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NAWC WARMINSTER
5090.3a

FINAL REPORT
EVALUATION OF WASTEWATER TREATMENT PLANT
WARMINSTER, PENNSYLVANIA

PREPARED FOR:
Naval Facilities Engineering Command
Philadelphia, Pennsylvania

PREPARED BY:
GZA GeoEnvironmental, Inc.
Newton Upper Falls, Massachusetts

August 1992
File No. 12821

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GZA
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Engineers and Scientists

August 25, 1992
File No. 12821

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Re: Evaluate Operations - Tasks 2.A and 2.B

Dear Matt:

This submittal constitutes the Final Report of the Evaluation of the Existing Operations (Task 2.A.) and the Future Operation (Task 2.B.) as required by Sections 4.2.A and B. of the Contract N62472-90-D-1449, Amendment No. 13, Project No. 19. This Final Report is based on the information supplied by you to GZA GeoEnvironmental, Inc. (GZA) with your letter of January 8, 1992, on information collected by Mr. Pat Sheehan of GZA and myself during our visit to the Naval Air Warfare Center (NAWC) on January 27 and 28, 1992, and on the set of drawings received by GZA on April 27, 1992.

In addition to an evaluation of the Existing and Future Operations, this Final Report contains discussion and preliminary suggestions regarding recommended pilot investigations. The results of these investigations could help in the process of finalizing the future design of modifications and additions to the Warminster wastewater treatment facility. Analyses presented in this Final Report indicate that such modifications and additions would have to be made if requirements of the Industrial Waste NPDES Permit PA 00022420 are to be met.

As you know, Code 6280, Ser 92320/1811/MLJ in his letter of March 27, 1992, suggested that we include all requirements for pilot investigations in this Report. We would be happy to submit a proposal for this work. However, we would appreciate a preliminary discussion with you and all other interested parties to clarify the extent of such investigations for the reasons stated below.

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When we originally discussed this subject, only chemical phosphorus removal was planned for a pilot investigation.

However on the basis of clarification by the Bureau of Water Quality Management of the Department of Environmental Resources of Commonwealth of Pennsylvania, as was explained by the letter Code 6280, Ser 92320/1811/MLJ it appears that more nitrification support and dedicated denitrification units, in addition to modifications foreseen for phosphorus control, might be required.

It might be advisable to perform pilot a investigation regarding nitrification and denitrification prior to completion of the final design. Such investigations can result in substantial savings during design and construction stages of the project, as well as in facility operation and maintenance.

The approach and budget necessary for such pilot investigation will depend on degree of NAWC participation, location of investigation site (some of the tests might be performed on a laboratory scale) and degree of analytical support by NAWC.

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The questions and comments by Northern Division on the Draft of this Report, which was submitted to you under our cover letter dated June 5, 1992, were received by GZA via facsimile. The first set of questions and comments was dated June 23, 1992, and contained 12 questions and comments. A memorandum containing a draft of GZA's responses to this set of questions and comments was prepared and communicated to you, and then discussed in detail and approved during our meeting in Warminster, Pennsylvania, on July 16, 1992. The second set of questions and comments was dated July 24, 1992, was received by GZA via facsimile on August 14, 1992, and contained 17 additional questions, corrections, recommendations and comments.

On August 19, 1992, during our telephone conversation, I requested your advice on the format of responding to this last set of questions, corrections, recommendations and comments by the Northern Division. A log of this telephone conversation containing your instructions, is attached to this letter. The Final Report is organized and addressed in accordance with your instructions expressed during this telephone conversation.

We would like to reiterate that, as it is indicated by our responses to your questions and comments, we are ready to proceed with this project on the basis of an already approved, modified, or even revised scope of work, and are looking forward to your instructions and guidance.

Very truly yours,

GZA GEOENVIRONMENTAL, INC.

Mikhail Schiller, Sc.D., P.E.
Chief Wastewater Design Engineer

Michael A. Powers, P.E.
Senior Principal FOR

John J. Balco
Associate Principal

MS/JJB/MAP:ms
Attachment: Telephone log of August 19, 1992
Final Report

cc: Mr. M. Hunter, Code 8303
Naval Air Warfare Center
Street & Jacksonville Road
Warminster, Pennsylvania 18974

GZA GEOENVIRONMENTAL INC.
SUMMARY OF TELEPHONE CALLS

☐ Incoming ☒ Outgoing

File No.: 12821.00 (Page 1 of 2)	
Project: P/N control, NAWC	
Date: 8/19/92	Time: 11:45 am
Person ~~Calling~~ or Called: Matthew Jablonec, code 1812	Phone: 215-595-0567
Company or Organization: NAWC	Subject: Final report

Summary of Call:

MS: Would you, please, fax to me again the questions I received from you on June 24, 1992 - I seem to lost it in Philadelphia during our meeting on 7/16/92.

MJ: I will fax them to you today.

MS: Mr. Roche in his comments dated 24 July 1992, which I received on August 14, 1992 in Reference 15 informs me that your current code is 1812. Is that true?

MJ: It is.

MS: The same comments, reference 14, requires references to letter from Northern Division by date and serial number. Which number does he mean?

MJ: In the upper right corner, following letters Ser xxxx/xxxxxx.

MS: Would you like me to draft answers to the comments dated 24 July 1992, or to issue a Final Report, incorporating the answers in the table format, much as I responded to your questions of June 24, 1992?

Action: MJ: Issue the final report. No draft for answering questions is needed.

MS: Will it be allright to incorporate the questions and answers into a separate Appendix?

MJ: Yes, but the changes in the text shall be made, as necessary.

MS: Of course. These references will be responded to by indication "Corresponding correction (note) is incorporated in the final report".

CC:	Name: M. Khalil Schiller

GZA GEOENVIRONMENTAL INC.
SUMMARY OF TELEPHONE CALLS

☐ Incoming ☒ Outgoing

File No.: 12821.00 (Page 2 of 2)	
Project: P/N control, NAVY	
Date: 8/19/92	Time: 11:42 am
Person ~~Calling~~ or Called: Matt Jabloner, code 1812	Phone: 215-595-0567
Company or Organization: NAWC	Subject: Final report

Summary of Call:

MS: You are aware that some of the comments dated July 24, 1992, are clearly out of scope of the Task 2, and even of the entire project?

MJ: Yes, and expect you to indicate so in your responces.

MS: Whom shall I address the cover letter for the Final report? To you or to Mr. Ruche?

MJ: Address it to me.

MS: Thanks. Have a nice day. Good Bye.

MJ: I will send my fax right away. Goodbye.

Action:

CC:

Name: Michael Schiller

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1.00 INTRODUCTION

In accordance with the Terms and Conditions of Contract No. N62472-90-D-1449 dated January 3, 1992, GZA GeoEnvironmental, Inc. (GZA) is pleased to present this report which:

- summarizes GZA's investigation of nitrogen and phosphorous treatment at the wastewater treatment plant (WWTP) (excluding chemical pretreatment of the industrial stream and chemical sludge handling) located at the Naval Air Development Center (NAWC), Warminster, Pennsylvania;

- identifies some of the possible approaches which might be taken to meet the requirements concerning nitrogen and phosphorus control at the WWTP, as specified by the Industrial Permit No. PA 0022420; and

- presents a performance evaluation of the WWTP, based on the results of routine analyses of the BOD_5 and suspended solids concentrations, performed by the WWTP personnel, and made available to GZA.

The purpose of this report is to satisfy the objective as presented by the Section 3 of the aforementioned Contract, and to fulfill the requirements of Section 4.2, Tasks 2A and 2B of the Scope of Work by evaluating the following WWTP parameters:

EXISTING OPERATIONS

- Overall operating efficiency;
- Design limitations;
- Design capacity of the entire plant; and
- Design capacity of each component of the WWTP.

FUTURE OPERATIONS

- Expected effluent values;
- Compliance with NPDES permit (the new discharge limits);
- Additional operating requirements and procedures;
- The new design capacity of the WWTP;
- If additional treatment of nitrogen and/or phosphorus is needed; and
- Effects on WWTP if NAWC future base operations and discharges reduce significantly.

The analysis was based in part on:

- Information obtained during a January 27-28, 1992 site visit by Project Manager Mikhail Schiller, and Project Engineer Patrick Sheehan;
- Monthly plant operating data for the years 1989-1991 and daily plant operating data for the year 1991 (supplied by Mr. Michael Hunter, NAWC), and;
- WWTP design drawings (supplied to us by Mr. Matthew Jabloner (Naval Facilities Engineering Command [NFEC]).

2.00 DEFINITIONS

The following are definitions for abbreviations to which frequent referrals are made throughout this report:

TABLE OF DEFINITIONS

ABBREVIATION	DEFINITION
BOD_5	Five day biochemical oxygen demand
CBOD	Carbonaceous biochemical oxygen demand
Current Permit	NPDES permit which is valid through completion of the upgrade
Existing Operations	Operating the WWTP with the existing facilities
Future Operations	Operating the WWTP with upgraded facilities
Future Permit	NPDES permit which is valid from completion of the upgrade through expiration
gpd	Gallons per day
gpd/sf	Gallons per day per square foot
MGD	Million gallons per day
mg/l	Milligrams per liter
NH_3-N	Ammonia expressed as nitrogen equivalent

TABLE OF DEFINITIONS
(Continuation)

ABBREVIATION	DEFINITION
NO_3-N	Nitrate expressed as a nitrogen equivalent
NO_2-N	Nitrite expressed as a nitrogen equivalent
NPDES	National Pollutant Discharge Elimination System
P	Phosphorus
PADER	Commonwealth of Pennsylvania Department of Environmental Resources
ppm	Parts per million
PST	Primary settling tanks
SST	Secondary settling tanks
Summer	The period of the year during which effluent requirements are generally more stringent than through the "winter" (see below). The period varies by effluent constituent
TF	Trickling filter
TKN	Total Kjeldahl nitrogen
TN	Total nitrogen as per WWTP chemist: TN = ([TKN] + [NO_3-N] + [NO_2-N])
TSS	Total suspended solids
Winter	The period of the year during which effluent requirements are generally less stringent than through the "summer" (see above). The period varies by effluent constituent
WWTP	Wastewater treatment plant

3.00 BACKGROUND

The United States Navy currently owns and operates a WWTP at the NAWC Warminster, Pennsylvania facility. This treatment plant, originally designed to process wastewater generated both by base operations and base housing complex, currently

treats only those wastewater generated by base operations. The plant receives two completely separate wastewater streams: (1) a clarified liquid train of the pretreated industrial stream which is discharged from a separate pretreatment complex designed to remove primarily heavy metals via ferric chloride and lime coagulation, flocculation, and gravity settling; and (2) a sewage stream with a composition which is similar to municipal wastewater.

The WWTP consists of:

- A lift pumping station which houses the centrifugal influent lift pumps, plunger primary sludge transfer pumps, a laboratory and an office;
- Four rectangular primary settling tanks equipped with mechanical sludge and scum collectors;
- Three trickling filters equipped with stone media and rotating inertial influent distribution double arms;
- Four rectangular equipped final settling tanks with centrally located sludge hoppers which accommodate gravity sludge removal,
- One chlorination tank equipped with a chlorinator,
- Three heated anaerobic digesters equipped with floating covers; two of which are decommissioned beyond repair; and
- Completely decommissioned sludge drying beds.

The WWTP is designed to remove suspended solids, carbonaceous organic material and bacterial contamination. The treated aqueous effluent from the WWTP is currently discharged to an unnamed tributary of the Little Neshaminy Creek (Creek) under a NPDES permit; the humus from the Trickling Filter is pumped to the Primary Settling Tanks, and the combined (primary and secondary) sludge (excluding chemical sludge from the industrial pretreatment units) is pumped to an anaerobic digester for further treatment. A series of sludge drying beds was provided for dewatering of the anaerobically digested sludge; however, operation of the drying beds has been abandoned.

In 1989, the Navy committed to upgrading the WWTP by reconfiguring the Trickling Filters from a parallel flow operation to a series flow operation. This decision was made, and corresponding actions taken, prior to GZA's engagement. The reconfiguration was undertaken based on the assumption that it will induce biological nitrification (the biological oxidation of ammonia nitrogen into nitrate nitrogen)

thereby allowing the NAWC to meet future permit effluent requirements. It is our understanding that this construction is expected to be completed in 1992.

On September 27, 1989, PADER issued a revised NPDES permit to the Navy for the discharge of the plant effluent to the Creek. The permit establishes discharge standards for specific effluent parameters for two separate time periods: (1) from issuance of the permit through completion of the upgrade (current); and (2) from completion of the upgrade through permit expiration on September 27, 1994 (future). A comparison of key aspects of the two sets of requirements are presented in Table 1. The more significant changes that will occur when the future permit requirements take effect are:[1]

- Ammonia nitrogen allowable effluent concentrations will be reduced by 30 percent (i.e., from 3 mg/l to 2.1 mg/l during the summer and from 9 mg/l to 6.3 mg/l during the winter. The summer period will be expanded to include May.

- Total Nitrogen will no longer be regulated. Instead, the sum of nitrate nitrogen and NO_2-N will be required not to exceed 8.9 mg/l during the months of July through October, inclusive.

- Phosphorus, not regulated under the current permit, will be required not to exceed 2 mg/l during the months of April through October, inclusive.

This report presents an evaluation of the efficiency, design limitations, and design capacity of the existing NAWC WWTP on the basis of data provided by NAWC. At the request of the NAWC, the industrial pretreatment complex will not be discussed. This report will focus primarily on the sewage treatment complex of the WWTP as described in the beginning of this Section 3.00.

4.00 OVERALL PLANT OPERATING EFFICIENCY FOR CURRENT AND FUTURE OPERATIONS

To assess the overall operating efficiency of the WWTP, GZA analyzed the following sets of the operational data supplied to us by the NAWC: (1) average monthly data

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[1] Note that the NPDES permit specifies both concentration limits and mass limits for each constituent. The mass limits are based on the concentration limits and wastewater flow rate of 0.15 MGD. (See Appendix C - Design Calculations, page 1.) However, because the average flow rate for the WWTP is approximately 0.09 MGD (based on operational data), only concentration limits are referred to throughout this report.

for the years 1989 through 1991, and; (2) average daily data for the year 1991. The data was analyzed in this manner primarily to facilitate identification of both seasonal trends and daily trends.

Because the NAWC was not required to collect information regarding influent and some future effluent parameters as part of the normal reporting procedures, we were unable to calculate removal efficiencies for many of the constituents of concern. As a result, we assessed the overall plant operating efficiency in two manners:

1. **Removal efficiencies** for BOD_5 and total suspended solids (i.e., for which influent data exist) were calculated to provide an indication of plant operational efficiency, and;

2. **Compliance efficiencies** for many of the constituents for which effluent limitations have been established were calculated by comparing measured concentrations to permit requirements.

4.10 REMOVAL EFFICIENCY

Under the NPDES permit, the NAWC is required to report the average monthly BOD_5 removal efficiency of the plant (it must be greater than 85 percent). To fulfill this requirement, raw wastewater (e.g., influent), Primary Settling Tanks effluent, Trickling Filter effluent, Secondary Settling Tanks effluent, and chlorination tank effluent samples are periodically collected and analyzed for BOD_5 and total suspended solids by the NAWC personnel.

4.11 Five-Day Biochemical Oxygen Demand

Based on the 1989-1991 average monthly data and the 1991 average daily data, GZA estimates that total plant influent BOD_5 removal rates are approximately 99 percent (Figures 1 and 2). The literature[2] indicates that BOD_5 removal rates greater than 85 percent are considered excellent for municipal wastewater treatment plants utilizing Trickling Filters. This 99 percent BOD_5 removal rate breaks down by each process unit as follows: 80 percent by the Primary Settling Tanks, 17 percent by the Trickling Filter, and 2 percent by the Secondary Settling Tanks. These removal rates are estimated as percentage of the total WWTP influent BOD_5 that is removed by a particular unit. The 80 percent BOD_5 removal rate by the Primary Settling Tanks is high for typical sewage treatment facilities (typical removal rates are on the order of 40 percent to 50 percent).

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[2] Metcalf and Eddy, Inc., Wastewater Engineering - Treatment, Disposal, Reuse, McGraw-Hill, Inc., New York, 1991.

The BOD_5 removal efficiencies of each unit (Figures 3 through 8) vary with time, but are approximately 80 percent for the Primary Settling Tanks, 80 percent for the Trickling Filter, and 40 percent for the Secondary Settling Tanks. These removal rates are estimated as ratios of corresponding unit effluent and influent BOD_5 values to characterize the BOD_5 removal efficiency of a particular unit only. Such high removal efficiencies indicate that the facilities, as currently operated, appear to be capable of meeting the future permit requirement of 30 mg/l for BOD_5 in the range of expected wastewater flows.

4.12 Total Suspended Solids

Based on the 1989-1991 average monthly data and the 1991 average daily data, GZA estimates that total plant influent total suspended solids removal rates are approximately 97 percent (Figures 9 and 10). The literature (Metcalf and Eddy, Inc., 1991) indicates that total suspended solids removal rates greater than 85 percent are considered excellent for municipal secondary wastewater treatment plants.

The total suspended solids removal efficiencies data presented by the NAWC WWTP was organized by unit operation (Figures 11 through 14). This was done strictly for the ease and uniformity of data presentation. The efficiency of total suspended solids removal in the Primary Settling Tanks constitutes approximately 80 percent of the influent total suspended solids, while overall facility efficiency is approximately 97 percent, as was indicated in the preceding paragraph. These removal efficiencies indicate that the current facilities appear to be capable of meeting the future permit effluent requirements of 30 mg/l for total suspended solids in the range of expected wastewater flows.

4.20 COMPLIANCE EFFICIENCY

The overall removal efficiency of the plant for most of the effluent limitation constituents could not be calculated directly due to the fact that the NAWC does not (and is not required to) report influent constituent concentrations. Therefore, we have compared the effluent constituent concentration data with the current and future permit requirements to ascertain both the current and future compliance of these parameters.

4.21 Flow Rate

The 1989-1991 average[3] monthly flow data (Figure 15) indicates that over the course of the last three calendar years, the monthly flow through the WWTP has

[3] Flow Rate values do not follow a normal distribution curve, but are represented by a relatively uniform cloud of values concentrated around the arithmetic average.

averaged 0.08 MGD[4], with a maximum of 0.123 MGD, and a minimum of 0.049 MGD. The 1991 daily flow data (Figure 16) indicates that the average daily flow through the WWTP in 1991 was 0.077 MGD, with a maximum of 0.216 MGD, and a minimum of 0.001 MGD.

To identify flow variation trends, we also plotted the 1991 flow data by days of the week (Figures 17, 18 and 19). The dark bands on Figure 17 indicates the portion of the flow on that day which was greater than 0.15 MGD. The values plotted on Figure 19 represent a yearly average of the flow rates on each day of the week.

These graphs indicate that with the exception of several high flow days, the Average Daily Flowrate during the work week (Monday through Friday) is approximately 0.09 MGD, and Average Daily Flowrate during the weekend (Saturday and Sunday) is approximately 0.045 MGD. There is no one day where flow rates are consistently higher than average. Based on these analyses of past flow data, we have estimated that for design purposes, the Average Daily Flowrate should be 0.09 MGD, and the Maximum Daily Flowrate should be 0.16 MGD.

4.22 Five-Day Biochemical Oxygen Demand

The 1989-1991 average monthly data (Figure 20) and 1991 average daily data (Figure 21) both indicate that effluent BOD_5 concentrations are consistently below both the current and future winter and summer permit requirement of 30 mg/l. As previously noted, the BOD_5 compliance efficiency of the WWTP is extremely high. We believe that both the existing and future WWTP operations should be sufficient to meet both current and future NPDES permit requirements.

4.23 Total Suspended Solids

The 1989-1991 average monthly data (Figure 22) and 1991 average daily data (Figure 23) both indicate that effluent total suspended solids concentrations are consistently well below both the current and future winter and summer permit requirement of 30 mg/l. As previously noted, the total suspended solids compliance efficiency of the WWTP is extremely high. It appears that both the existing and future WWTP operations are capable of meeting both current and future NPDES permit requirements.

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[4] Though the existing NPDES permit specifies maximum permitted discharge flow rate at 0.75 MGD, we suspect that it is a printing error, and the intended value was 0.15 MGD. The supposition flows from the NPDES mass limits, which are based (see Footnote 1) on maximum flow rate of 0.15 MGD. Figure 15 indicates that the WWTP currently is not in violation of either 0.15 or 0.75 MGD average monthly discharge flow rate.

4.24 Ammonia-Nitrogen

The 1989-1991 average monthly data (Figure 24) indicates that the WWTP effluent is generally in compliance with both the current ammonia nitrogen winter permit requirements of 9 mg/l and the future ammonia nitrogen winter permit requirements of 6.3 mg/l. With the exception of an approximately one month period in October-November, 1991 when effluent ammonia nitrogen concentrations were in the range of 10 mg/l to 40 mg/l, the 1991 data (Figure 25) supports this trend.

The 1989-1991 average monthly data indicates that the WWTP has generally met both the current effluent ammonia nitrogen summer permit requirements of 3 mg/l and the future effluent ammonia nitrogen summer permit requirements of 2.1 mg/l since late 1990. However, the 1991 average daily effluent ammonia nitrogen concentrations have been greater than the current permit requirements approximately 25 percent of the time and greater than the future permit requirements approximately 50 percent of the time. This indicates that the current nitrifying capabilities of the WWTP should be enhanced to meet the future summer effluent ammonia requirements (see discussion, Section 5.00 - Ammonia removal).

4.25 Nitrite and Nitrate-Nitrogen

Although this parameter is not regulated under the current permit (total nitrogen is regulated), it will be regulated under the future permit during the months of July through October, inclusive. The effluent limit of 8.9 mg/l was established for this parameter. Based on the 1989-1991 average monthly data (Figure 26) and the 1991 average daily data (Figure 27), the WWTP did not appear to meet the future permit requirements approximately 50 to 75 percent of the time. The denitrification capability of the WWTP will not be enhanced by the future operations (see discussion, Section 5.00 - Nitrate removal). As such, we believe the NAWC should consider constructing a dedicated denitrification unit.

4.26 Total Nitrogen

Under the current permit, the effluent concentration of total nitrogen is limited to 8 mg/l during the summer, and to 24 mg/l during the winter. This parameter will not be regulated under the future permit. Based on the 1989-1991 average monthly data (Figure 28) and the 1991 average daily data (Figure 29), the WWTP did not appear to meet these limitations 100 percent of the time during summer and approximately 25 percent of the time during winter. Although total nitrogen will not be regulated under the future permit, the available data indicates that neither current nor future permit requirements concerning various forms of nitrogen can be met without enhancing the nitrification capacity of the WWTP and constructing a dedicated denitrification unit (see discussion, Section 5.00 - Ammonia removal and - Nitrate removal).

4.27 Phosphorus

Phosphorus, not regulated under the current permit, will, for future operations, be limited to 2 mg/l during summer. Based on the 1989-1991 average monthly data (Figure 30) and the 1991 average daily data (Figure 31), the WWTP does not appear to be capable of meeting the permit requirement 100 percent of the time. Attached growth biological reactors (such as Trickling Filters), unlike suspended growth reactor (such as aeration tanks) are not very effective in removing phosphorus. Therefore, chemical precipitation of phosphates using either existing or new dedicated facilities should be considered (see discussion in Section 5.00 - Phosphorus removal).

5.00 DESIGN LIMITATIONS

Based on analysis of the efficiency and design capacity of the WWTP (see Sections 4.00, 6.00, and 7.00), we have identified the following design limitations, which are pertinent to the parameters discussed above:

- BOD_5 Removal - Under the existing operations and the future operations, at the average influent BOD_5 concentration of 200 mg/l, the WWTP can process an Average Daily Flowrate of approximately 0.17 MGD. The hydraulic capacity of the Trickling Filter represents the limiting factor.

- Total suspended solids Removal - Under the existing operations and the future operations, the actual design capacity is limited by the hydraulic capacity of the Trickling Filters and is approximately 0.17 MGD, although the Primary Settling Tanks could process up to 0.96 MGD at the average influent total suspended solids concentration of 300 mg/l.

