds. The cost of land application of dewatered sludge is less than landfilling due to the elimination of landfill charges and the additional fuel (35 mile round trip), additional wear on equipment and man hours.

3. Methods of Storage

During inclement weather, when trucks cannot enter the fields, the plant will have various methods of holding and disposal of sludge.

a. Anaerobic sludge can be stored in the secondary digester.

b. Waste activated sludge can be stored, under aeration, in open digester tanks. The cost of prolonged storage once sludge is stabilized is extremely high due to high electrical rates, unnecessary motor and blower wear and operational man hours. It is recommended that this method not be used except during adverse conditions and when all other methods have been exhausted.

c. (Provided a sludge storage area is budget approved and constructed in accordance with EPA and State recommendations) Dewatered sludge can be stored in the same manner as "composted" sludge is handled. Wood chips are spread approximately 12 feet wide and 18 to 24 inches deep in windrows. Dewatered sludge is then dumped load by load on the wood chips. The wood chips and dewatered sludge is then turned and mixed with snow plows attached to the 12 yard dump trucks. The windrows are turned daily until well mixed and then turned every 3 to 5 days or as deemed necessary.

The difference between composting and windrowing sludge for storage is that composting is a method of its own for the stabilization of sludge; temperature, time and pathogen kill is monitored. However, windrowing for storage is only a method of holding the sludge in a controlled detention area until it can be moved without being restricted by temperature, time or pathogen kill, to fields for land application.

A more economical method of windrowing (once the material has been established) is to regenerate the windrows with dried sludge from the drying beds instead of continuously adding new wood chips.

Under certain conditions dewatered sludge can be hauled directly to a storage site provided by the user.

d. Dewatered sludge can be hauled to the landfill, as is now being practiced, for burial.

4. Land Application by Injection

It has been documented that liquid application by injection is the most cost effective option of sludge disposal available; chemical costs are drastically reduced; the operation and maintenance of the filter presses become minimal which reduces electrical and labor costs. However, liquid application is limited to periods of the year when subsurface injection is feasible. Accessibility to fields for liquid is less than dewatered surface application due to compaction and drying of soil during dry weather. During these periods liquid sludge can be splattered from tank trucks much in the same fashion as dewatered sludge is scattered. Bad weather precludes the use of liquid application causing storage problems. Some storage of liquid sludge can be achieved by some of the same methods described above for the storage of dewatered sludge. However, the ability to concentrate liquid sludge for storage is much less and therefore needs much more storage space. Storage tanks and lined lagoons are two additional methods of storage.

Also, the initial cost for injector and related equipment is two thirds more expensive than that required for dewatered sludge application equipment. Injector equipment is notorious for high down time and high maintenance costs.

5. Complete Land Application Program

By far the most efficient method of sludge to land application would be a combination of liquid injection, surface application of dewatered sludge and windrowing for storage. The combined system would utilize wastewater sludge for land application to the maximum. With a complete system all bad weather and field conditions could be met.

Liquid application should be feasible for the majority of the time from May to November. During the remaining months of the year sludge would be dewatered and disposed of using surface application methods. Dewatered sludge would be stored on land which has been specifically selected for storage. In selecting and preparation of a storage site consideration should be given to groundwater monitoring, prevailing winds, vegetation barriers, topography, residence locations, runoff and other factors as outlined in the State Regulations and EPA Recommendations. As weather permitted stored sludge would be land applied using dry type sludge spreaders. All surface applied sludge would be tilled into the soil by the receiving land owner following application.

B. SUMMARY OF CONSIDERATIONS

1. General

Items considered in evaluating alternatives for wastewater sludge disposal includes land availability, product acceptance, versatility of system, reliability and economics. Of the two systems evaluated; landfilling or land application, land application of sludge was concluded to be most viable for Grand Junction.

Land availability and product acceptance do not appear to be limiting factors for Grand Junction. Based on questionaires sent to two rural routes directly north of the plant and within a pie shaped radius of eight miles from the plant, the City of Grand Junction has received a 10 percent response and an accumulation of nearly 2,500 acres. This amount of land would be more than adequate for the sludge quantities anticipated at the Persigo Plant.

Land application includes additional benefits not associated with landfilling. Sludge is utilized as a fertilizer, for pH adjustment and as a soil conditioner. These benefits are difficult to quantify but will result in improved soil conditions, increased crop yield, and land tillage. These benefits are important in impressing upon the public the advantages land application provides over landfilling.

Landfill disposal costs will exceed land application costs by approximately $15,000 each year in just landfill fees.