- Ammonia removal: The ammonia nitrogen removal (i.e., nitrification) capacity of the WWTP under both the existing operations and future operations is inadequate. It appears that the original WWTP design did not anticipate ammonia nitrogen removal requirements. The conversion of ammonia nitrogen into nitrate nitrogen (nitrification) requires strict alkalinity and oxygen control[5]. The pH and temperature conditions substantially affect efficiency of nitrification. The original design, according to information available to GZA, does not seem to contain provisions for controlling these parameters. Furthermore, the current practice of recycling 200 percent of the effluent flow back to the Trickling Filters to keep them moist, though a valid operational tool, affects nitrification processes adversely. By recycling such a high flow,

[5] The nitrification of 1 pound of ammonia (as nitrogen) requires approximately 7.2 pounds of alkalinity and 4.6 pounds of oxygen.

concentration of ammonia nitrogen is diluted 300 percent and the environment becomes less favorable for the development of a viable *nitrosomonas/nitrobacter* (the principle nitrification bacteria) population.

- Nitrate removal (i.e., denitrification): Under both the existing operations and future operations, the sewage treatment plant is incapable of reducing nitrate nitrogen concentrations. The reduction of nitrate nitrogen to nitrogen gas via biological denitrification requires combined aerobic nitrification/anoxic denitrification facilities. According to information available to GZA, WWTP design does not appear to provide for biological denitrification.

- Anaerobic digesters: Operational data (e.g. digester gas production rate) indicate that the anaerobic digesters are not functioning properly. This fact is primarily attributable to the configuration of the digester. The heating coils in internally heated anaerobic digesters typically became encrusted with both organic and inorganic materials when they are not maintained properly. As a result, heat transfer is limited and sludge temperatures decrease to the point where anaerobic digestion rates are substantially reduced, and digestion times increase up to six months. The fact that the difference between the sludge temperature and the heating coil temperature is greater than 10 degree Fahrenheit (as indicated by NAWC personnel) supports this supposition.

- Phosphorus removal: Under both the existing and future operations the WWTP does not appear to be capable of meeting permit requirements for phosphorus removal, assuming that the influent phosphorus concentration is not drastically reduced. The original WWTP design (excluding the industrial wastewater pretreatment portion) did not provide for phosphorus removal. In secondary treatment plants utilizing attached growth reactors, phosphorus is typically removed by chemical precipitation.

  Phosphates removal usually entails controlling pH and adding a coagulant (e.g., ferric, aluminum or calcium salts) to the wastewater, creating insoluble salts, and flocculating the resulting suspension which settles as a sludge. It appears that the WWTP may have the facilities to perform this operation (i.e., via the industrial treatment complex or direct wet well injection). However, some retrofit design (i.e., pH control and coagulant feeding system, sludge pumping facilities, etc.) based on a preceding pilot scale investigation would be necessary.

6.00 DESIGN CAPACITY OF THE ENTIRE WASTEWATER TREATMENT PLANT FOR CURRENT AND FUTURE OPERATIONS

The design capacity of a WWTP is defined by the design capacity of its individual units (an analysis of the design capacity of the unit operations is presented in Section 7.00). Based on the unit operation analyses, we estimate that the hydraulic design capacity of the existing WWTP (assuming that one Trickling Filter is operating in low rate mode and that denitrification and phosphorus removal processes are incorporated into the WWTP) is approximately 0.17 MGD and is limited by the hydraulic capacity of the Trickling Filters (see Appendix C for design calculations).

Under the future WWTP operations (assuming two Trickling Filters are operating in series in low rate mode, necessary modifications to BOD_5/NH_3-N controlling part of the WWTP are implemented and denitrification and phosphorus removal processes are incorporated), the WWTP should be able to process higher organic loading than achievable under the current operations. However, the hydraulic capacity of the WWTP will still be limited to the hydraulic capacity of the Trickling Filters and equal to 0.17 MGD (see Appendix C for design calculations).

We believe that WWTP, as it appears to be designed, can process the Average Daily Flowrate of 0.09 MGD and the Maximum Daily Flowrate of 0.16 MGD[6]. A comparison of the design capacity of the WWTP versus the actual average flow rates is summarized in Table 2.

7.00 DESIGN CAPACITY OF EACH COMPONENT OF THE WWTP FOR CURRENT AND FUTURE OPERATIONS

To estimate the design capacity of each component of the WWTP, we have analyzed their capacities, with respect to the following parameters:

- Hydraulic loading
- Solids loading
- CBOD loading (BOD_5)
- Ammonia nitrogen loading

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6 The capacity of the main pumping station, the sludge transfer pumps, the flow metering device, the chlorination facility, and the force and gravity piping, as well as oxygenation and oil and grease removing capacities of the WWTP were not considered during the analysis due to lack of available information regarding these parameters. However, because design calculations indicate the WWTP was designed to process a flow of greater than 0.5 MGD, we feel the hydraulic capacity of the pumps and piping is probably sufficient.

- Nitrate nitrogen loading
- Phosphorus loading

The component design capacities were compared to historical WWTP loadings (estimate is based on the 1989 to 1991 operational data), to provide an indication of WWTP capacity as it is currently used.

Based on available operational data and our experience with sewage treatment plant incorporating Trickling Filters, we made several assumptions regarding current plant loadings. Specifically, these assumptions are:

Influent	Assumption		Basis
	Average	Maximum	
Flow	0.09 MGD	0.16 MGD	1991 data for "work week" days
BOD_5	PST: 200 mg/l TF: 100 mg/l	PST: 370 mg/l TF: 185 mg/l	1989 to 1991 operational data and typical removal efficiencies.
TSS	PST: 300 mg/l TF: 150 mg/l SST: 50 mg/l	PST: 500 mg/l TF: 250 mg/l SST: 100 mg/l	1989 to 1991 operational data and typical removal efficiencies.

A summary of pertinent design calculations and assumptions are included in Appendix C. A summary of the design capacities is included in Table 2.

7.10 PRIMARY SETTLING TANKS

The WWTP has four Primary Settling Tanks (concrete basins equipped with settled sludge scrapers and scum baffles) designed to remove both settleable solids and floating material. Based on the drawings provided to us by the NAWC, each Primary Settling Tank is 32 feet 6 inches long by 6 feet 2 inches wide by 5 feet 4 inches deep. Due to the relatively low average daily flow rate, the NAWC is currently operating only two Primary Settling Tanks in parallel. According to the operational data, approximately 75 percent of the influent BOD_5 and 80 percent of the influent total suspended solids are removed by these tanks.

7.11 Hydraulic Loading

The basic design criterion for Primary Settling Tanks is the Overflow Rate. Typical design guidelines (Metcalf and Eddy, Inc., 1991) indicate that, for adequate BOD_5 and total suspended solids removal, the hydraulic detention time of the tank should be on the order of 1 to 2 hours and the Overflow Rate should be approximately 600 gpd/sf of tank surface area at the Average Daily Flowrate, and 1,200 gpd/sf at the Maximum Daily Flowrate. Based on these guidelines, and assuming all four Primary Settling Tanks were placed on line, the NAWC WWTP might be capable of treating an average flow rate of approximately 0.48 MGD at a detention time of 1.6 hours and a maximum flow rate of 0.96 MGD at a detention time of 0.8 hours. Under the existing and future operations (two Primary Settling Tanks operating), the overflow rate at the Average Daily Flowrate of 0.09 MGD is, and will be, 225 gpd/sf. At the Maximum Daily Flowrate of 0.16 MGD, the overflow rate is, and will be, 400 gpd/sf. This indicates that the Primary Settling Tanks are hydraulically capable of treating the range of expected wastewater flows. As such, the Primary Settling Tanks appear to be capable of treating the current Average Daily Flowrate of 0.09 MGD and the current Maximum Daily Flowrate of 0.16 MGD.

7.12 Solids Loading

Generally, if Primary Settling Tanks are designed based on the previously mentioned Overflow Rate criterion, they should reduce influent total suspended solids concentrations by approximately 40 to 50 percent. Since the Primary Settling Tanks operate, and most likely will operate in the future, well below their capacity, under both the existing and future operations, they appear to be capable of meeting this total suspended solids removal requirement. According to the operational data, Primary Settling Tanks are reducing influent total suspended solids concentrations by approximately 80 percent.

7.13 Carbonaceous Organic Loading (BOD_5)

Generally, if Primary Settling Tanks are designed based on the previously mentioned Overflow Rate criterion, they will reduce influent BOD_5 concentrations by approximately 40 to 50 percent. Since the Primary Settling Tanks operate, and most likely will operate in the future, well below their capacity under both the existing and future operations, they appear to be capable of meeting this BOD_5 removal requirement. According to the operational data, Primary Settling Tanks are reducing influent BOD_5 concentrations by approximately 80 percent.

7.14 Ammonia Loading

Primary Settling Tanks are not designed to remove ammonia nitrogen.

7.15 Nitrate Loading

Primary Settling Tanks are not designed to remove nitrate nitrogen.

7.16 Phosphorus Loading

Although some settling of insoluble or adsorbed phosphorus compounds may occur, Primary Settling Tanks are generally not capable of reducing phosphorus concentrations without preceding coagulation and flocculation steps.

7.20 TRICKLING FILTERS

The sewage treatment facility was originally equipped with three identical rock media Trickling Filters operated in a parallel flow configuration. Under the existing operations only one Trickling Filter is operated due to low flows. Under future operations, two of the Trickling Filters could be operated in either a series or parallel flow configuration. The primary purpose of these Trickling Filters is to reduce the influent concentrations of soluble organic matter.

A Trickling Filters can be operated in one of two primary modes: low rate and high rate. During low rate operation, organic loading rates are such that in the presence of ammonia nitrogen, the growth of nitrifying organisms is promoted, hence the Trickling Filter effluent is typically, at least partially, nitrified. During high rate operation, more emphasis is placed on removal of soluble organic compounds at the expense of nitrification capabilities. Because such a high percentage of the influent BOD_5 at the NAWC WWTP appears to be removed by the Primary Settling Tanks we have based our design capacity calculations on the assumption that the Trickling Filter should be operated in the low rate mode to encourage nitrification.

Based on the drawings provided to us by the NAWC, we estimate that the diameter of each tank is 65 feet, and the depth of the rock media of each tank is 6 feet 3 inches. When estimating the design capacity of the WWTP, we considered four potential operating scenarios: one Trickling Filter operating; two Trickling Filters operating in series; two Trickling Filters operating in parallel; or three Trickling Filters operating in parallel.

7.21 Hydraulic Loading

The design capacity of a Trickling Filter treating typical municipal wastewater can be estimated based on the Hydraulic loading rate, the Trickling Filter equivalent of an Overflow Rate. Typical design guidelines (Metcalf and Eddy, Inc., 1991) indicate that, for a Trickling Filter operating in the low rate mode, the Hydraulic loading rate should be in the range of approximately 25 to 100 gpd/sf.

Assuming a typical Hydraulic loading rate of 50 gpd/sf, we estimate that, under both the existing operations (one Trickling Filter) and future operations (two Trickling Filters), the Trickling Filter system can process a wastewater flow of approximately 0.17 MGD. Under the two Trickling Filters in parallel operational mode, the Trickling Filter system can process a wastewater flow of approximately 0.33 MGD. Under the three Trickling Filters in parallel mode, the Trickling Filter system can process wastewater flow of approximately 0.50 MGD. This indicates that the Trickling Filter appears to be hydraulically capable of processing both Average Daily Flowrate of 0.09 MGD and Maximum Daily Flowrate or 0.16 MGD. It should be noted that for Trickling Filters operated in series the use of an intermediate settling tank between the first and the second Trickling Filter is recommended.

Under both the existing and future operations, at the current Average Daily Flowrate of 0.09 MGD, the Hydraulic loading rate is approximately 27 gpd/sf. At the Maximum Daily Flowrate of 0.16 MGD, the Hydraulic loading rate is approximately 48 gpd/sf. This indicates that the Trickling Filter appears to be hydraulically capable of processing both the Average Daily Flowrate of 0.09 MGD and Maximum Daily Flowrate of 0.16 MGD.

7.22 Solids Loading

Generally, the concentrations of total suspended solids in the Trickling Filter effluent is higher then in the influent due to the sloughing of humus from the rock media. The apparent decrease of total suspended solids concentrations by the NAWC Trickling Filter is currently unexplained.

7.23 Carbonaceous Organic Loading (BOD_5)

The design capacity of a Trickling Filter operating in the low rate mode should be checked based on the Trickling Filter ability to reduce the concentrations of soluble organics in the wastewater. Typical design guidelines (published elsewhere) indicate that, for a Trickling Filter operating in the low rate mode, the Organic Loading Rate should be in the range of 12.5 pounds of BOD_5 per 1,000 cubic feet of media per day. At this loading rate, existing operations can process a BOD_5 loading of approximately 250 pounds per day (lb/d), future operations (in parallel) can process a BOD_5 loading of approximately 500 lb/d, and three Trickling Filters in parallel can process a BOD_5 loading of approximately 750 lb/d. Under existing and future hydraulic loadings Organic Loading Rate for two Trickling Filters in series will not differ from Organic Loading Rate for a single Trickling Filter, and is approximately at 250 lb/d. Therefore it appears that both the existing operations and future operations can effectively treat the average organic loading rate of 75 lb/d of BOD_5 and the maximum organic loading of 250 lb/d of BOD_5. The future operation, however, might require utilization of an intermediate settling tank, as mentioned earlier.

To estimate the effectiveness of the Trickling Filter under the existing operations mode, we used the National Research Council (NRC) equation for substrate removal by a rock media Trickling Filter. The results indicate that, at both the Average Daily Flowrate of 0.09 MGD and the Maximum Daily Flowrate of 0.16 MGD, the effluent BOD_5 concentration should be approximately 5 mg/l. As such, under both the existing and future operations the Trickling Filter appears to be capable of treating expected organic loadings.

7.24 Ammonia Loading

A Trickling Filter operating in a low rate mode may fully nitrify reduced forms of nitrogen (e.g., ammonia nitrogen) when proper operating conditions are provided. Design guidelines published elsewhere indicate that at BOD_5/NH_3-N ratios between 10 and 2, sufficient quantities of alkalinity and oxygen, proper pH and temperature conditions, and the absence of toxic substances, especially copper, may promote the development of a healthy nitrifying bacteria population.

Under the existing operations, at the average Trickling Filter influent BOD_5 concentration of 40 mg/l (assuming an influent ammonia nitrogen concentration of 10 mg/l), the BOD_5/NH_3-N ratio is approximately 4, indicating that if the other above-mentioned conditions are controlled, nitrification may occur. Under the future operations, the BOD_5/NH_3-N ratio will be even lower, as influent BOD_5 concentration to the second Trickling Filter, if utilized, will be reduced.

7.25 Nitrate Loading

Trickling Filters are not designed to reduce nitrate nitrogen concentrations.

7.26 Phosphorus Loading

Generally, Trickling Filters are not implicitly designed to reduce phosphorus concentrations. Phosphorus removal that does occur is due to the biological metabolization of phosphates and the uptake of the phosphorus by the cell tissue of the microorganism. However, the operational data indicates that phosphorus removal via this mechanism in fixed media biological reactors is limited.

7.30 SECONDARY SETTLING TANKS

The primary purpose of the Secondary Settling Tanks is to clarify the final effluent by removing sloughed biomass produced by the Trickling Filter. The WWTP is equipped with four Secondary Settling Tanks, three of which are operated in parallel[7] (the

[7] The NAWC has not indicated that the operational configurations of SST will change under future operations.

fourth is used by the industrial pretreatment complex to transfer the already clarified industrial portion of the WWTP influent to the lift pumping station wet well for biological treatment via the Trickling Filters). The sludge removed by the Secondary Settling Tanks is currently gravity fed back to the head of the WWTP and then pumped to the Primary Settling Tanks.

Based on the drawing provided by the NAWC, we estimate that each Secondary Settling Tank is approximately 40 feet 6 inches long and 13 feet wide. The side water depth of the Secondary Settling Tanks varies, as the bottom of the Secondary Settling Tanks is sloped from each end toward a central sludge removal channel.

7.31 Hydraulic Loading

As is the case with the Primary Settling Tanks, Secondary Settling Tanks are designed based on Overflow Rate. Design guidelines (Metcalf and Eddy, Inc., 1991) indicate that for Secondary Settling Tanks following Trickling Filters, the recommended design Overflow Rate is approximately 400 gpd/sf at the Average Daily Flowrate and approximately 800 gpd/sf at Maximum Daily Flowrate.

Based on these guidelines, we estimate that if all four Secondary Settling Tanks were placed on line, the total design capacity of the Secondary Settling Tanks would be approximately 0.84 MGD at the average daily flow rate and 1.68 MGD at the maximum daily flow rate.

Under the existing and future operations, at the Average Daily Flowrate of 0.09 MGD, the overflow rate of the tanks is approximately 85 gpd/sf. At the Maximum Daily Flowrate of 0.16 MGD, the overflow rate is approximately 150 gpd/sf. This indicates that the Secondary Settling Tanks appear to be capable of treating the range of expected wastewater flows.

7.32 Solids Loading

It is typically assumed that if the design criteria for Overflow Rate are met, the Secondary Settling Tanks will effectively reduce total suspended solids concentrations to approximately 15 to 30 mg/l. Operational data available to GZA appear to indicate that the Secondary Settling Tanks are reducing total suspended solids concentration to less than 10 mg/l.

7.33 Carbonaceous Organic Loading (BOD_5)

Secondary Settling Tanks are not designed to remove BOD_5 specifically. BOD_5 removal in Secondary Settling Tanks is coincidental to the removal of wasted biomass.

7.34 Ammonia Loading

Secondary Settling Tanks are not designed to remove ammonia nitrogen.

7.35 Nitrate Loading

Secondary Settling Tanks are not designed to remove nitrate nitrogen.

7.36 Phosphorus Loading

Although Secondary Settling Tanks may remove some phosphates from the wastewater flow via settling of the sloughed biomass, they are not specifically designed to remove phosphorus unless phosphates coagulation and flocculation facilities are installed ahead of the Secondary Settling Tanks.

7.40 ANAEROBIC DIGESTERS

The WWTP is equipped with three identical heated anaerobic sludge digesters operated in a parallel configuration. NAWC personnel have indicated that only one of the digesters is currently operated due to the low plant flow. The personnel have also indicated that the digester that is currently being used is the only operational digester of the three (i.e., the other two require substantial repairs). Based on the drawings provided to us by NAWC personnel, we estimate that diameter of each digester is approximately 16 feet and 6 inches and the depth of each digester is approximately 10 feet and 10 inches.

7.41 Hydraulic and Solids Loading

The design capacity of the digesters is based primarily on the sludge detention time. The literature (Metcalf and Eddy, Inc., 1991) indicate that for a heated anaerobic digester, a typical design detention time is 15 days.

Based on this assumption, we estimate the design capacity of one digester is approximately 0.12 MGD and the design capacity of three digesters is approximately 0.35 MGD. Therefore the digesters appear to be capable of processing sludge from both the Average Daily Flowrate of 0.09 MGD and the Maximum Daily Flowrate of 0.16 MGD. However, if chemical precipitation of phosphates is employed, and the chemical sludge is co-settled in Primary Settling Tanks and pumped to the digesters along with the organic sludge, the digester capacity and efficiency should be reevaluated.

7.42 Organic Loading

Anaerobic digesters are typically designed for an organic (volatile solids) load of 0.10 $lb/ft^3/d$. Organic removal efficiency can be estimated by measuring the volume of produced digester gas (a combination of methane, carbon dioxide, and other gases). Based on typical design guidelines (Metcalf and Eddy, Inc., 1991), and the average organic loading rates, approximately 2,000 cubic feet of methane should be produced per day. NAWC personnel estimate that approximately 500 cubic feet of digester gas are actually produced per day, indicating that the digester may not be functioning at its full capacity.

7.43 Ammonia Loading

Biological nitrification of ammonia nitrogen is an aerobic process. It typically does not occur in anaerobic digesters. Generally, under anaerobic conditions, such as those found in the digesters, the TKN retained by the biomass will be substantially converted to ammonia nitrogen, negating the removal of ammonia nitrogen which occurred previously during aerobic biological treatment in the Trickling Filter. Thus, recycling the digester supernatant back into the liquid train, in fact, equates to partially closed loop recirculation of ammonia nitrogen.

7.44 Nitrate Loading

Denitrification might occur in anaerobic digesters to a limited degree. However, the efficiency of this process is extremely low. It should be noted that denitrification is an anoxic process, and not an anaerobic process.

7.45 Phosphorus Loading

Typically, excess phosphorus might be assimilated into the cell structure of the microorganism only during aerobic treatment process (i.e., Trickling Filter). When aerobic microorganisms are exposed to anaerobic conditions, they will release this stored polyphosphate. As such, anaerobic digester supernatant is typically rich in phosphates compounds. Thus, recycling the digester supernatant back into the liquid train, in fact, equates to partially closed loop recirculation of phosphorus.

8.00 EFFECTS OF POSSIBLE FUTURE SIGNIFICANT REDUCTION OF BASE OPERATION AND DISCHARGE ON WWTP OPERATION

Currently, at the Average Daily Flowrate, the NAWC WWTP is operating at only 35 percent of its potential design capacity (i.e., three Trickling Filters operating) and 53 percent of its current operations design capacity (one Trickling Filter operating). A

significant reduction in the WWTP flow may negatively affect the following aspects of the WWTP operations:

- The organic and hydraulic loads to the Trickling Filter may be insufficient to support a viable microbial population. If the WWTP flow is reduced, the recycle rate will have to be increased to prevent drying of the Trickling Filter. However, an increase in the recycle rate will result in dilution of the organic loading. As such, the microbial population might effectively "starve" and die out. Also, as the flow is diluted, the ammonia nitrogen concentrations may become insufficient to promote nitrification.

- The flow velocity in the gravity sewer might decrease to a degree where low, "non-scouring" velocities will cause the development of a permanent layer of decaying sludge in the sewer. This might lead to the deterioration of the sewer structures and odor problems in the vicinity of the NAWC facility.

- The flow recording devices might be forced to operate outside of their recommended ranges, thus affecting accuracy and precision of flow measurement.

9.00 RECOMMENDATIONS

Based on our analysis of the current facilities and operations at the NAWC WWTP, we have several recommendations to assist the NAWC in meeting the future permit requirements:

- General: In reviewing the operational data provided to us by the NAWC, we noticed several inconsistencies. For example, when we attempted to back calculate the concentrations from reported nitrate nitrogen, nitrite nitrogen and total nitrogen concentrations, we encountered negative values. This indicates that the NAWC may be incorrectly reporting total nitrogen concentrations. Since both the current and future discharge permits specify requirements for nitrogen components (i.e., nitrate nitrogen, nitrite nitrogen, total nitrogen, and TKN), NAWC should consider reviewing the calculations of all the permit parameters prior to submitting them to the PADER.

- Ammonia Removal: Operational data indicates that the WWTP is removing some ammonia nitrogen primarily via nitrification in the Trickling Filter. However, this limited removal will not be sufficient to satisfy current and future permit limitations. To investigate the ways to enhance the nitrification capabilities of the plant we recommend that the NAWC:

- Analyze the following characteristics of the influent wastewater: alkalinity, pH, BOD_5/TKN ratio, alkalinity/TKN ratio, seasonal temperature changes dynamics, toxic substances (particularly copper) concentration and dissolved oxygen concentration. Nitrification processes are highly sensitive to these parameters, and a detailed analysis would allow NAWC to identify deficient areas.

- Perform a full-scale nitrification pilot study utilizing one of the Trickling Filters at the WWTP. This study should be based on the information obtained during the wastewater analysis, as recommended above.

• Nitrate Removal: As mentioned previously, the WWTP is incapable of meeting future permit requirements for nitrite nitrogen and nitrate nitrogen because the current facilities do not appear to be designed to perform denitrification. As such, we recommend that the NAWC considers retrofitting the WWTP to include an anoxic denitrification operation. Anoxic denitrification is a proven process for reducing of nitrate nitrogen to a nitrogen gas. Typically, it is installed directly after the Trickling Filters, prior to either recirculation or secondary settling.

There are two primary processes for performing biological denitrification; suspended growth and fixed media. Both processes have a variety of advantages and disadvantages. For example, suspended growth denitrification processes typically do not require additional wastewater pumping facilities (the head loss through the unit is low); however, they are generally more operator-intensive and have larger space requirements. Fixed media processes generally require less space and are less operator-intensive; however, they require additional wastewater pumping facilities.

As such, we recommended that the NAWC consider performing Trickling Filter effluent analytical characterization of parameters important for denitrification, followed by an engineering analysis to identify the most efficient and cost-effective denitrification process.

• Phosphorus Removal: The WWTP does not appear to be capable of meeting the future permit requirements for phosphorus under either existing or future operations. As such, we recommend that the NAWC consider chemically treating either all or part[8] of the raw wastewater flow for phosphorus removal. We recommend that NAWC consider performing a laboratory-scale pilot study

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[8] If phosphorus is removed in front of biological treatment units, care should be taken to retain sufficient quantities of phosphorus in the wastewater to sustain proper functioning of the treatment plant biota.

to investigate different coagulation/flocculation options, followed by a field pilot study to confirm results obtained during this laboratory-scale study.

- Sludge Handling Facilities: As currently operated, the sludge handling facilities of the WWTP does not appear to be adequate. Operational data indicates that the efficiency of the only operational anaerobic digester is low, and that the recycling of the sludge and digester supernatant to the head of the WWTP may be exacerbating the nitrogen and phosphorus control problems. We recommend that the NAWC consider either: (1) contracting a licensed hauler to remove all of the combined sludge on a regular basis or (2) repairing the existing anaerobic digesters, reactivating the sludge drying beds, and contracting a licensed hauler to remove all dried sludge from drying beds on a regular basis.

- Additional Operating Requirements and Procedures: We have outlined several additional operating requirements and procedures which we believe would enhance the operating and compliance efficiency of the WWTP:

  - General: The NAWC should consider monitoring some of the characteristics (i.e. ammonia nitrogen, nitrite nitrogen, nitrate nitrogen, TKN, phosphates and oil and grease, dissolved oxygen concentration) of the influent and effluent, as well as at other appropriate intermediate points of the WWTP. In this manner, the NAWC could assess the operating efficiency of the WWTP and identify daily and seasonal trends in influent and effluent wastewater characteristics.

  - Ammonia Removal: The primary mechanism for ammonia nitrogen removal will be nitrification via the Trickling Filter. However, to establish an efficient nitrification process, several wastewater parameters must be both monitored and controlled, creating, at a minimum, the following additional analytical and operating requirements:

    - Analytical: As discussed in Section 7.00, the efficiency of nitrification is dependent on several parameters, specifically NH_3-N concentration, BOD_5/NH_3-N/P ratio, pH, alkalinity, dissolve oxygen concentration, temperature, and presence and concentration of toxic substances, especially copper. As such, the NAWC should monitor these parameters in both the Trickling Filter influent and effluent.

    - Operating: The NAWC will need to operate and maintain the following systems to enhance nitrification operations: a chemical system for pH control, a chemical system for alkalinity control,

and possibly a compressor/blower for dissolved oxygen enhancement.

- Nitrate Removal: nitrate nitrogen removal can be accomplished by an anoxic denitrification unit. Minimum analytical and operating requirements associated with this operation are:

  - Analytical: The efficiency of anoxic denitrification is dependent on oxidation - reduction potential, proper organic substrate, NO-N_3, pH, and absence of free or elemental oxygen. As such, the NAWC will need to monitor these parameters in the influent and effluent of the denitrification unit.

  - Operating: The operating requirements of the denitrification unit will depend on the type of process that is used (i.e., attached or suspended growth). The denitrification unit would be installed between the Trickling Filter and Secondary Settling Tanks and will require control of the following parameters: pH, proper organic substrate, nitrate nitrogen, and dissolved oxygen. However, if some of these parameters are outside of the desired range, they may need to be enhanced via a dedicated chemical feed system. Denitrification of the wastewater will require construction and operation of some or all of the following units:

    - denitrification pumping station;
    - denitrification reactor;
    - carbon source (probably methanol) supply system;
    - solid separation unit (clarifier or); and
    - reaeration facility.

- Phosphorus Removal: Phosphorus removal can be accomplished by chemical phosphates removal system. Minimum analytical and operating requirements associated with this operation are:

  - Analytical: The primary wastewater characteristics affecting chemical phosphates removal include pH, alkalinity, and phosphates. As such, the NAWC will need to monitor the influent and effluent of the phosphates removal facility for these parameters. Also, the NAWC should consider performing routine jar coagulation tests to update coagulant dosage requirements.

  - Operating: The operating requirements for chemical phosphates removal system will depend on location of the system. The three

operations which should be considered are: (1) in front of Primary Settling Tanks, (2) after denitrification reactor and prior to Secondary Settling Tanks, or (3) after Secondary Settling Tanks and prior to chlorination facilities. The new operations will include all or part of the following:

- coagulant (metal salt) storage/preparation/dosing facility;
- pH control, including chemicals and equipment;
- wastewater/coagulant/pH control mixing facility;
- flocculation facility;
- chemical sludge separation facility. Primary Settling Tanks or Secondary Settling Tanks might be used for this purpose. This approach, however, will lead to combining of the organic and chemical sludge. If separate handling of the chemical sludge is desirable, a dedicated chemical sludge separation and handling system will be needed.

- Sludge Handling Facilities:

To enhance the efficiency of the sludge handling facilities, the NAWC should consider, at a minimum, the following additional requirements:

- Analytical: The volume, percent total solids and percent volatile solids of the sludge pumped should be measured on a regular basis. In addition, the following digesting parameters should be monitored on a regular basis:

  - digester temperature;
  - digester gas generation rate;
  - digested sludge pH.

  Alkalinity and concentration of volatile organic acids in the digester supernatant should be measured periodically. This information should be used to assess digester efficiency and adjust operating procedures.

- Operating: If denitrification and phosphates removal processes are incorporated into the WWTP, the volume of sludge produced by the plant will increase by approximately 30 to 70 percent. As such, additional sludge pumping capacity might be needed. Also, the existing sludge drying beds might be reactivated, operated and maintained, if digested sludge will not be hauled away without drying. Alternately, a mechanical dewatering facility might be considered.

- Flow rates: A clarification of the inconsistencies between the allowed average monthly flow of effluent discharge of 0.750 MGD (NPDES Permit No. 0022420, page 2 of 14, part A, paragraph 1.B) and flows associated with the average monthly mass units discharge limitations. (See Appendix C - Design Calculations, page 1) of 0.15 MGD, should be requested from the PADER.

TABLES

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TABLE 1

COMPARISON OF SPECIFIC EFFLUENT LIMITATIONS
FOR CURRENT AND FUTURE PERMITS

NADC/WWTP
Warminster, Pennsylvania

Parameter	Current Permit Effluent Limitation (average monthly)	Future Permit Effluent Limitation (average monthly)	Change
Flow	0.75 MGD	0.75 MGD	No
Maximum Temperature in the Receiving Water Body	varies monthly	varies monthly	No
$CBOD_5$	14.4 mg/l (summer) 25 mg/l (winter)	14.4 mg/l (summer) 25 mg/l (winter)	No
TSS	30 mg/l	30 mg/l	No
D.O. (dissolved oxygen)	At least 5 mg/l	At least 5 mg/l	No
TN	8 mg/l (summer) 24 mg/l (winter)	no requirement	Yes
NH_3-N	3 mg/l (summer) 9 mg/l (winter)	2.1 mg/l (summer) 6.3 mg/l (winter)	Yes
NO_3-N+NO_2-N	no requirement	8.9 mg/l (summer)	Yes
Total Phosphorus (P)	no requirement	2 mg/l (summer)	Yes
Fecal Coliform	200/100 ml geometric average	200/100 ml geometric average	No
pH	6 to 9 at all times	6 to 9 at all times	No
Oil and Grease	15 mg/l	15 mg/l	No
Surfactants (MBAS)	0.5 mg/l	0.5 mg/l	No

Notes:

1. Other effluent limitations and monitoring requirements are included in the revised permit. A copy of this permit is contained in Appendix B.

File No. 12821
04/27/92:dmh

TABLE 2

DESIGN CAPACITY OF THE WWTP UNIT OPERATIONS
AT AVERAGE DAILY FLOW RATE[1,2,3] NADC/WWTP
Warminster, Pennsylvania

Unit Operation	Design Capacity (MGD)	Percentage of Capacity Used Under Current Operational Mode
Primary Settling Tanks	0.48	19
One Trickling Filter	0.17	53
Two Trickling Filters in Series[4]	0.17	53
Two Trickling Filters in Parallel	0.33	27
Three Trickling Filters in Parallel	0.50	18
Secondary Settling Tanks	0.84	11
One Anaerobic Digestor	0.12	75
Three Anaerobic Digestors	0.35	26
Total WWTP Capacity[5]	0.48	35

Notes:

1. See Appendix C for design calculations and assumptions.
2. Average BOD_5 and TSS loadings are assumed.
3. Average flow rate is 0.09 MGD.
4. Second TF is considered for nitrification only. The original design did not anticipate series of the TF.
5. Assumes the total WWTP capacity is to capacity of the WWTP if all unit operations are placed on line.