2. Economics

To comply with permit requirements, the City must inform the Colorado Department of Health, no later than July 1, 1985, of its decision to land apply sludge from the Persigo Plant.

Presently, it is unlikely that federal funds will be available to assist this program. However, all possibilities for future funding must continue to be examined before this source of future assistance is eleminated. As it stands now all funds necessary to proceed with the program must be made available through City funds.

It is therefore recommended by the Persigo Plant that if the City decides to implement a sludge management program, that this plan be developed as a complete land application program. That this plan be developed as a three-stage project which would be implemented over a three to five year period.

A three-stage plan will allow flexibility to the needs of the program. It will ease the monetary burden which will be placed on the City's budget. It will allow for the plan to be implemented immediately.

3. Equipment Necessary

The City presently owns two (2) 12 yard dump trucks equiped with PTO operated snow plows which were initially funded through the Persigo Plant's construction grant. The plant has four filter presses and sixteen vacuum assisted drying beds which are used now for the final disposal of sludge by burial at the landfill.

These snow plows can be used to turn the aerated sludge which has been windrowed for storage. Woodchips can be supplied by the Parks Departments chipper. The beds on the dump trucks would be replaced with dry applicators similar to agriculture animal waste spreaders. Additional equipment would be purchased to compliment the equipment already owned by the City; such as a tractor with front end loader and blade for cleaning drying beds.

Funds will be required for the construction of a sludge storage area. Presently, there is no sludge storage area at the facility. High groundwater tables at the plant site require that should a storage area become necessary it must be constructed in such a fashion that it meets the requirements set forth in the State Regulations.

4. Contracting For Sludge Disposal

It was estimated in the 1984 Budget that it would cost $230,000 for a private company to contract for one years disposal of stabilized sludge, grease and the burial of rags and grit at the Landfill. Meetings with contract haulers made it obvious that only long term contracts would be considered and costs for this service would be reevaluated annually.

To date none of the parties interested have been able to provide data that indicated they have developed an outlet for sludge, nor have they been able to guarantee disposal on a year around basis.

Due to the uncertainties of a contract disposal system and the ultimate liability of the City for compliance with disposal regulations, it is recommended that the system be operated and managed by the City.

5. Consulting Engineers

At this point, the Persigo Plant does not see the necessity for the City to be burdened with the additional expenditures for the assistance from a consulting firm in developing a sound land application program. The Persigo Plant's operational staff feel that they are capable of establishing a sound and viable program, as herewith presented. That such funds necessary for such an effort would be better appropriated for the purchase of necessary equipment to implement stage-one of their recommended program. Also, a great deal of time will be lost at this time while consultants generate their information and then present their program to the City for final consideration.

To date, the plant has received the help and cooperation from Phil Hegeman, Environmental Analyst, Colorado Department of Health; Tom Huston, Wastewater Division Supervisor-Broomfield; Marv Webb, Field Operations Supervisor-Metro Denver, and Field Representative for METROGRO. Also, appearing in the Appendix of this report is a list of published source material.

C. SITE SELECTION

A well developed and coordinated Sludge Management Plan is critical to the successful implementation of a land application program. The City has solicited area land owners interested in the application of sludge on agricultural land. A listing of those showing interest and an area map is shown in the Appendix.

1. Criteria for Site Selection

The criteria for selection of application sites are important components of the management program. These criteria include:

a. Location

b. Accessibility

c. Crops Grown

d. Soil Characteristics

e. Topography

f. Groundwater

In selecting a site, the suitability should be evaluated with respect to distance from the treatment facility. Decreased haul distance will significantly reduce costs, therefore the sites nearest the source are the most desirable. The sites must then be reviewed regarding primary access and on-site access.

The soil characteristics of specific sites must be reviewed to determine compatibility of sludge and soil. The soil will be analyzed to determine background information of metals, cation

exchange capacity, soil pH, nutrient levels (nitrogen, phosphorous, potassium), soil type (percent organic content), and coliform count (soil contains coliforms; Landowners should be aware of this fact).

The cropping pattern must be identified to determine availability of land at specific times of the year and type of application required.

The topography of the site must be reviewed regarding slopes and runoff potential. The distance to the nearest surface watercourse will be identified. If necessary, the runoff would be controlled by terracing or other similar means to prevent a significant runoff of stockpiled sludge.

Background groundwater data need to be identified for each site as well as location of the nearest domestic water well.