FIGURES

AVERAGE PERCENTAGE BOD5 REMOVAL BY UNIT OPERATION

NADC – Warminster, Pa 1989 – 1991

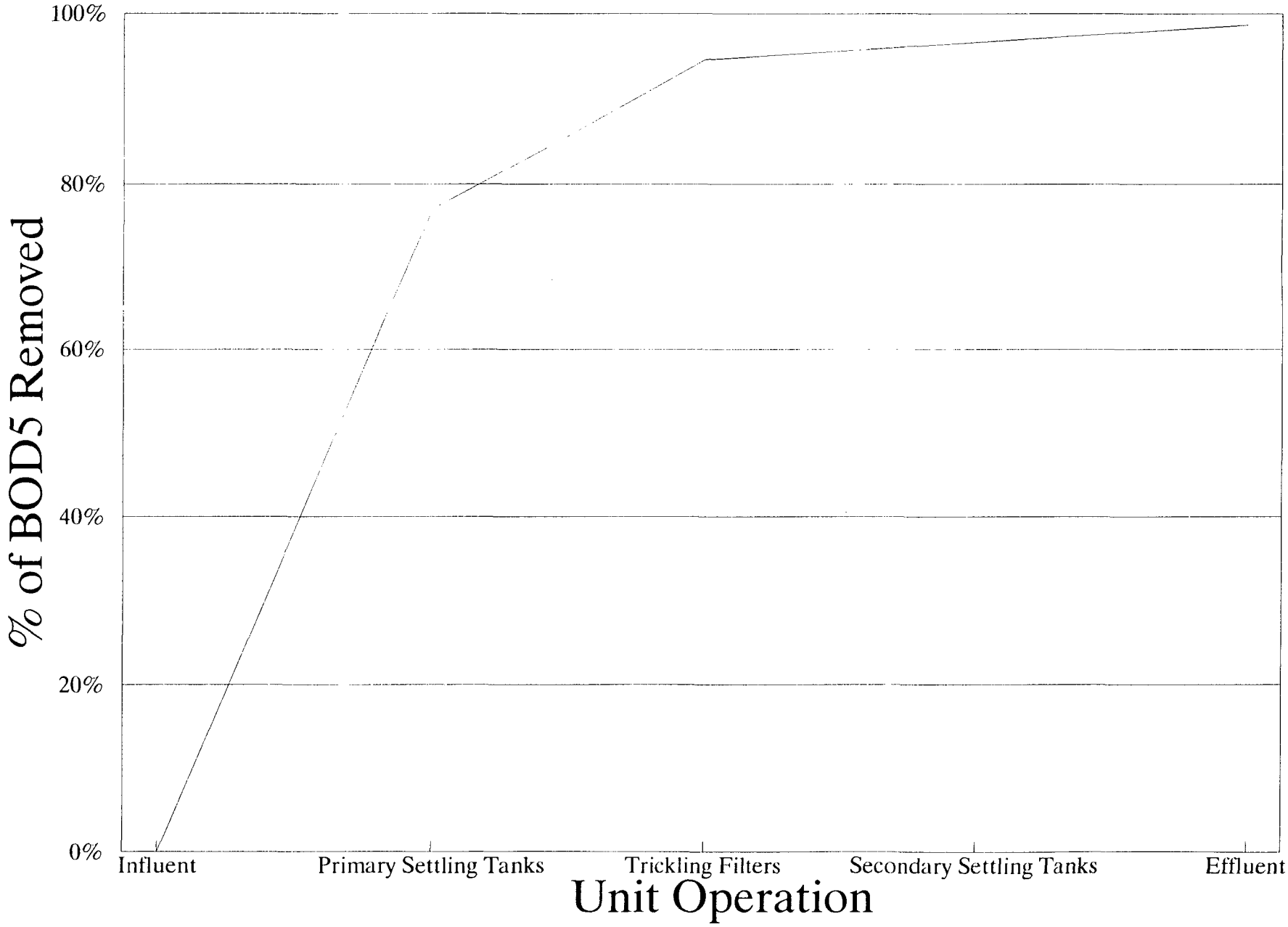


FIGURE 1

AVERAGE BOD5 REMOVAL EFFICIENCY BY UNIT OPERATION

NADC – Warminster, PA 1991

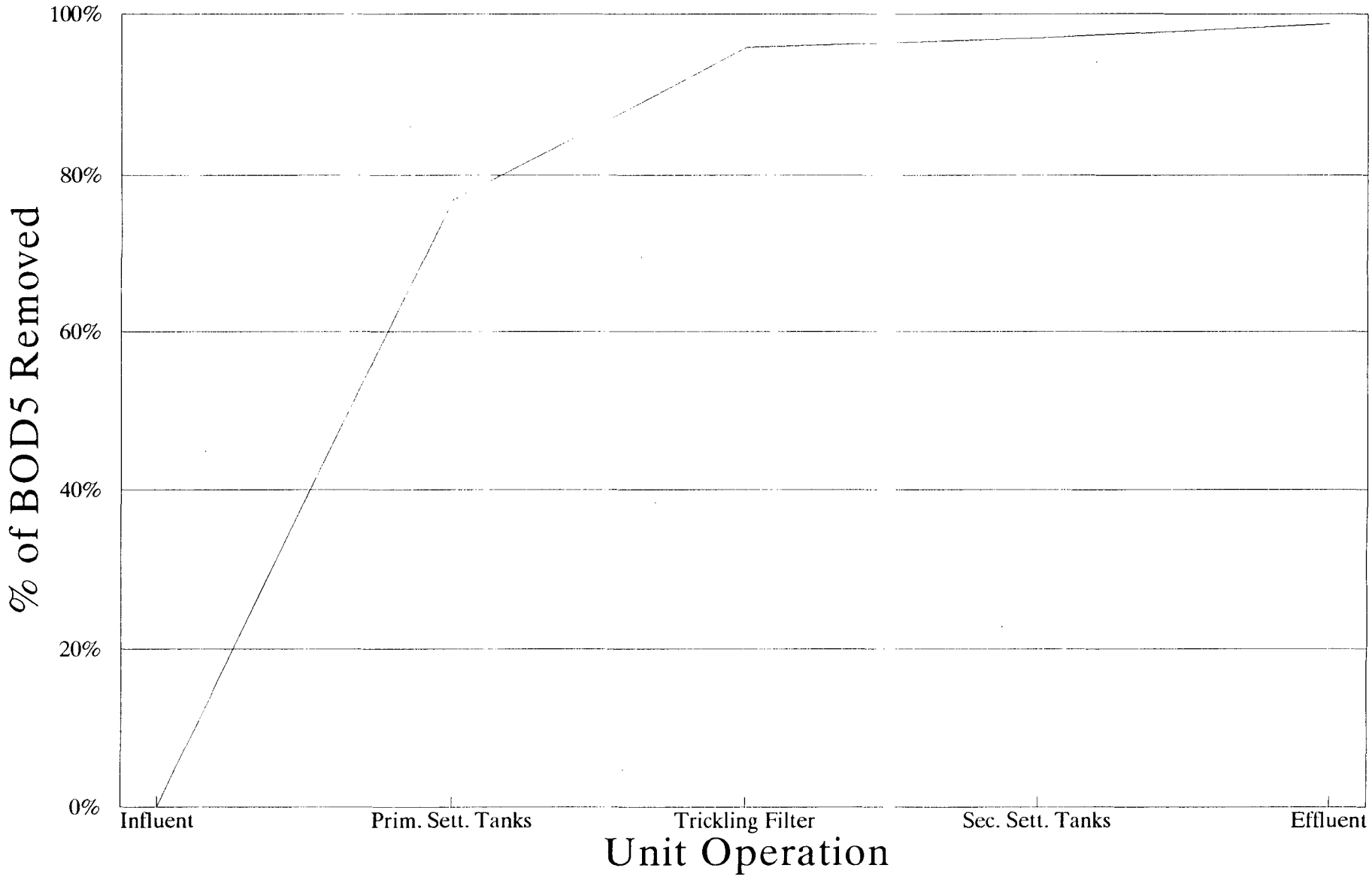


FIGURE 2

AVG. MONTHLY BOD5 REMOVAL EFF. – PRIM. SETT. TANKS

NADC – Warminster, PA 1989–1991

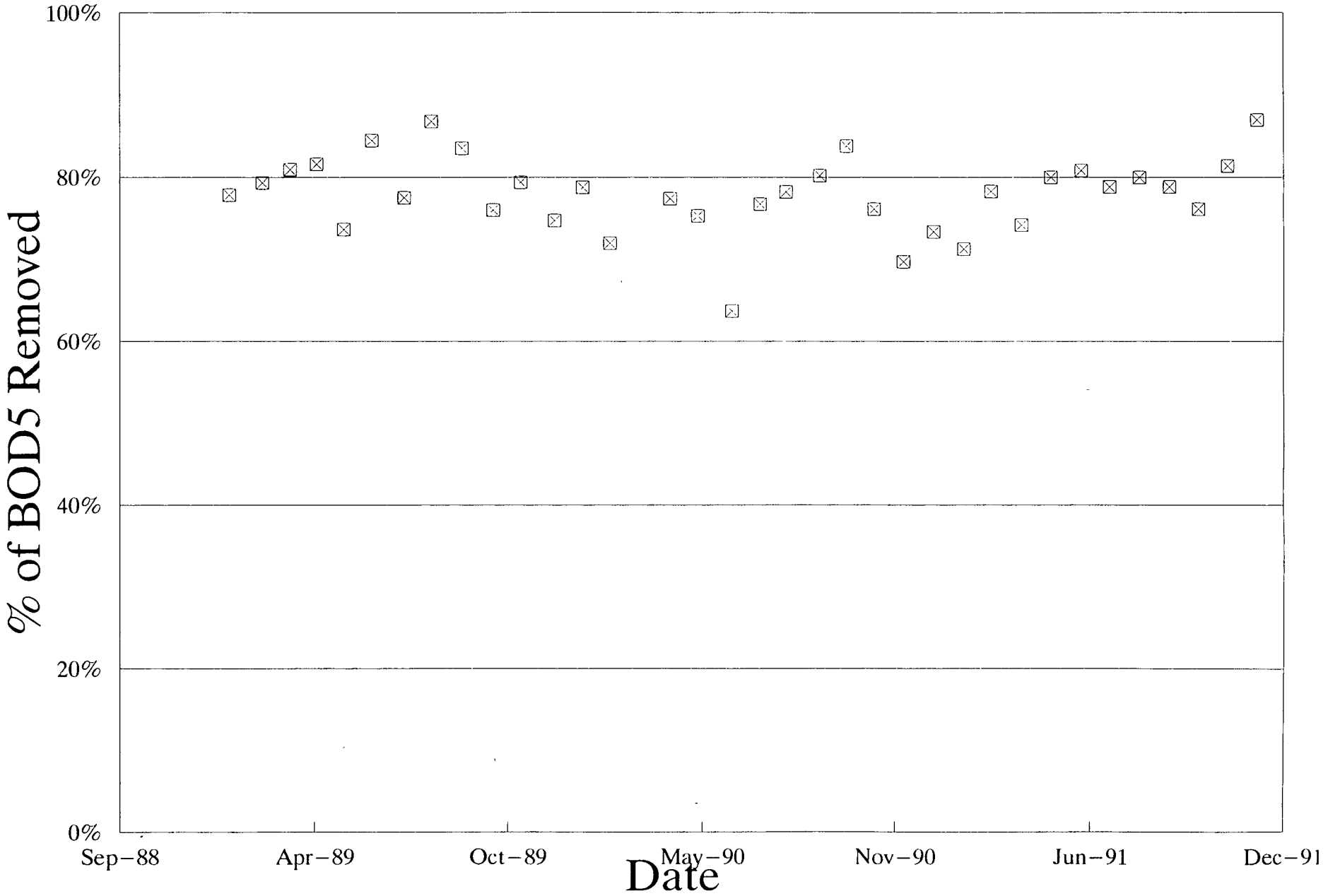


FIGURE 3

AVG. DAILY BOD5 REMOVAL EFF. – PRIM. SETT. TANKS

NADC – Warminster, PA 1991

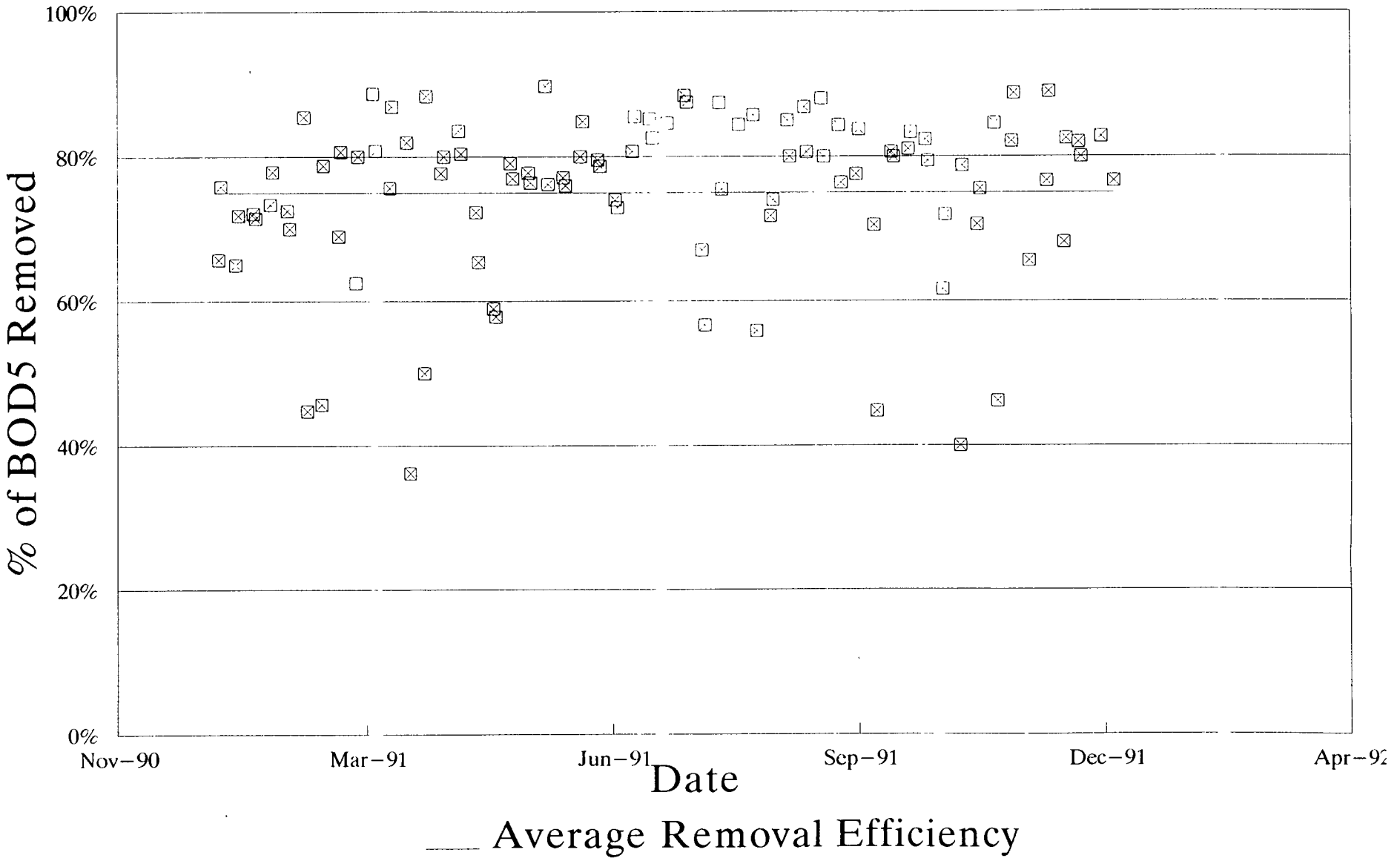


FIGURE 4

AVG. MONTHLY BOD5 REMOVAL EFF. – TRICKLING FILTERS

NADC – Warminster, PA 1989–1991

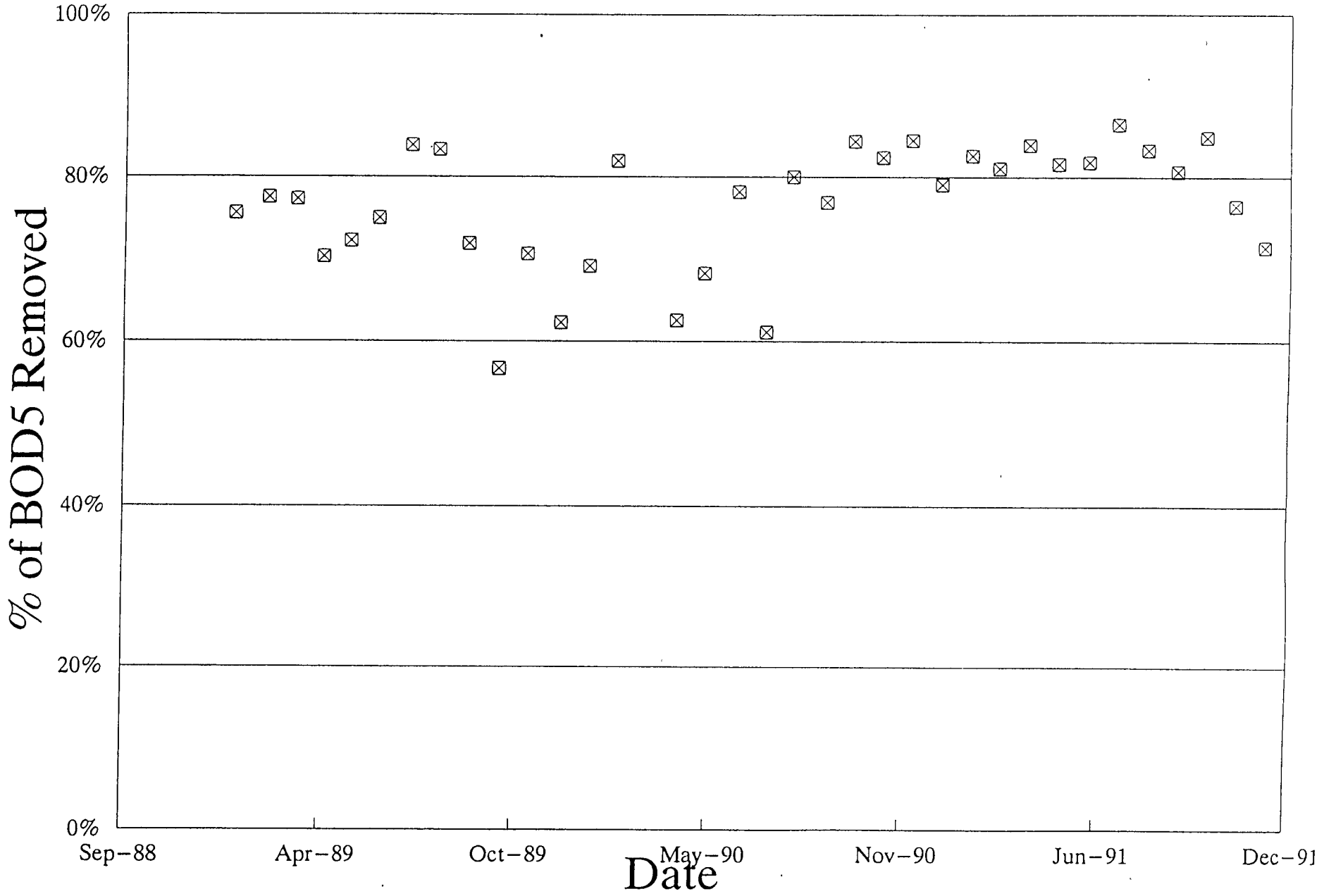


FIGURE 5

AVG. DAILY BOD5 REMOVAL EFF. – TRICKLING FILTER

NADC – Warminster, PA 1991

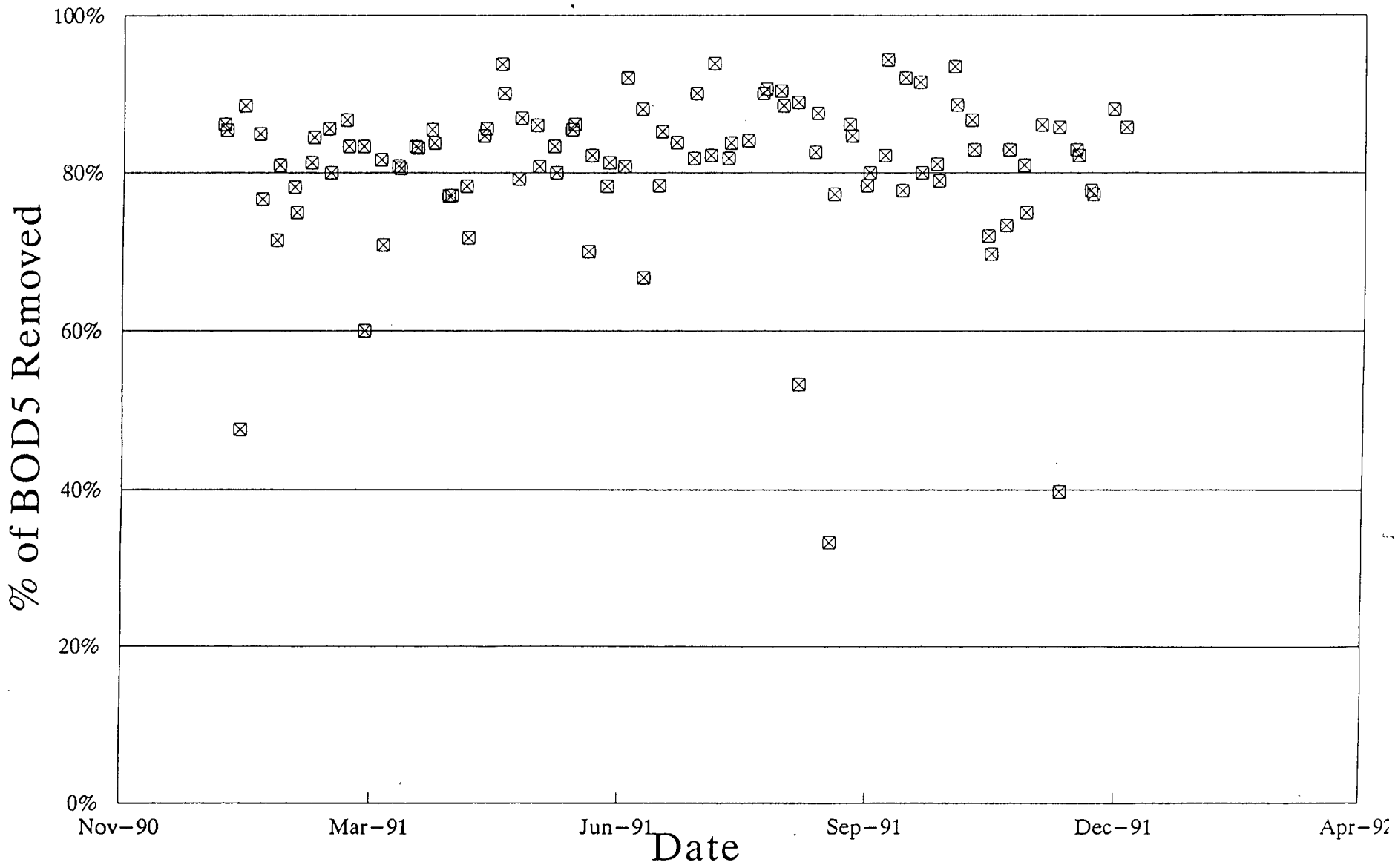


FIGURE 6

AVG. MONTHLY BOD5 REMOVAL EFF. – SEC. SETT. TANKS

NADC – Warminster, PA 1989–1991

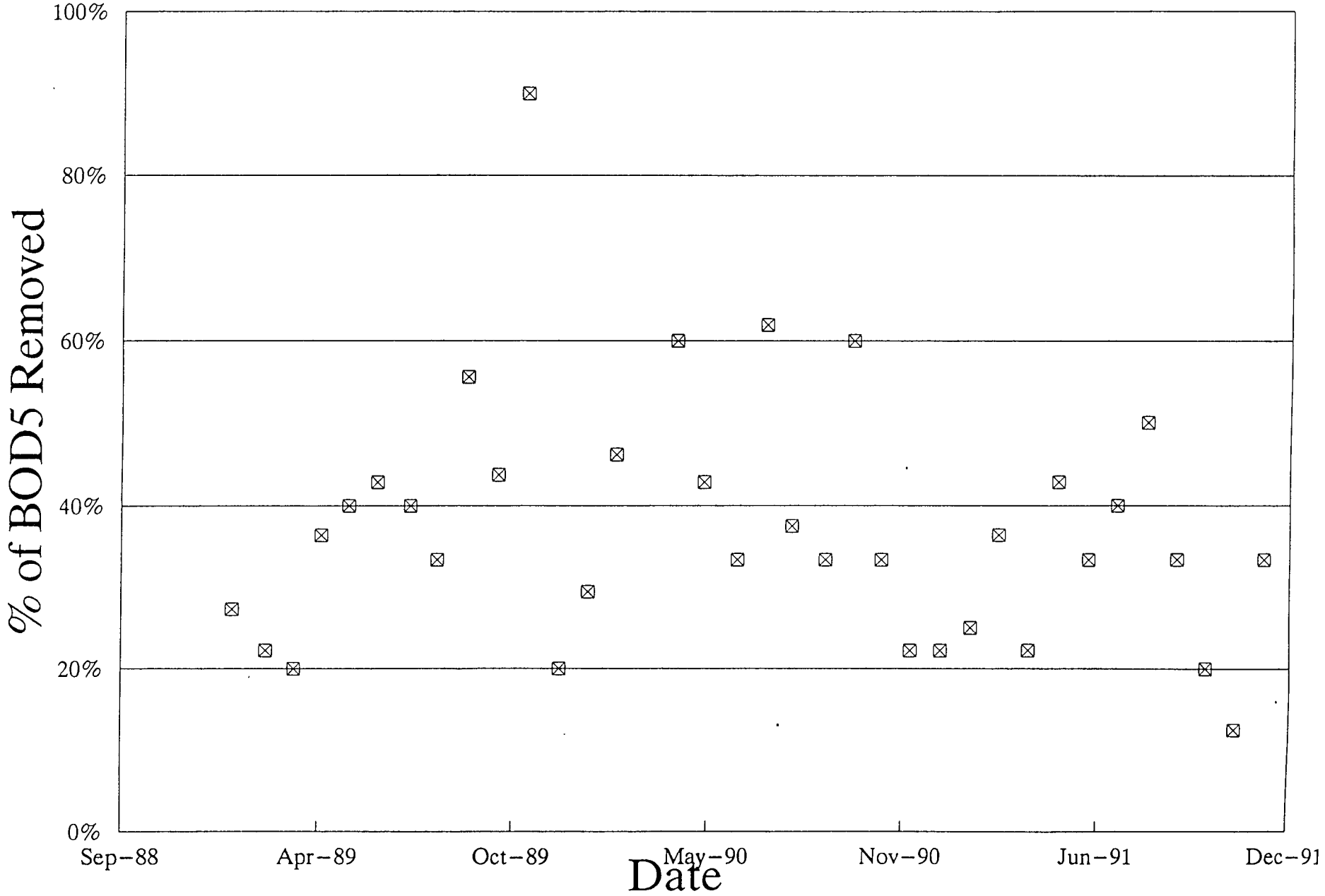


FIGURE 7

AVG. DAILY BOD5 REMOVAL EFF. – SEC. SETT. TANKS

NADC – Warminster, PA 1991

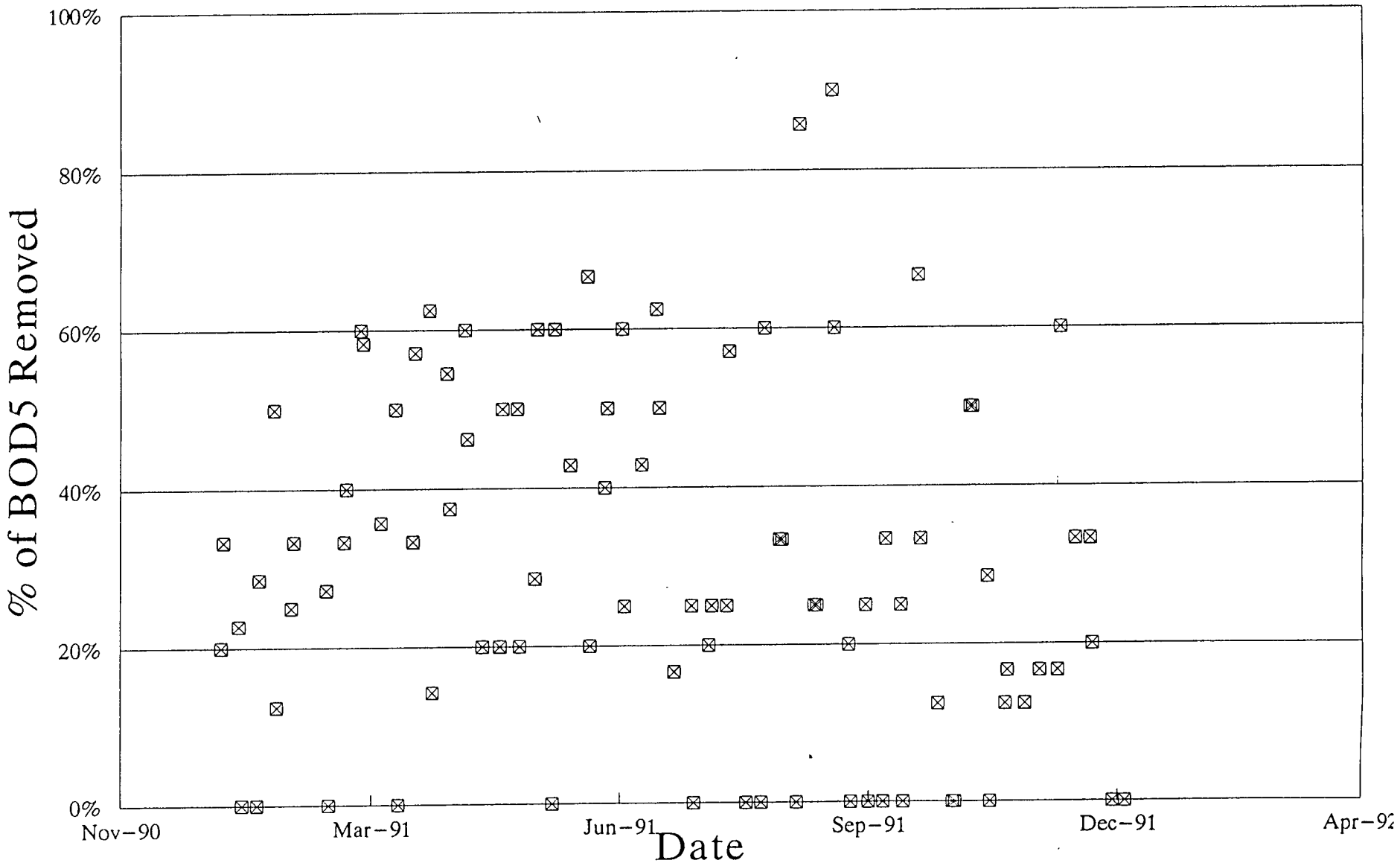


FIGURE 8

AVERAGE PERCENTAGE TSS REMOVAL BY UNIT OPERATION

NADC – Warminster, Pa 1989–1991

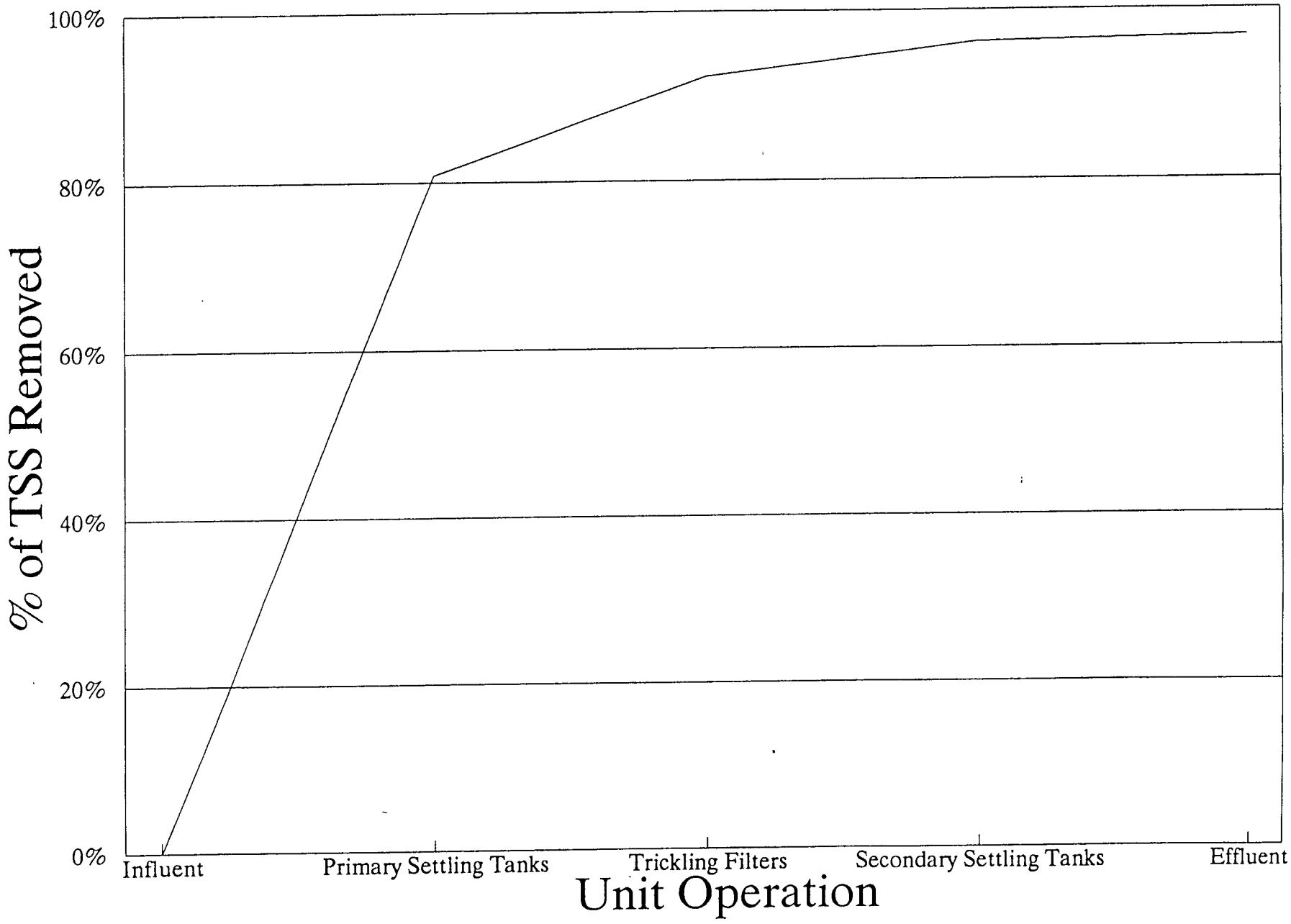


FIGURE 9

AVERAGE TSS REMOVAL EFFICIENCY BY UNIT OPERATION

NADC – Warminster, PA 1991

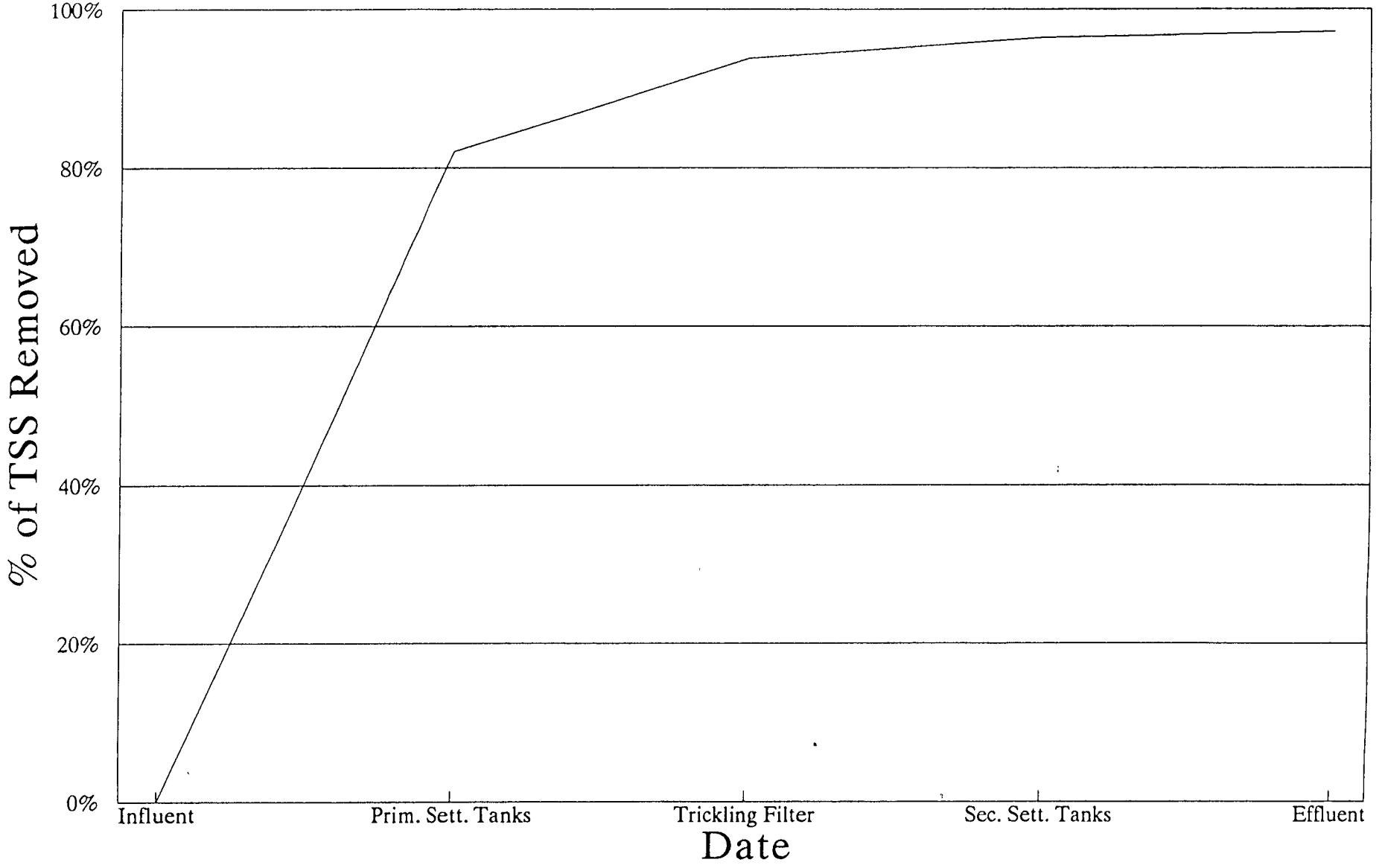


FIGURE 10

AVG. MONTHLY TSS REMOVAL EFF. – PRIM. SETT. TANKS

NADC – Warminster, PA 1989–1991

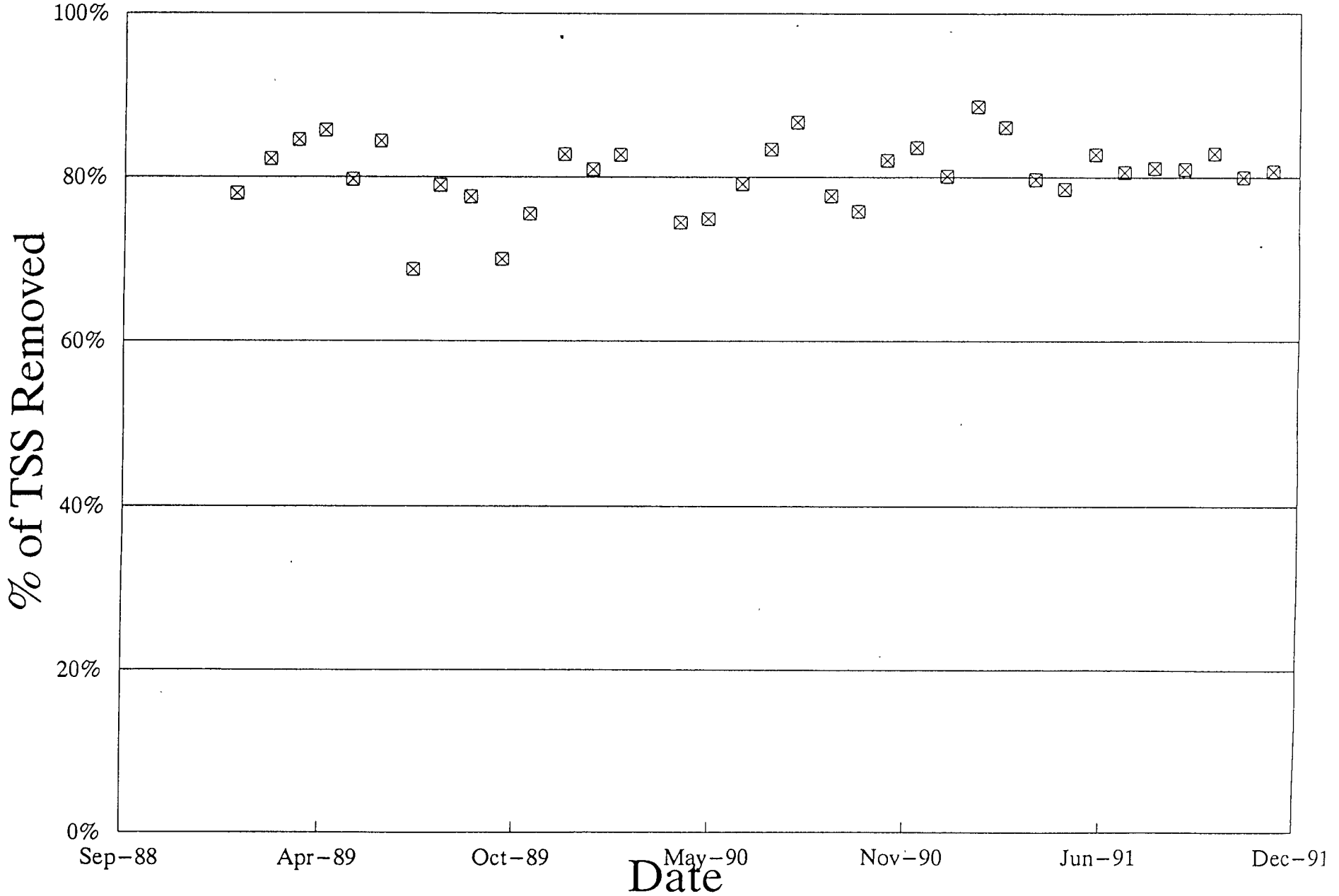


FIGURE 11

AVG. DAILY TSS REMOVAL EFF. – PRIM. SETT. TANKS

NADC – Warminster, PA 1991

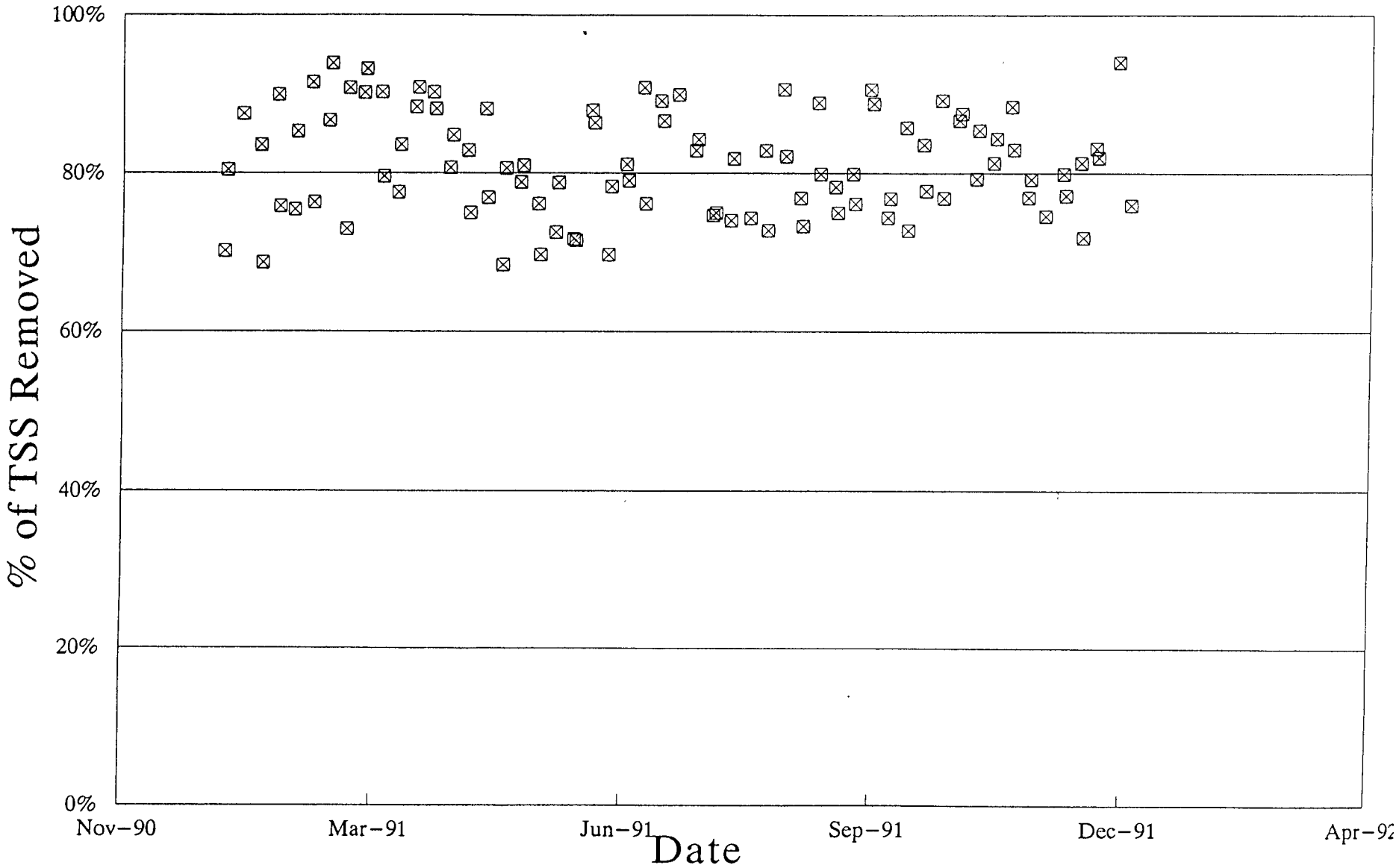


FIGURE 12

AVG. MONTHLY TSS REMOVAL EFF. – SEC. SETT. TANKS

NADC – Warminster, PA 1989–1991

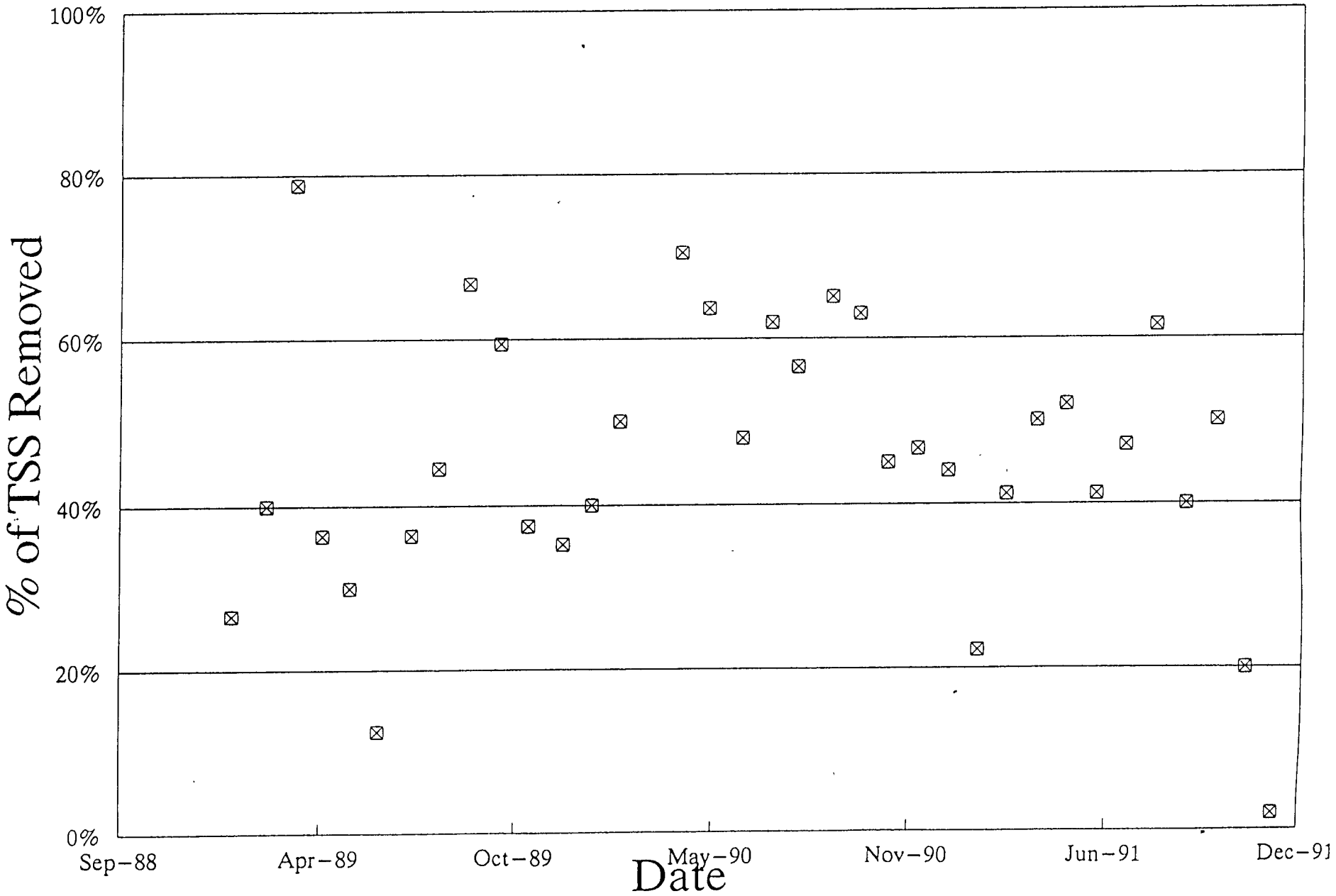


FIGURE 13

AVG. DAILY TSS REMOVAL EFF. – SEC. SETT. TANKS

NADC – Warminster, PA 1991

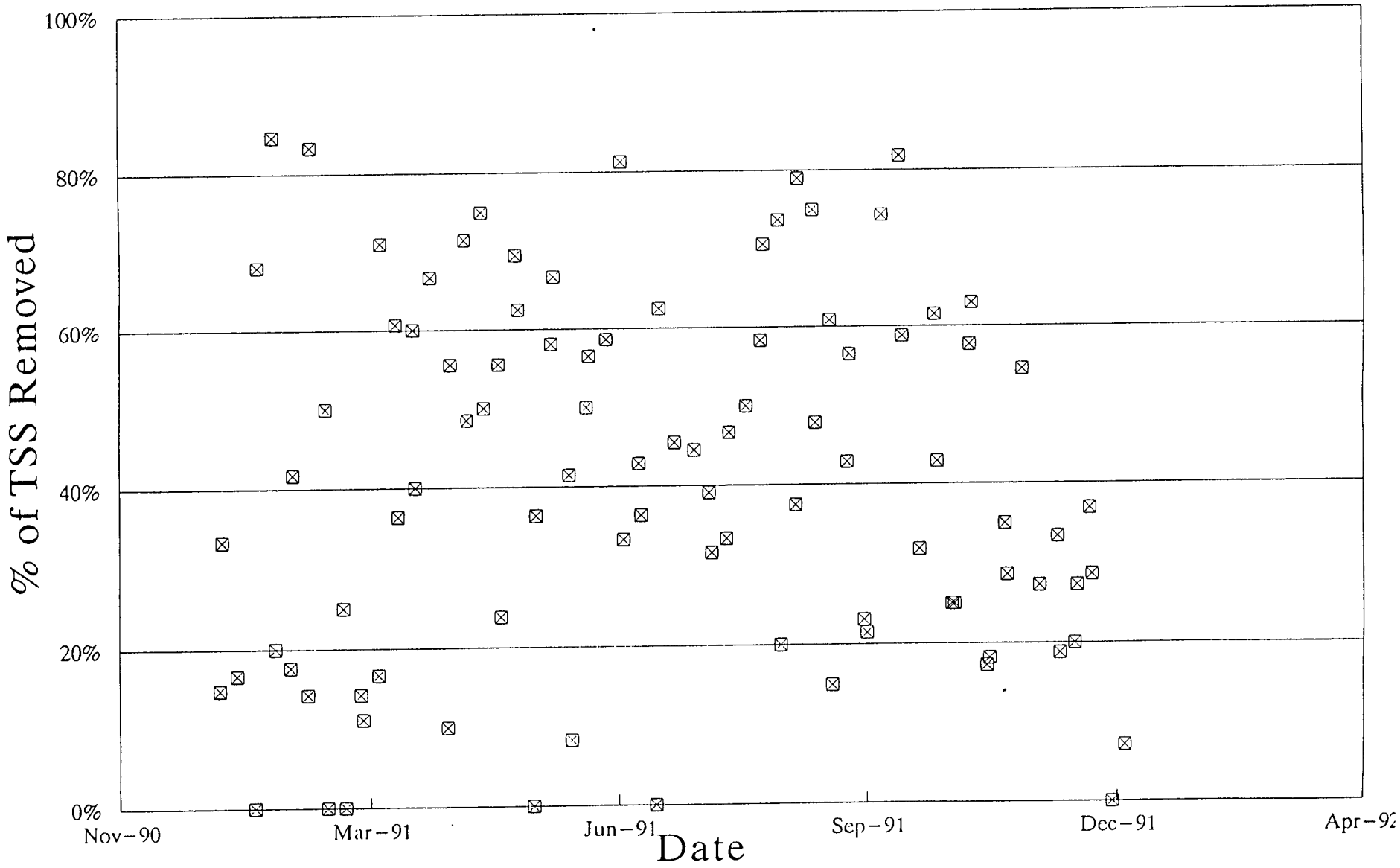
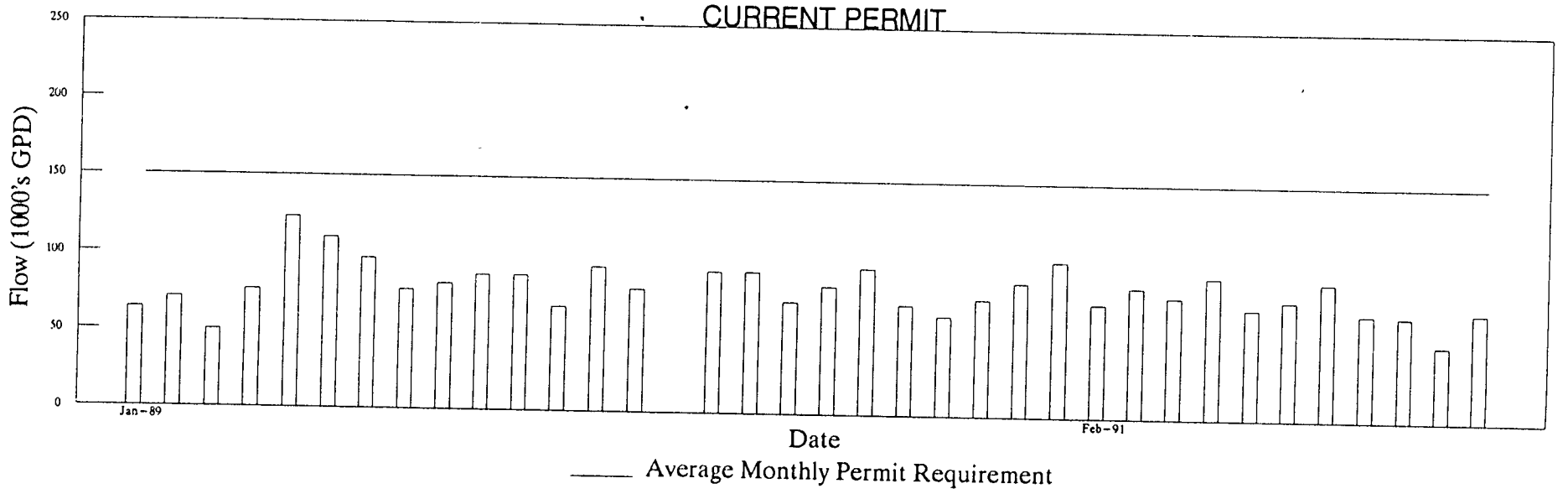


FIGURE 14

AVERAGE MONTHLY FLOW COMPLIANCE

NADC – Warminster, PA 1989–1991



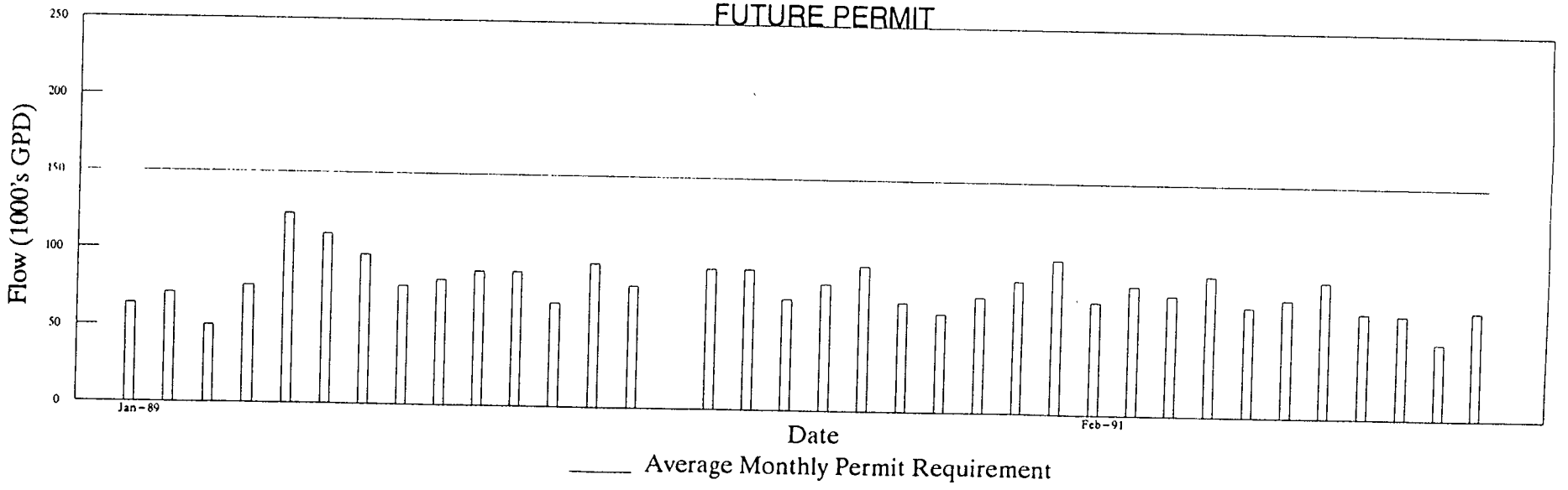
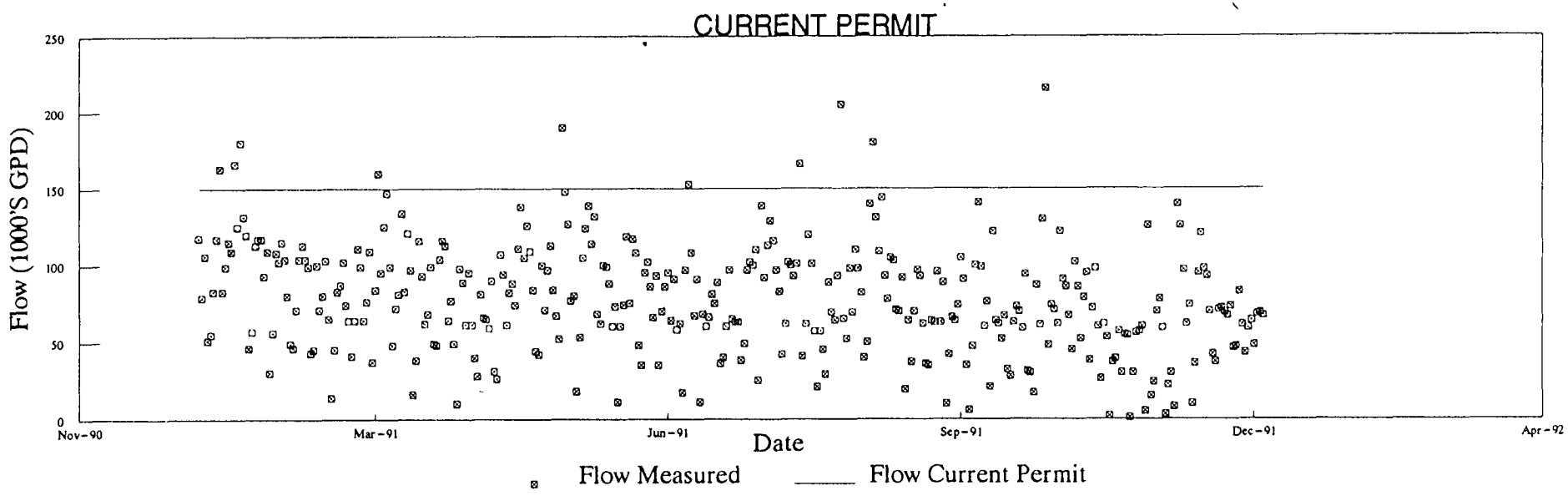