2. Contractual Agreements

The application of sludge to agricultural land is a joint venture between the City and the landowner. Success of the program is dependent upon clearly defined objectives, policies and procedures. The following characteristics should be considered:

a. Length of the contract: A commitment to the program by the farmer may require an investment on the part of the City or landowner for site preparation, monitoring wells, etc. Thus a minimum contract life of five years is recommended to provide program stability. This would also allow adequate flexibility for the City to adjust for future events.

b. Management: The importance of sound management by the City and landowner is critical to a successful on-going operation. Pollution of ground or surface waters could effectively ruin a sound program through adverse public reaction.

c. Well-Defined Responsibilities: Delivery and application of the sludge, monitoring, and records keeping requirements should be identified. The City has ultimate responsibility for the disposal of the sludge, therefore, the application, monitoring and record keeping will be done by the City. The landowner will be responsible for site access, land availability and incorporation of surface applied sludge if required.

d. Clearly Defined Objectives: The City's objective is to dispose of the sludge in an environmentally sound manner at minimal overall cost. The objectives of the farmer may be pH adjustment, nutrients for crop production, tillage from subsurface injection, or soil conditioning from the humus content. If the nutrient value is the primary objective the desired crop and anticipated yield must be identified to determine proper application rates for the appropriate nutrient.

e. Sound Economic Potential: Ultimate disposal of the sludge at minimum overall cost is the City's primary goal. Partial compensation by the landowner may be appropriate for benefits received. At this time, the establishment of a minimum charge per ton of sludge or for tillage per acre is not recommended. However, it is recommended that all land parcels less than 100 acres in size be responsible for soil analysis and any fee or permit assessments which might occur.

f. A written agreement should be negotiated with each land owner.

IV. PROGRAM CONTROL AND MONITORING-Field Data

A. SLUDGE APPLICATION RATES

Wastewater sludge application will be based on crop uptake of nutrients. Sludge application rates recommended for crop production are calculated in the same manner as commercial fertilizer application rates. Annual application rates for agricultural soils will be based on nutrient and heavy metal limitations, site life will be dependent on the heavy metals content of the sludge.

Wastewater sludge is applied at the nitrogen utilization rate of a crop to minimize groundwater contamination due to nitrate leaching. The amount of nitrogen to be applied will be coordinated with the soil texture of the application site.

TABLE 4

MAXIMUM ALLOWABLE NITROGEN LEVELS (lbs/acre)

Crop	Field/Acre	Course	Medium	Fine
Alfalfa	4 ton	180	210	230
	6 ton	280	340	370
Barley	80 bushel	100	110	120
Bluegrass	3 ton	180	210	230
Corn	75 bushel	100	120	130
	100 bushel	130	150	160
	125 bushel	150	180	190
	150 bushel	180	210	230
	175 buslel	210	250	270
Oats	75 bushel	80	90	100
	100 bushel	130	150	160
Wheat	50 bushel	100	120	130
	75 bushel	160	180	190

The quantity of wastewater sludge applied to the site will be monitored to prevent excessive heavy metal build-up in the soil. The metals given the greatest consideration include lead, zinc, copper, nickel and cadmium. In addition to these, other metals and organics will be monitored as needed for application control or to satisfy the requirements of the regulations.

TABLE 5

MAXIMUM APPLIED METALS (lbs/acre)

	Cation Exchange Capacity		
Metals	0-5	5-15	15
Lead	300	1000	2000
Zinc	250	500	1000
Copper	125	250	300
Nickel	50	100	200
Cadmium	5	10	20

In determining the sludge applied to each site, interaction between the City and the land owner will be required. Each land owner and the City will complete an annual sludge disposal report. The report will summarize the following items:

1. Land Owner
2. Legal Description of Land
3. Initial Soil Data
4. Subsequent Soil Data
5. Crop to be Produced
6. Consumer Nutrient Request
7. Sludge Characteristics
8. Site Condition Summary
9. Sludge Application Summary
10. Schedule for Applying Sludge

Other reports and records will be compiled to meet the criteria and requirements which will be added to the Persigo Plant Discharge Permit if the Sludge to Land Application Program is initiated.

B. SLUDGE SAMPLING AND ANALYSIS

Knowledge of wastewater sludge characteristics is important to a sludge management program. Testing will be done to determine nutrient potential, the concentration of trace metals and the amount of solid matter in the sludge.

Once a baseline is established, the time between analyses can be doubled if the first year results are consistent.

C. SOILS SAMPLING AND ANALYSIS

Soils analysis yields information on nutrient carry over and trace metal accumalation. Soil grab samples will be used. Visual inspection of the soil is also significant. Soil samples should be taken before any sludge application to a site to establish background information and to serve as a data base for loading calculations.

The Appendix contains a form for recording soils analysis.