FIGURE 15

AVERAGE DAILY FLOW COMPLIANCE

NADC – Warminster, PA 1991



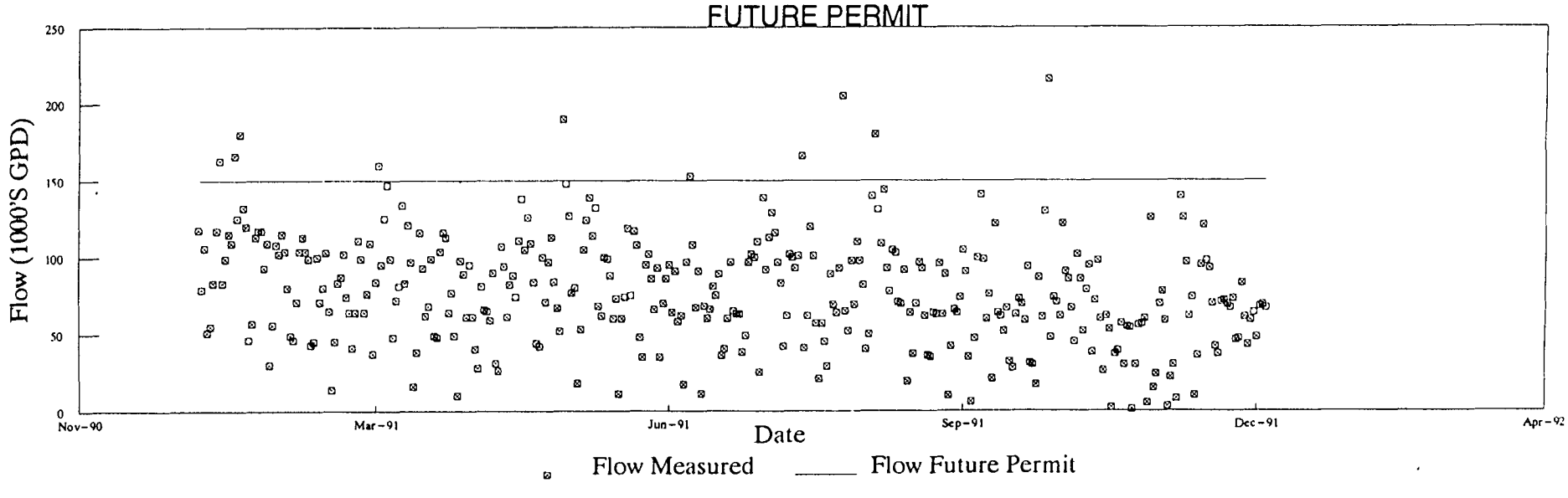
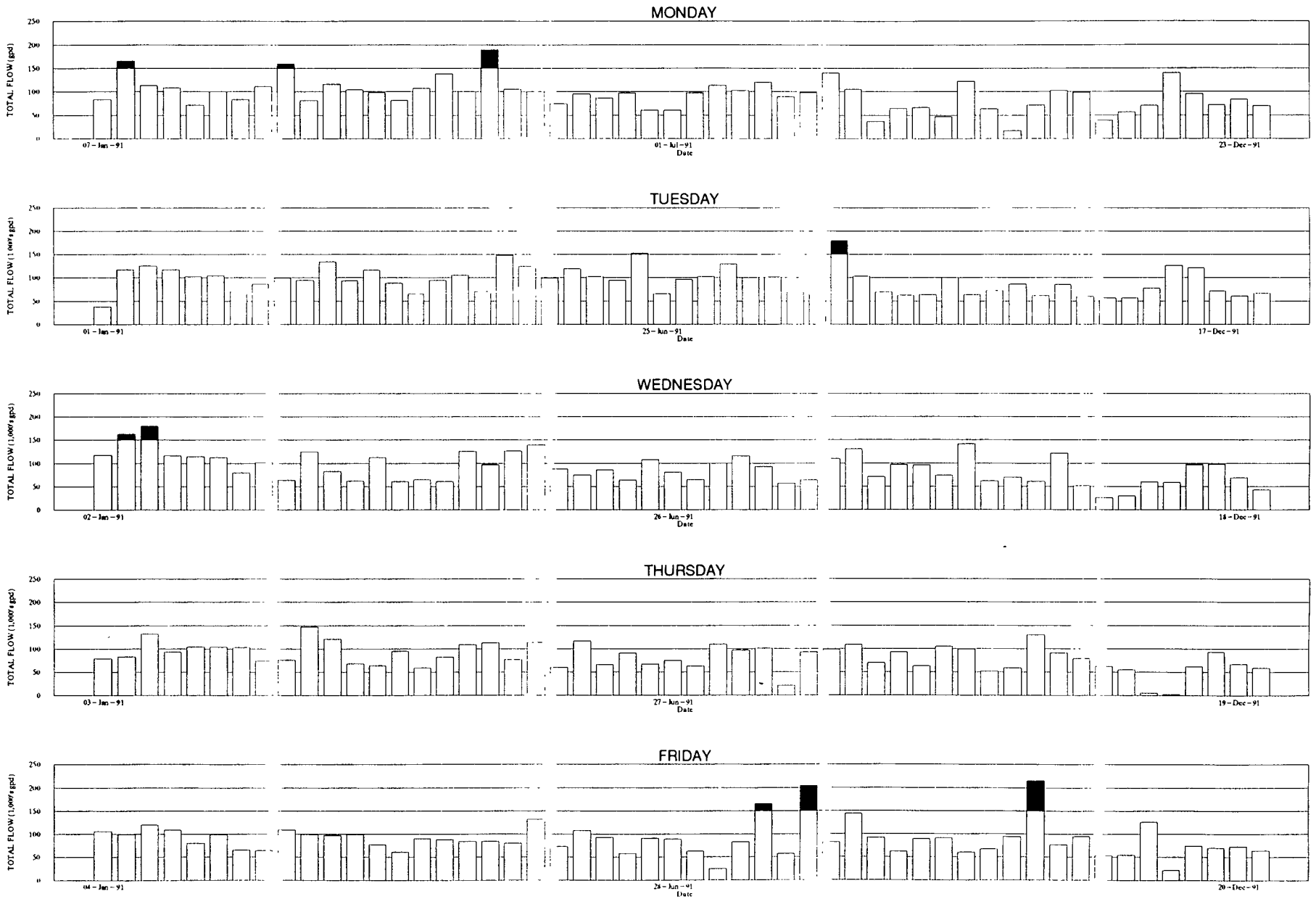


FIGURE 16

AVERAGE DAILY FLOW – DAYS OF THE WEEK

NADC – Warminster, PA 1991

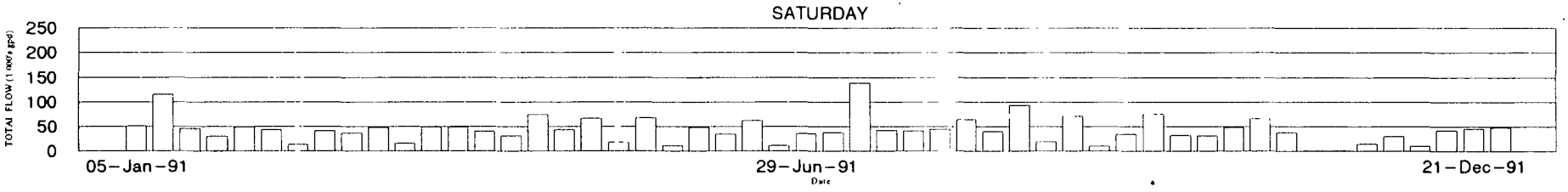


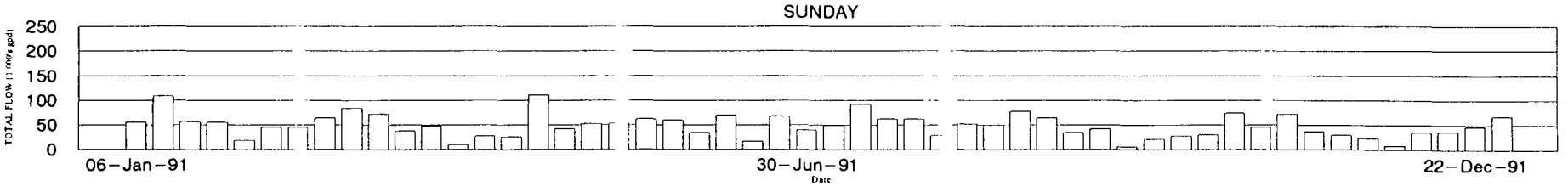
Note that the darkened bands indicate days where the average daily flow rate was greater than 0.15 MGD. They do not represent NPDES permit violations.

FIGURE 17

AVERAGE DAILY FLOW – DAYS OF THE WEEK (CONT.)

NADC – Warminster, PA 1991





Note that the darkened bands indicate days where the average daily flow rate was greater than 0.15 MGD. They do not represent NPDES permit violations.

FIGURE 18

AVERAGE FLOW – DAYS OF WEEK

NADC – Warminster, PA 1991

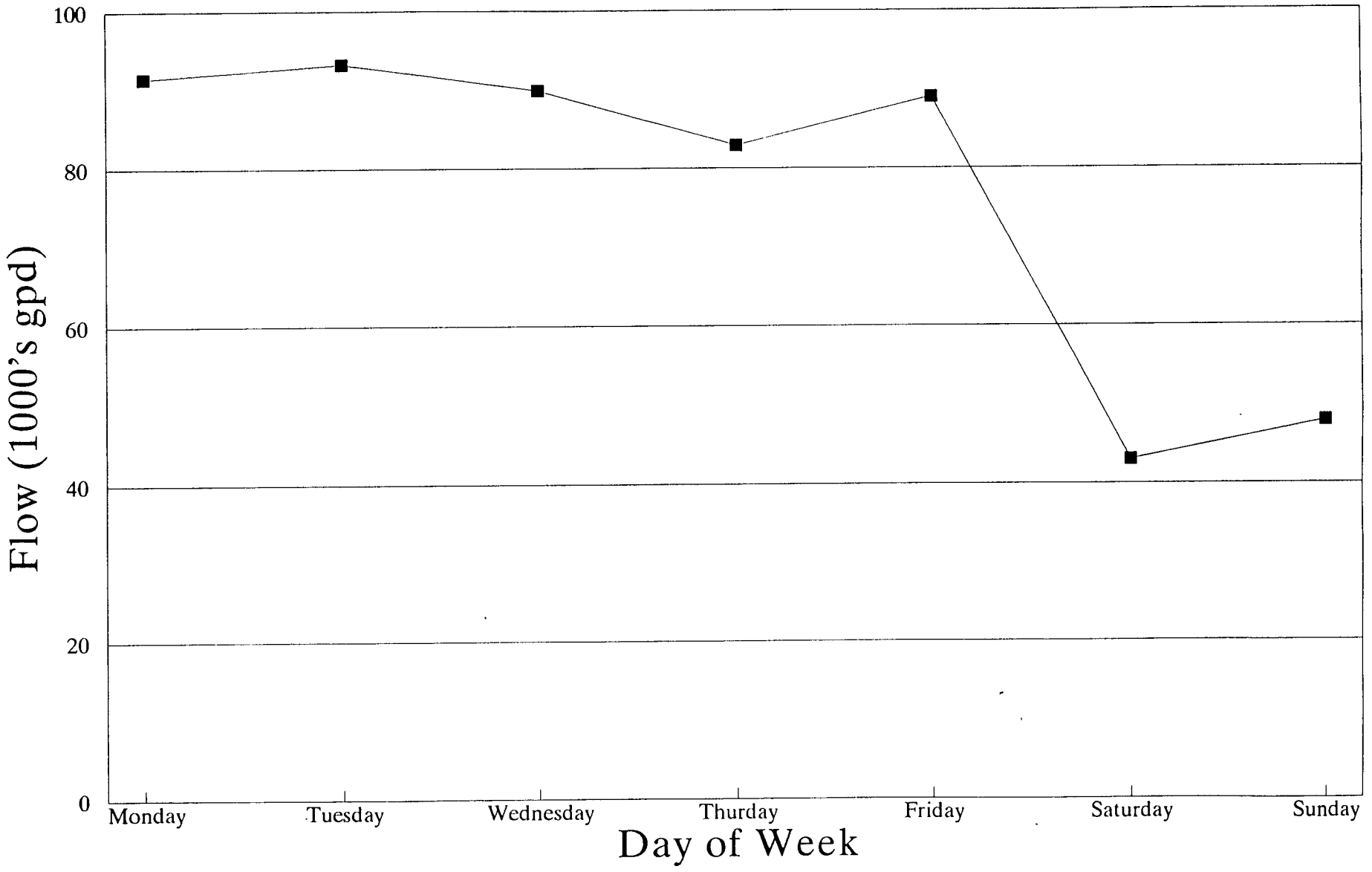
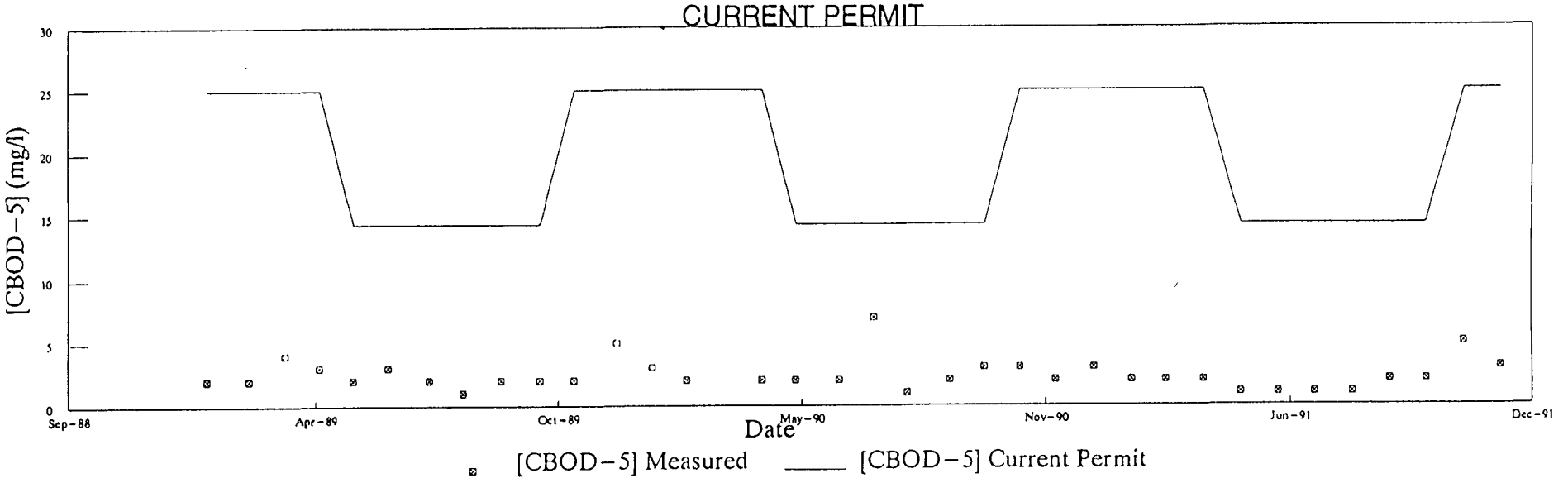


FIGURE 19

AVERAGE MONTHLY CBOD-5 COMPLIANCE

NADC – Warminster, PA 1989–1991



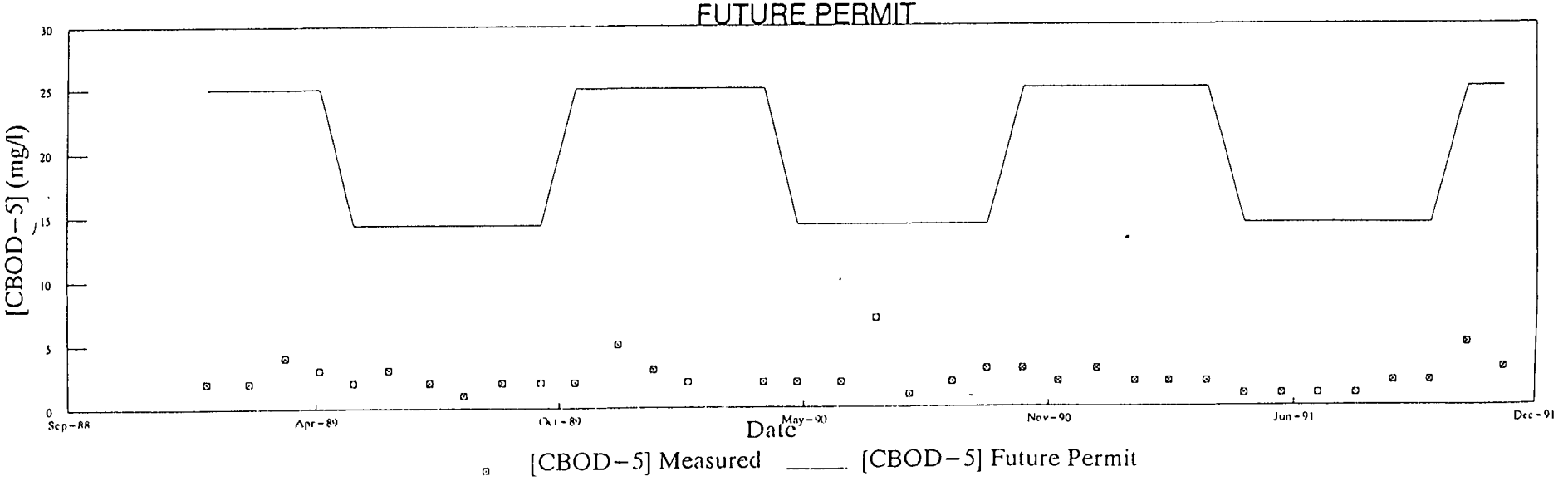
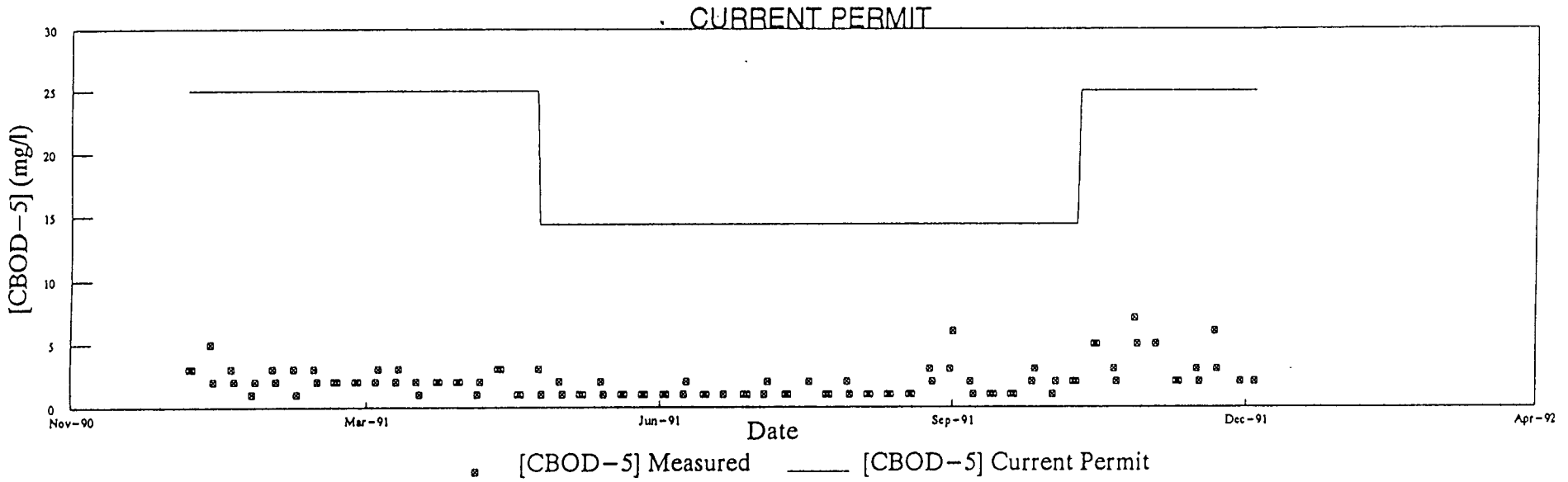


FIGURE 20

AVERAGE DAILY CBOD–5 COMPLIANCE

NADC – Warminster, PA 1991



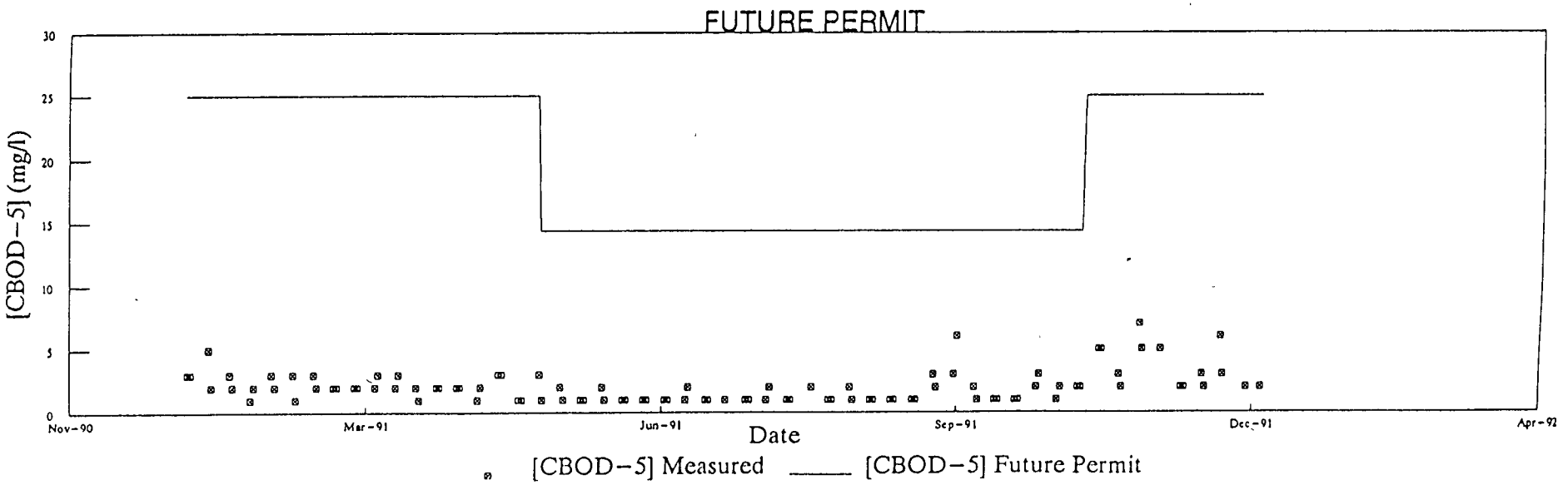
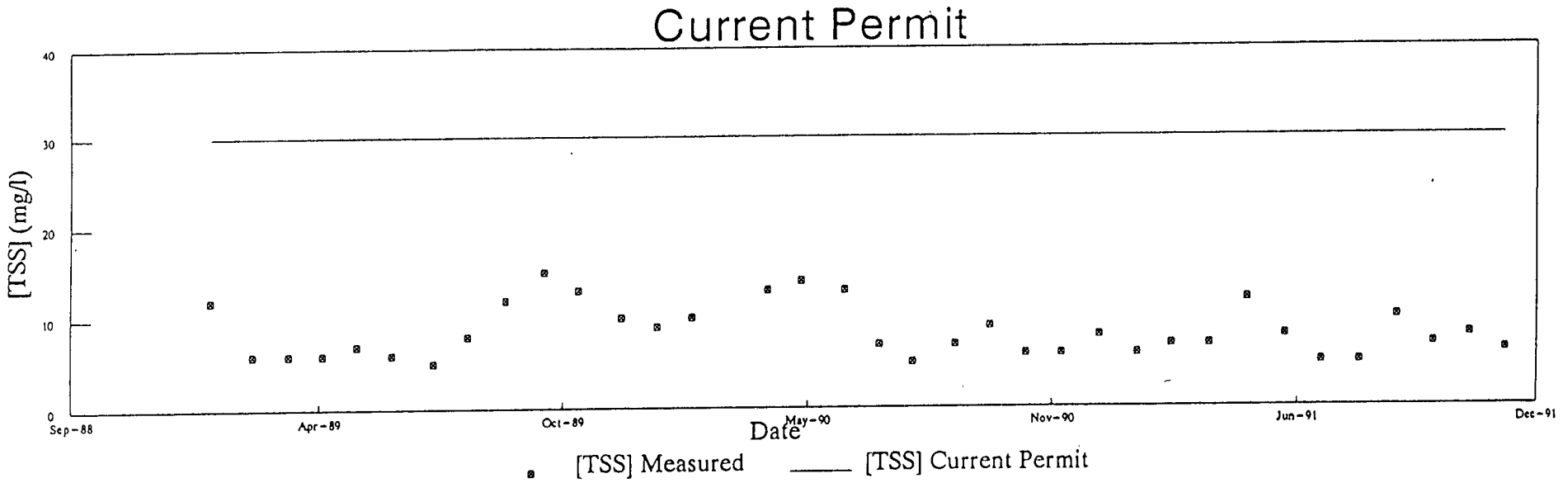


FIGURE 21

AVERAGE MONTHLY TSS COMPLIANCE

NADC – Warminster, PA 1989–1991



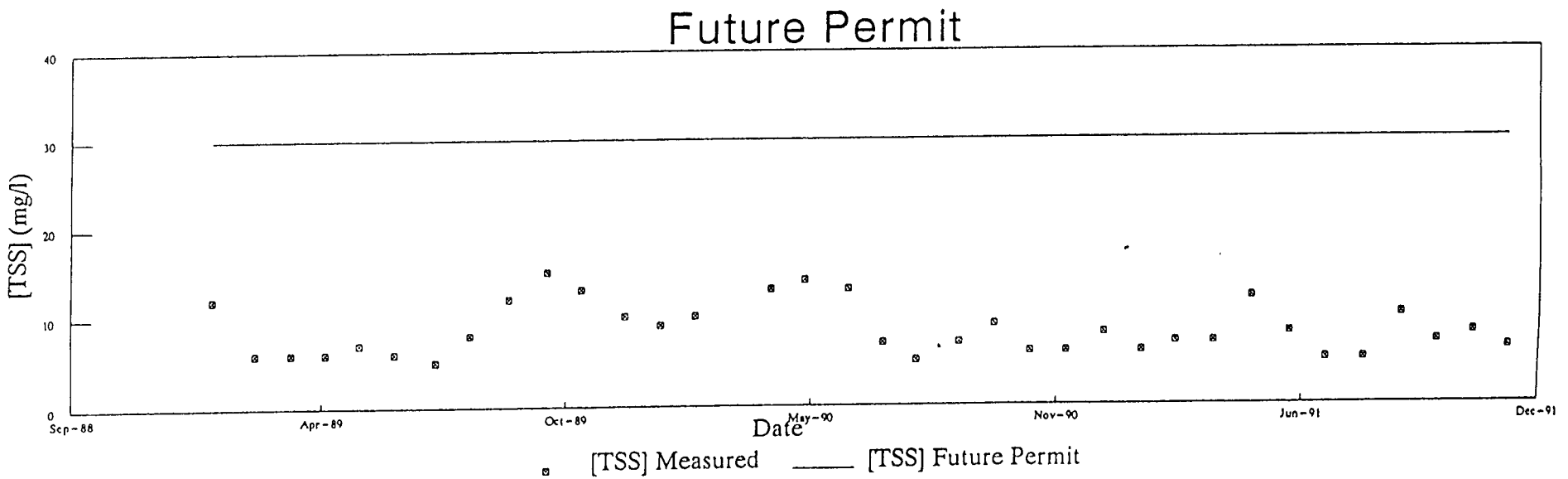
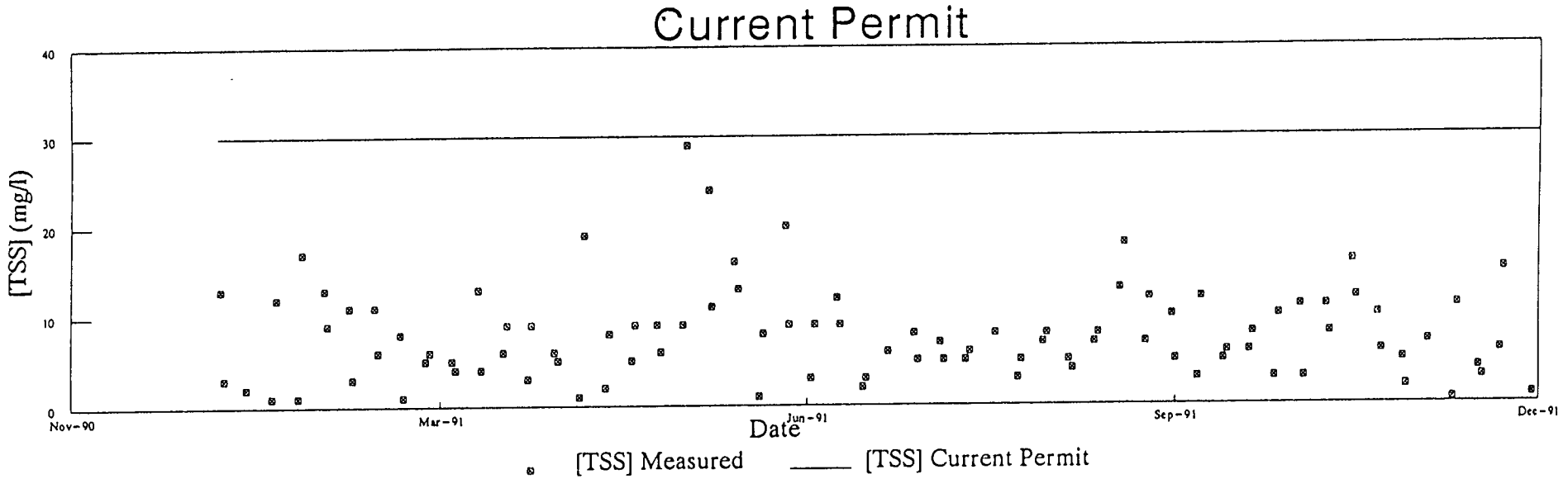


FIGURE 22

AVERAGE DAILY TSS COMPLIANCE

NADC – Warminster, PA 1991



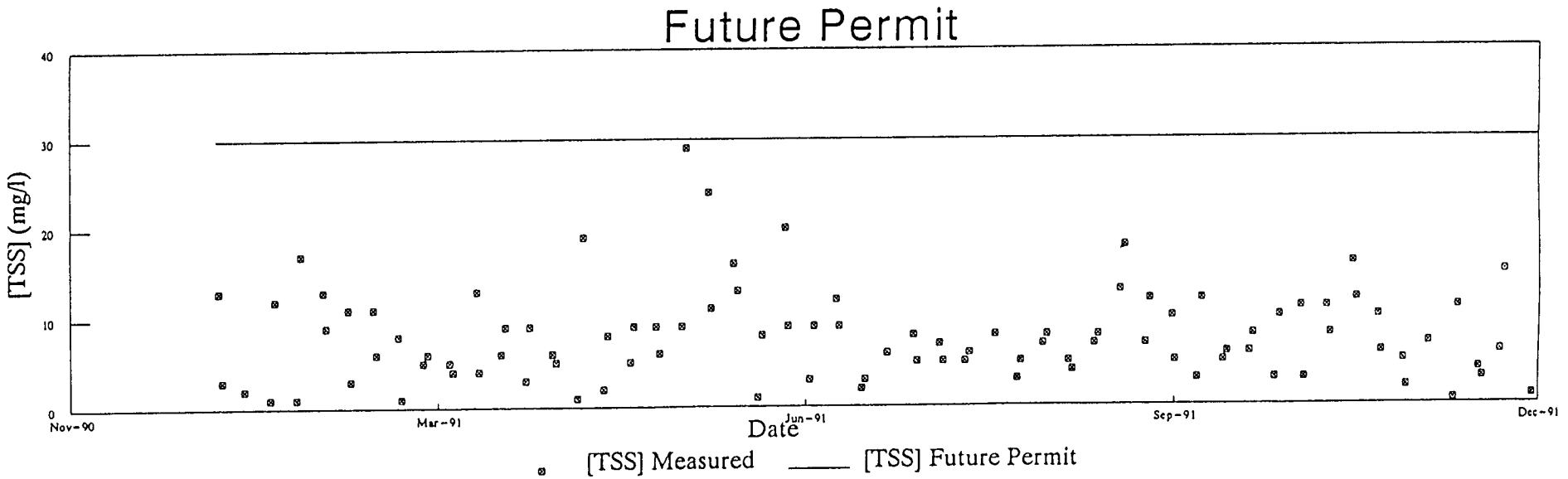
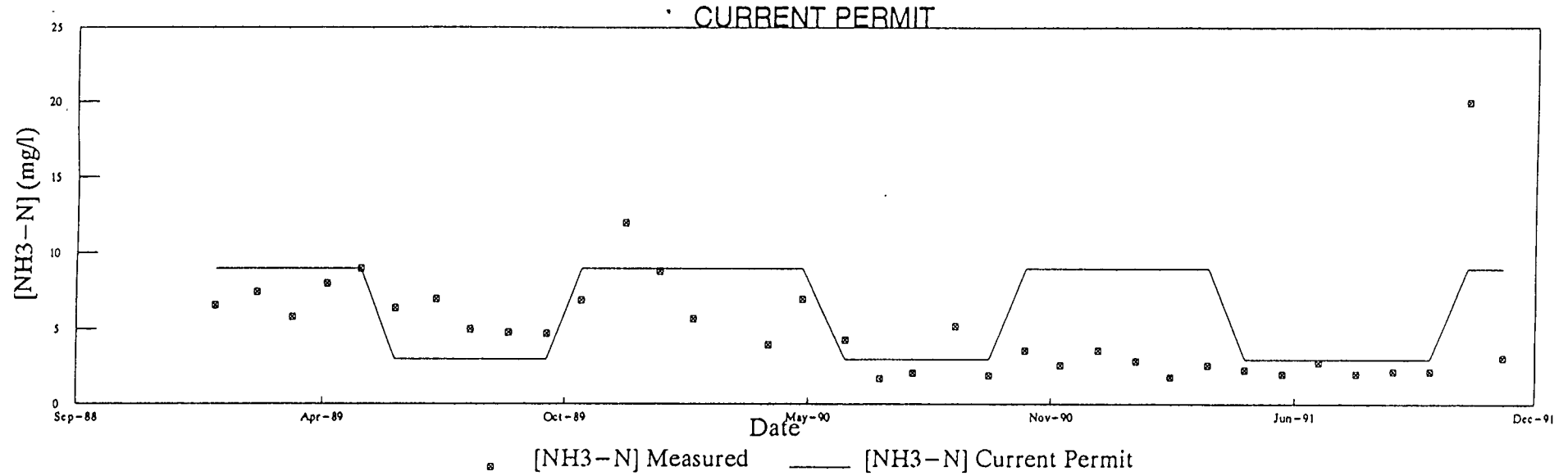


FIGURE 23

AVERAGE MONTHLY NH3–N COMPLIANCE

NADC – Warminster, PA 1989–1991



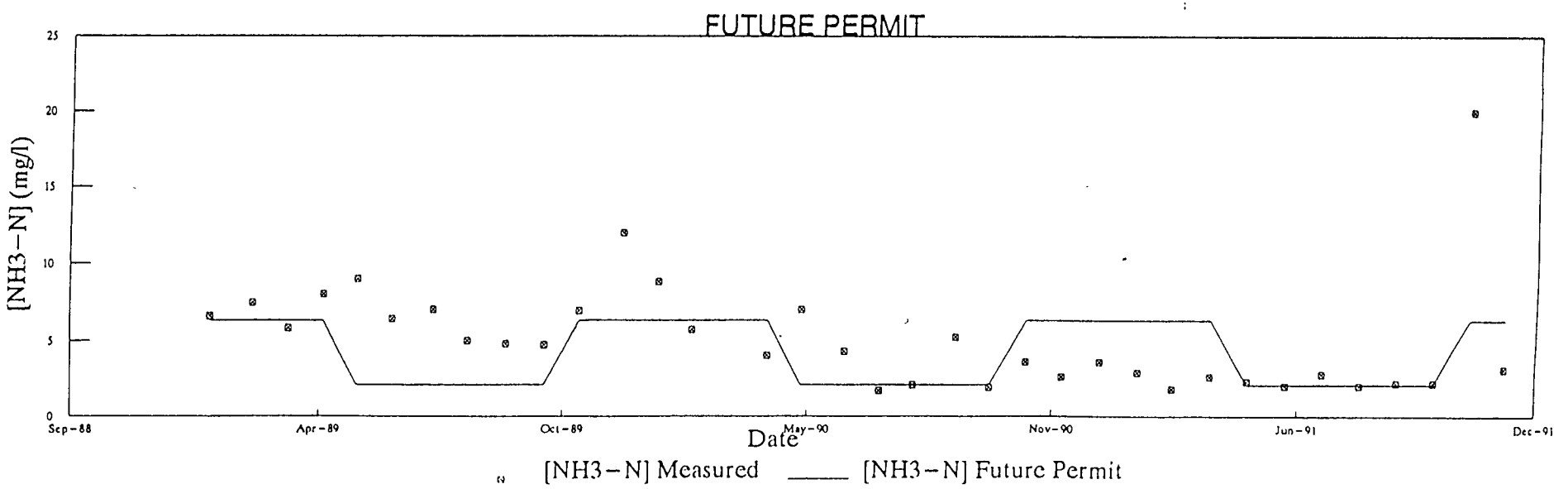
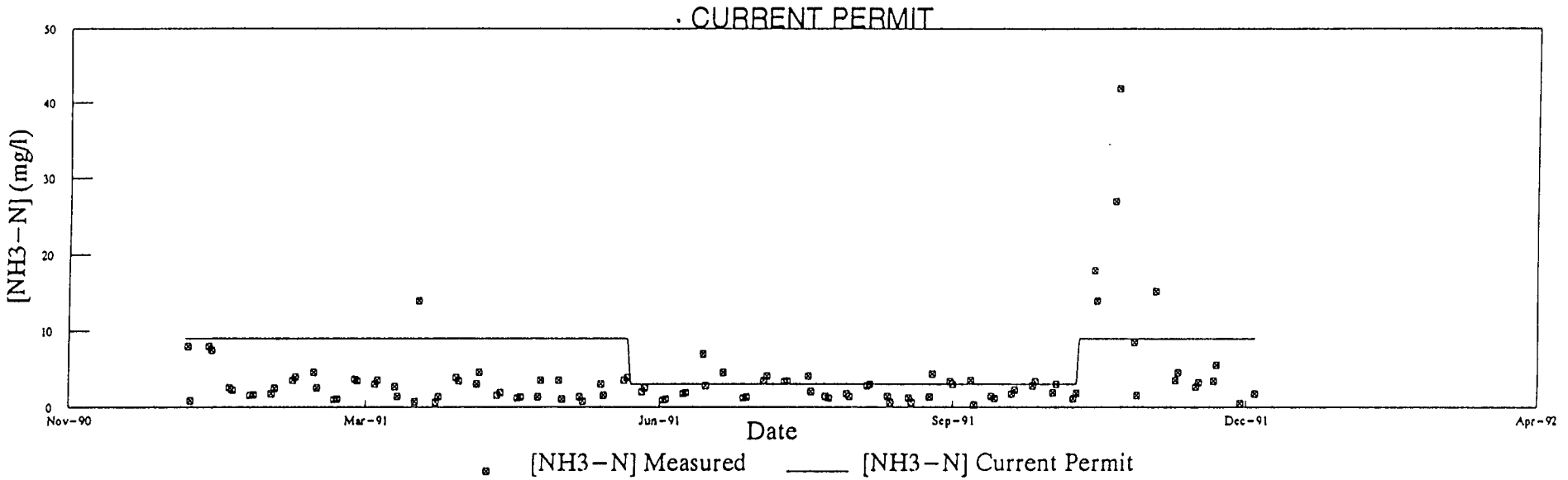


FIGURE 24

AVERAGE DAILY NH3–N COMPLIANCE

NADC – Warminster, PA 1991



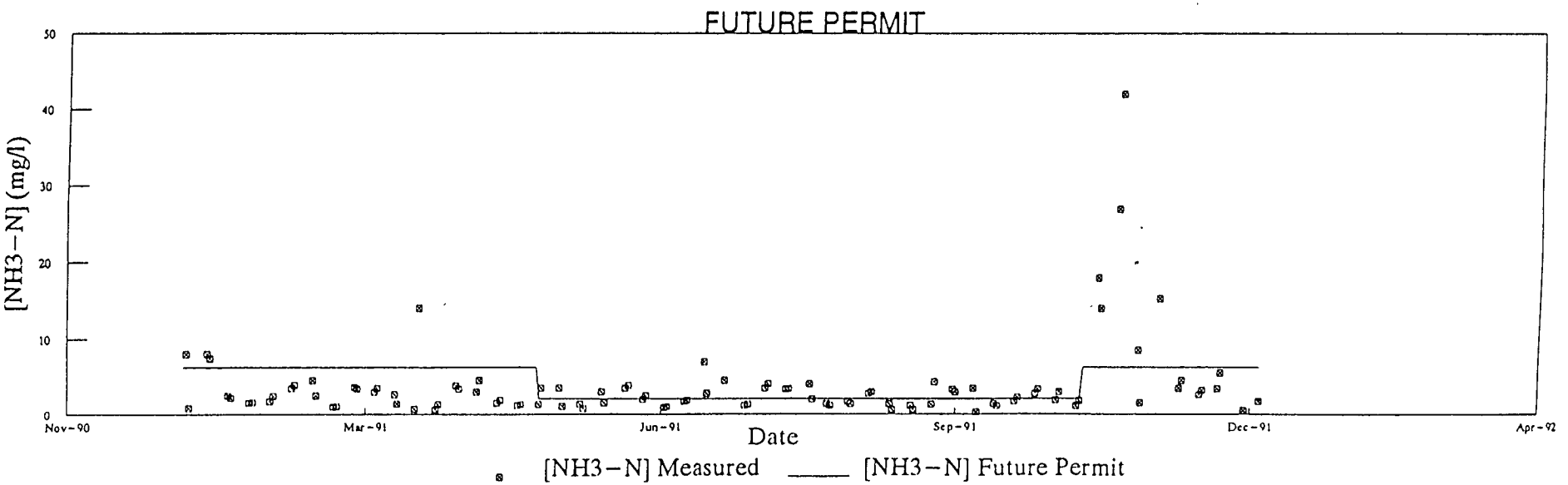


FIGURE 25

AVERAGE MONTHLY NO3–N AND NO2–N COMPLIANCE

NADC – Warminster, PA 1989–1991

{NO CURRENT PERMIT REQUIREMENTS FOR NO3–N AND NO2–N}

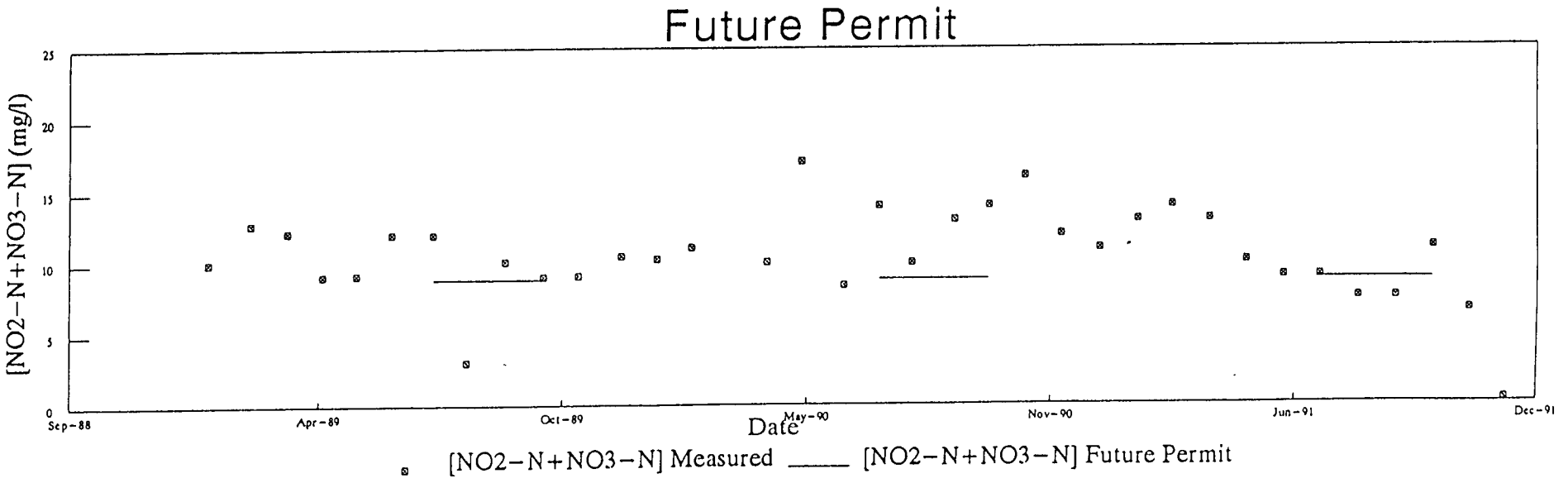


FIGURE 26

AVERAGE DAILY NO3–N AND NO2–N COMPLIANCE

NADC – Warminster, PA 1991

{[NO CURRENT PERMIT REQUIREMENTS FOR ([NO3]+[NO2])}

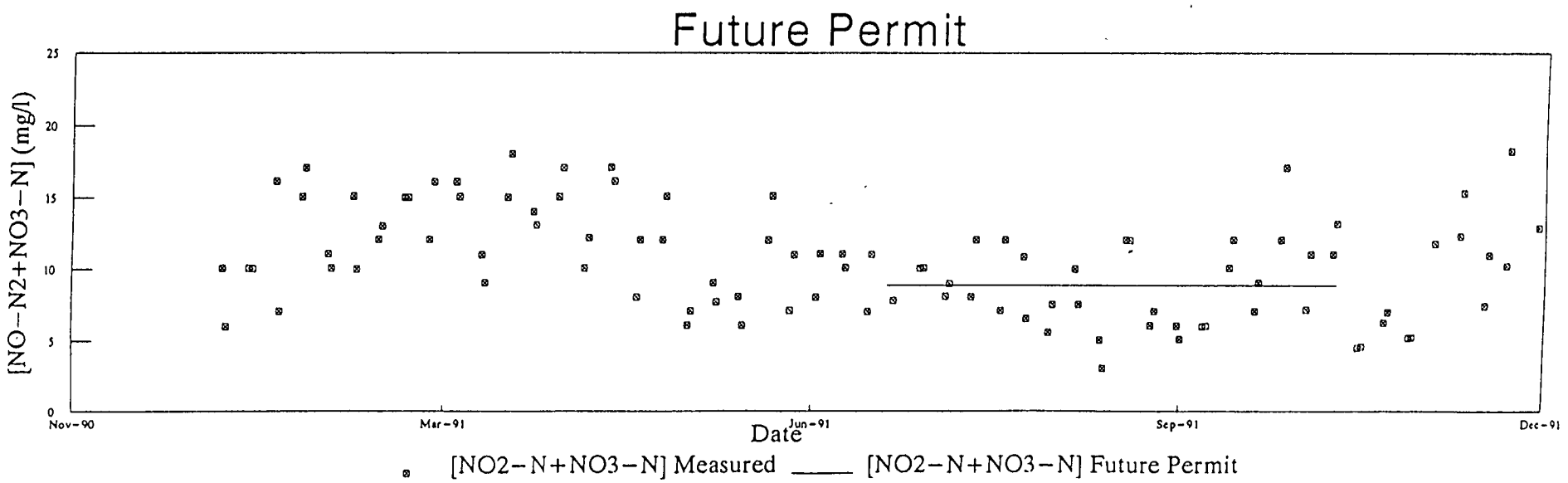
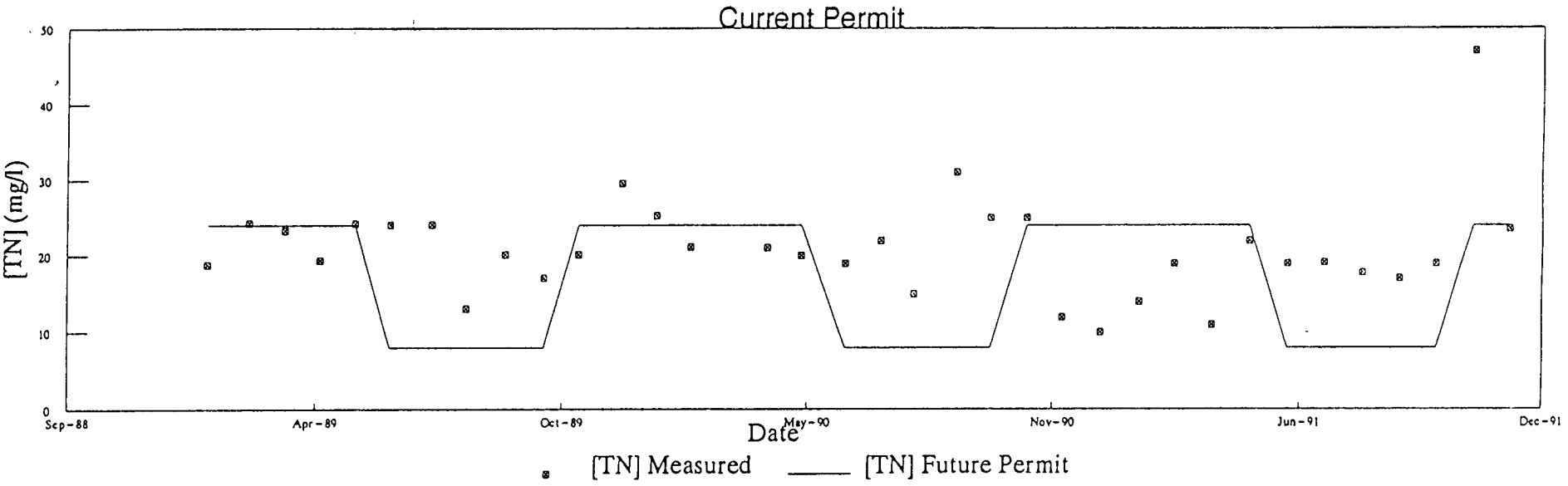