D. GROUNDWATER ANALYSIS

Groundwater analysis will be performed to verify that sludge application has no adverse effects on the groundwater. Groundwater will be documented as correct information and/or sampled initially before sludge application.

The Appendix contains a form for recording groundwater sampling results and documentation.

V. THREE-STAGE PROGRAM

It must be noted here, that there is no "best" method or program for stabilized sludge to land application. Each community must determine this for themselves. For example, as priviously discussed, liquid injection is the most economical method of land application, but the high cost of the expensive equipment necessary for a successful program makes it prohibitive to many municipalities. The effectiveness of the program suffers because all the equipment necessary for the program could not all be purchased at one time. Also, on-hand equipment presently owned by the City must be considered.

The Persigo Plant recommends that a complete land application program, as described on page 7, III., A. 5 of this recommendation. And, is described briefly herewith:

A. STAGE-ONE October 1984 to July 1985

The plant would continue to haul dewatered sludge to the landfill for disposal by burial. The plant would continue to monitor and record all sludge data. Selected sites would be submitted to the Colorado Deptment of Health for approval as application areas. Adequate funds would be requested in the 1985 Budget for initial equipment and the construction of a storage site. And, only the surface application of dewatered sludge and windrowing for storage be planned.

B. STAGE-TWO January 1985 to January 1987

That portion of the program whereby all stabilized dewatered sludge is applied to fields or windrowed for storage until weather or soil conditions allow access again to the fields. Continuous documentation of this portion of the program would continue. Special attention to odor and associated problems will be carefully monitored and considered.

C. STAGE-THREE January 1986 to January 1988

During 1986 the viability of enlarging the program to incorporate the disposal of liquid sludge, either by surface application and/or injection will be considered. Should it be recommended at that time for the expantion of the program, justification and request for additional funds would be requested in the 1987 Budget.

D. COMPLETE LAND APPLICATION PROGRAM July 1987 to January 1995

A complete land application program is by far the most effective and efficient means for sludge disposal. It is the most economical means for a wastewater treatment facility to dispose of stabilized sludge.

Chemical cost are drastically reduced for dewatering chemicals. Electrical useage is reduced. Wear and equipment operation and maintenance are reduced. And, landfill fees are markably and substantially reduced.

The Appendix contains the Action Plan for this program.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. RECOMMENDATION

Based on the review presented in this report it is recommended that the City of Grand Junction proceed with the proposed land application program. Land application is recommended for the following reasons:

1. Lower cost on a per ton dry weight solids basis of sludge disposed.
2. Beneficial nutrients within sludge are recycled.
3. Does not utilize landfill space required for refuse disposal.
4. Offers benefits to the public as a fertilizer and soil conditioner.

B. EQUIPMENT NECESSARY FOR PROGRAM

The equipment necessary for the implementation of the plan through Stage-two is as follows:

1.	Two (2) Dump Trucks - (owned by the City)	12 yard beds
2.	Blades for turning sludge (City owned)	PTO truck operated plows
3.	One Dry Box Sludge Applicator	Interchangeable from Dump Truck
4.	One Tractor	Medium size for loading dry solids and cleaning drying beds
5.	One front-end loader attachment	For loading dry solids
6.	One scraper blade	For cleaning drying beds
7.	One disk	For tillage of sludge into the soil

The equipment necessary for the implementation of the plan through Stage-three is as follows:

8.	Liquid sludge injector	2,200 gallons
9.	Nurse trailer	6,000 gallon for hauling liquid sludge to fields.
10.	Tractor-truck	To pull nurse trailer

C. SLUDGE STORAGE AREA

Because of the high groundwater tables at the Persigo Plant site a suitable sludge storage area will be constructed. The area immediately surrounding the sludge drying beds was choosen for its proximity to available in-plant drains and in-plant return waste pump station. Also, the improvement of this area allows for greater accessibility to the drying bed area during bad weather.

D. FINALLY

In the event the City approves this draft and finds it equitable; the Persigo Plant suggests the following:

1. That a complete land application program be implemented; as discussed in Section III., A. 5 pp 7; and, Section V. pp 13 of this report.

2. That the program meet all the requirements and criteria of the Approved Colorado Department of Health Sewage Sludge Regulations.

3. That the sludge hauling equipment be City owned.

4. That the program be operated and managed by the City.

5. That this plan be a complete program utilizing a combination of surface application of dewatered and liquid sludge; windrowing for storage; and, finally, liquid injection.

6. That the disposal of rags, grit, and scum and dewatered sludge which does not meet the criteria of the regulations would continue to be disposed of by burial at a landfill.