FIGURE 27

AVERAGE MONTHLY TN COMPLIANCE

NADC – Warminster, PA 1989–1991

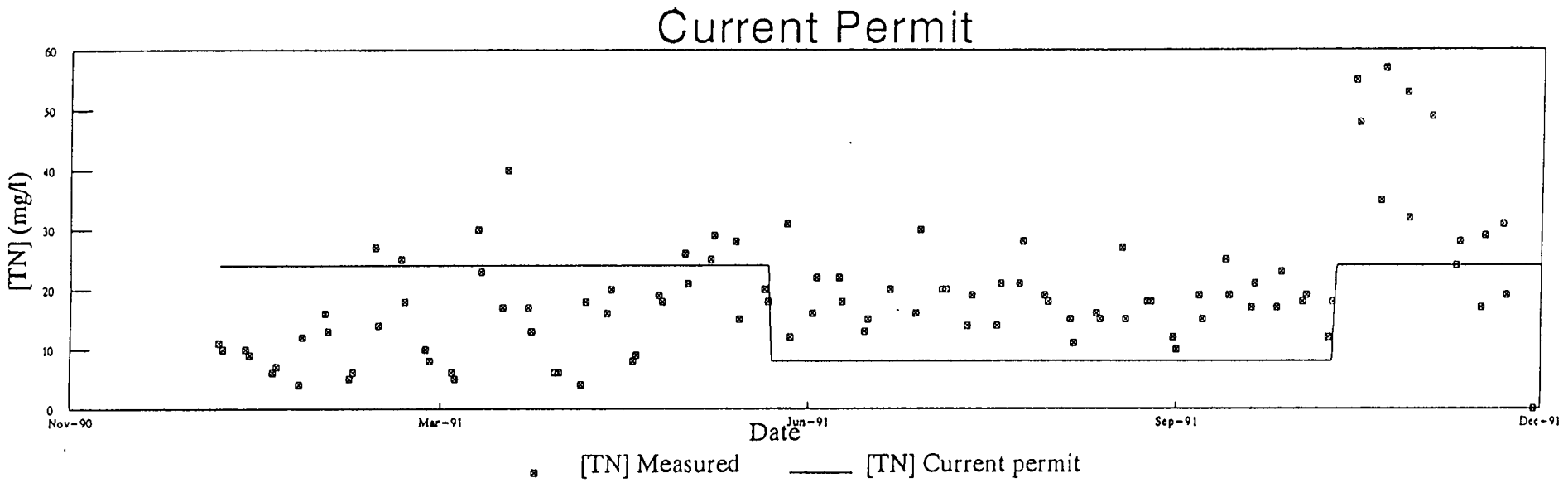


{NO FUTURE PERMIT REQUIREMENTS FOR [TN}

FIGURE 28

AVERAGE DAILY TN COMPLIANCE

NADC – Warminster, PA 1991



{NO FUTURE PERMIT REQUIREMENTS FOR [TOTAL N]}

FIGURE 29

AVERAGE MONTHLY PHOSPHORUS [P] COMPLIANCE

NADC – Warminster, PA 1989–1991

{NO CURRENT PERMIT REQUIREMENTS FOR [P]}

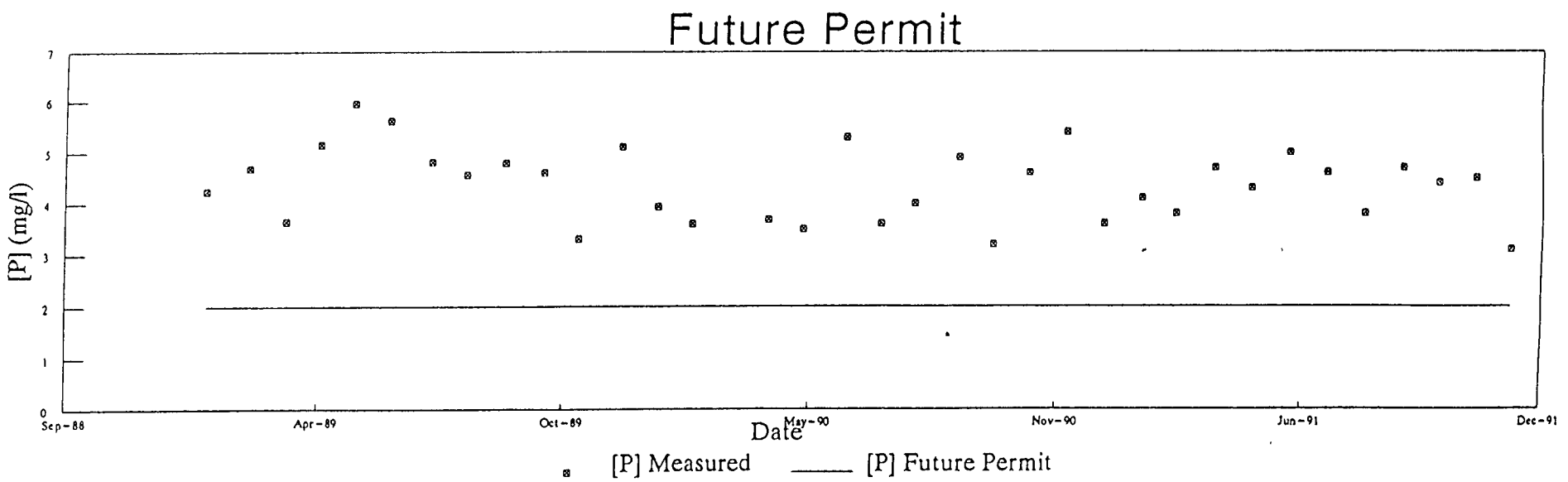


FIGURE 30

AVERAGE DAILY PHOSPHORUS [P] COMPLIANCE

NADC – Warminster, PA 1991

{NO CURRENT PERMIT REQUIREMENTS FOR [P]}

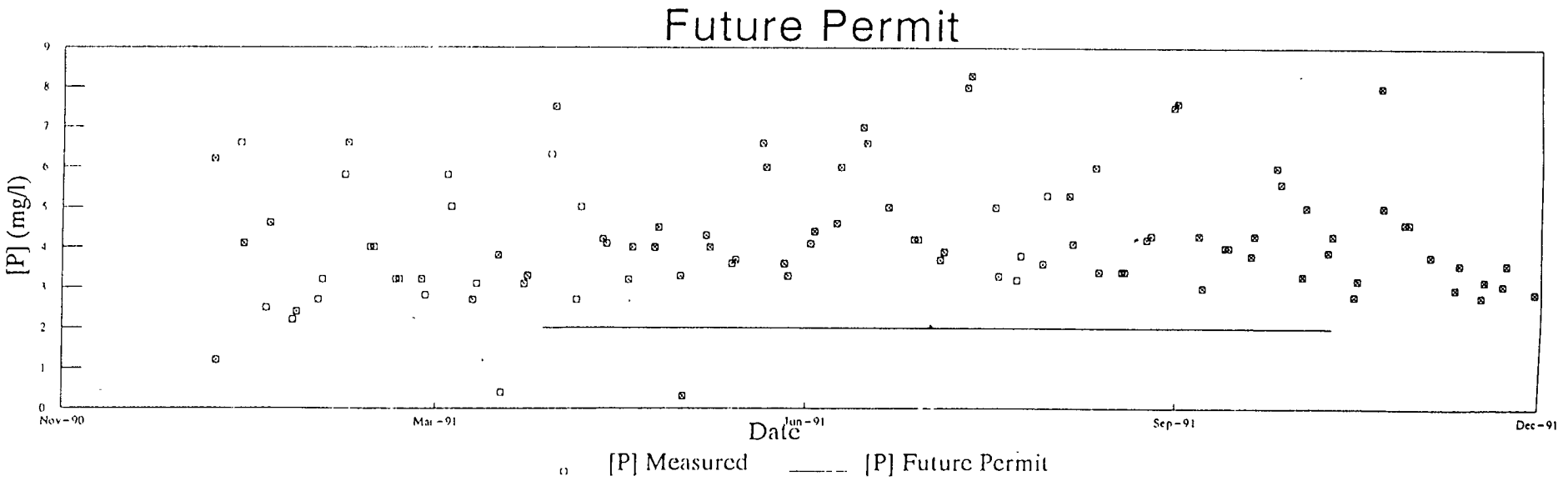


FIGURE 31

APPENDIX A

LIMITATIONS

APPENDIX A

1. The observations described in this report were made under the conditions stated therein. The conclusions presented in the report were based solely upon the information provided by the Client and published data, and not on any new investigations or experimental tasks or procedures beyond the scope of described services or the time and budgetary constraints imposed by Client. The work described in this report was carried out in accordance with the attached Statement of Terms and Conditions.

2. In preparing this report, GZA GeoEnvironmental, Inc. (GZA) has relied solely on information provided by the Client. Although there may have been some degree of disagreement between different sets of data made available to GZA, no attempt to independently verify the accuracy or completeness of any information reviewed or received during the course of preparation of this report was made by GZA.

3. This report discusses the compliance status with respect to the suspended solids (SS), carbonaceous (BOD_5), nitrogenous (TKN, NH_3-N, NO_3-N and NO_2-N) and phosphorous (PO_4-P and P_t) components of the influent. Compliance with regulations other than those indicated has not been evaluated.

4. Observations were made of the site and of structures on the site as indicated within the report. Where access to portions of the site or to structures located above and below ground on the site was unavailable or limited, GZA renders no opinion as to existence, conditions or capacity of utilities, equipment or structures, or to the presence of indirect evidence relating to evaluation of functioning, efficiency or capacity of such utilities, equipment or structures, or portion thereof. In addition, GZA renders no opinion as to the presence or possible effects of toxic substances, fats, grease and oils which might be contained in the influent to the facility on treatment processes.

5. GZA did not perform any testing or analyses in the course of preparation of this report, or in conjunction with it, whatsoever.

6. The stated purpose of this report was to assess the operating parameters of the existing facility on the basis of analytical data provided by the Client, and to render an opinion, based on common engineering practice as presented in commonly accepted text books pertinent to municipal wastewater treatment, regarding capacity of the facility to meet effluent requirements imposed by National Pollution Discharge Elimination System (NPDES) permit, a copy of which was provided by the Client. No specific attempt was made to independently verify any information provided by the Client, or to gather any information, pertinent to the site, in addition to information provided by the Client.

7. The conclusions and recommendations contained in this report are based solely upon information provided by the Client and contained in the commonly accepted text books pertinent to municipal wastewater treatment. Full extent of data concerning certain operational practices and parameters peculiar to the influent constituencies, and state and capacity of underground or otherwise not easily accessible structures and communications may not become evident without further exploration. If variations from the data provided or latent conditions are later discovered, it will be necessary to reevaluate the conclusions and recommendations of this report.

8. No quantitative laboratory testing was performed as part of preparation of this report. Where such analyses have been conducted by the Client, GZA has relied upon the data provided, and has not conducted an independent evaluation of the reliability of these data.

9. The conclusions and recommendations contained in this report are based in part on quantitative and qualitative types of chemical data and are contingent upon their validity. These data have been reviewed and interpretations made in the report. As indicated within the report, some of these data appear to

lack validity (see Section 8.00 of the Report and GZA's responce to NAWC's question and comments dated July 24, 1992, reference 8), and should be confirmed with quantitative analyses if more specific information is necessary. Moreover, it should be noted that variations in the types and concentrations of contaminants and variations in their flow rates may occur due to changes of operational practices at the facilities where wastewater is generated. Should additional chemical or operational data become available in the future, these data should be reviewed by GZA and the conclusions and recommendations presented herein modified accordingly.

10. It is recommended that GZA be retained to provide further engineering services during pilot investigations, trial operation and design modifications of any remedial measures recommended in this report. This is to allow GZA to observe compliance with the concepts and recommendations contained herein. Such further services will enable the development of design changes in the event that latent conditions differ from those anticipated.

APPENDIX B

COPY OF NPDES WWTP DISCHARGE PERMIT ISSUED BY THE PADER
TO THE NADC - WARMINSTER, PA

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
1875 New Hope Street
Norristown, PA 19401
215 270-1975

September 27, 1989

U.S. Department of the Navy
U.S. Naval Air Development Center
Street and Jacksonville Roads
Warminster, PA 18974

Attention: Mr. Ames (Code 83A)
Deputy Public Works Officer

Re: Industrial Waste NPDES Permit PA 0022420
U.S. Department of the Navy
U.S. Naval Air Development Center
Warminster Township
Bucks County

Gentlemen:

Referenced permit is enclosed.

It will be necessary for you to submit a completed Discharge Monitoring Report (DMR) on a monthly basis to the appropriate agencies (see p. 5, also Other Requirements on p. 14 of the NPDES permit).

A master copy of the DMR form is enclosed which should be reproduced for your use in this regard.

In accordance with Other Requirements item 12 (p. 14) please note that work is to begin on a Toxics Reduction Evaluation by October 1, 1989. The first progress report is due on February 1, 1990. For your reference, we have enclosed a copy of the "Guidelines for Conducting a Toxics Reduction Evaluation" October 1986.

Your attention is directed to Part C, Other Requirements No. 11 which approves the use of the chemical additives Betz Entec 310A, 703, 717 and sulfite. All other additives are not approved for use due to their toxic effects on aquatic life at the reported effluent concentrations. The maximum allowable effluent concentrations would be:

Entec 733	0.63 mg/l
Entec 748	1.31 mg/l
Entec 345A	0.1 mg/l
Entec 346	0.003 mg/l
Entec 349	0.001 mg/l

Since these allowable concentrations are less than your reported concentrations, these additives cannot be approved. Any new proposed additives must receive ·ior approval.

Please study the permit carefully and direct any questions to the Permits Section of this office.

Very truly yours,

Joseph A. Feola

JOSEPH A. FEOLA
Regional Water Quality Manager

ENCLOSURES: Permit
Master Discharge Monitoring Report
Guidelines for Conducting a Toxics Reduction Evaluation

cc: EPA (3WM51)
DRBC
Warminster Township (Transmittal letter only)
Permits & Compliance
Re 30 (NPDW)

ER-BWQ-15.1 9/78 (Rev. 5/81)

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF WATER QUALITY MANAGEMENT

AUTHORIZATION TO DISCHARGE UNDER THE
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

INDUSTRIAL PERMIT NO. PA 0022420

In compliance with the provisions of the Clean Water Act, 33 U.S.C. Section 1251 et seq. (the "Act") and Pennsylvania's Clean Streams Law, as amended, 35 P.S. Section 691.1 et seq.,

U.S. Department of the Navy
U.S. Naval Air Development Center

is authorized to discharge from a facility located at

Warminster Township
Bucks County

to receiving waters named

unnamed tributary of Little Neshaminy Creek

in accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts A, B, and C hereof.

This permit and the authorization to discharge shall expire at midnight, 9/27/94.

The authority granted by this permit is subject to the following further qualifications:

1. If there is a conflict between the application, its supporting documents and/or amendments and the terms and conditions of this permit, the terms and conditions shall apply.

2. Failure to comply with the terms or conditions of this permit is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or for denial of a permit renewal application.

3. Application for renewal of this permit, or notification of intent to cease discharging by the expiration date, must be submitted to the Department at least 180 days prior to the above expiration date (unless permission has been granted by the Department for submission at a later date), using the appropriate NPDES permit application form. In the event that a timely and complete application for renewal has been submitted and the Department is unable, through no fault of the permittee, to reissue the permit before the above expiration date, the terms and conditions of this permit will be automatically continued and will remain fully effective and enforceable pending the grant or denial of the application for permit renewal.

4. This NPDES permit does not constitute authorization to construct or make modifications to wastewater treatment facilities necessary to meet the terms and conditions of this permit.

PERMIT ISSUED

DATE 9/27/89

BY Joseph A. Feola

Joseph A. Feola
Regional Water Quality Manager

TITLE

I. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS FOR MONITORING POINT 101; LOCATED AT LATITUDE 40°12'11", LONGITUDE 74°4'50"

A. During the period beginning at issuance and lasting through expiration, the Permittee is authorized to discharge.
B. The average monthly flow of effluent discharged from the wastewater treatment facility shall not exceed 0.750 million gallons per day.

DISCHARGE PARAMETER	DISCHARGE LIMITATIONS							MONITORING REQUIREMENTS		
	MASS UNITS (lbs/day)			CONCENTRATIONS (mg/l)						
	AVERAGE MONTHLY	AVERAGE WEEKLY	MAXIMUM DAILY	AVERAGE MONTHLY	AVERAGE WEEKLY	MAXIMUM DAILY	INSTANTANEOUS MAXIMUM	MEASUREMENT FREQUENCY	SAMPLE TYPE	24 HOUR REPORT UNDER PART A.II.D
		150000								
FLOW (MGD)								2/Month	Measured	
CBOD-5				25			50	2/Month	8 Hour Comp.	
CBOD-5 * % REMOVAL	≥85%							2/Month	8 Hour Comp.	
TOTAL SUSPENDED SOLIDS				30			60	2/Month	8 Hour Comp.	

FOOTNOTES: 1. Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Monitoring Point 101, at the discharge from the sewage treatment plant before th discharge is combined with other wastewater.

* See Other Requirement 1.

1. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS, FOR DISCHARGE 001; LOCATED AT LATITUDE 40°13'01", LONGITUDE 75°04'28", WHICH RECEIVES WASTE FROM: Sewage Treatment Plant, Airplane Wash Racks, Boiler Blowdown, Cooling Water, Paint Spray Booths, and Print Shop Rinsewater.
   A. The permittee is authorized to discharge during the period from issuance through completion of upgrade.
   B. Based on production data and anticipated wastewater characteristics and flows described in the permit application and its supporting documents and/or amendments, the following effluent limitations and monitoring requirements apply:

DISCHARGE PARAMETERS	DISCHARGE LIMITATIONS*					MONITORING REQUIREMENTS		
	MASS UNITS (lbs/day)		CONCENTRATIONS (mg/l)					
	AVERAGE MONTHLY	MAXIMUM DAILY	AVERAGE MONTHLY	MAXIMUM DAILY	INSTANTANEOUS MAXIMUM	MEASUREMENT FREQUENCY	SAMPLE TYPE	24 HOUR REPORT UNDER A.3.C
FLOW (MGD)						Continuous	Recorded	
TEMPERATURE	See Other Requirement 4				110°F	1/Month	I-S	
CBOD-5 (5-1 to 10-31)	18		14.4		28.8	2/Week	8 Hour Comp.	
CBOD-5 (11-1 to 4-30)	31		25		50	2/Week	8 Hour Comp.	
TOTAL SUSPENDED SOLIDS	38		30		60	2/Week	8 Hour Comp.	
AMMONIA as N (6-1 to 10-31)	3.8		3.0		6.0	2/Week	8 Hour Comp.	
AMMONIA as N (11-1 to 5-31)	11		9.0		18	2/Week	8 Hour Comp.	
DISSOLVED OXYGEN			Minimum of 5.0 mg/l at all times			Daily	Grab	
TOTAL NITROGEN (6-1 to 10/31)	10		8.0		16	2/Week	8 Hour Comp.	
TOTAL NITROGEN (11-1 to 5-31)	30		24		48	2/Week	8 Hour Comp.	
FECAL COLIFORM			See Other Requirement 3			2/Week	8 Hour Comp.	
pH	Within Limits of 6 to 9 Standard Units at all times					Daily	Grab	

There shall be no discharge of floating solids or visible foam in other than trace amounts.
Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Outfall 001.
*Unless otherwise indicated, these are gross discharge limitations.

1. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS, FOR DISCHARGE 001; LOCATED AT LATITUDE 40°13'01", LONGITUDE 75°04'28", WHICH RECEIVES WASTE FROM: Sewage Treatment Plant, Airplane Wash Racks, Boiler Blowdown, Cooling Water, Paint Spray Booths, and Print Shop Rinsewater.
   A. The permittee is authorized to discharge during the period from completion of upgrade through expiration.
   B. Based on production data and anticipated wastewater characteristics and flows described in the permit application and its supporting documents and/or amendments, the following effluent limitations and monitoring requirements apply:

DISCHARGE PARAMETERS	DISCHARGE LIMITATIONS*					MONITORING REQUIREMENTS		
	MASS UNITS (lbs/day)		CONCENTRATIONS (mg/l)					
	AVERAGE MONTHLY	MAXIMUM DAILY	AVERAGE MONTHLY	MAXIMUM DAILY	INSTANTANEOUS MAXIMUM	MEASUREMENT FREQUENCY	SAMPLE TYPE	24 HOUR REPORT UNDER A.3.C
FLOW (MGD)						Continuous	Recorded	
CBOD-5 (5-1 to 10-31)	18		14.4		28.8	2/Week	8 Hour Comp.	
CBOD-5 (11-1 to 4-30)	31		25		50	2/Week	8 Hour Comp.	
TOTAL SUSPENDED SOLIDS	38		30		60	2/Week	8 Hour Comp.	
AMMONIA as N (5-1 to 10-31)	2.6		2.1		4.2	2/Week	8 Hour Comp.	
AMMONIA as N (11-1 to 4-30)	7.9		6.3		12.6	2/Week	8 Hour Comp.	
PHOSPHORUS (AS P) (4-1 to 10-31)	2.5		2		5	2/Week	8 Hour Comp.	
NITRITE & NITRATE (AS N) (7-1 to 10-31)	11		8.9		17.8	2/Week	8 Hour Comp.	
DISSOLVED OXYGEN			Minimum of 5.0 mg/l at all times			Daily	Grab	
FECAL COLIFORM			See Other Requirement 3			2/Week	Grab	
pH	Within Limits of 6 to 9 Standard Units at all times					Daily	Grab	

There shall be no discharge of floating solids or visible foam in other than trace amounts.
Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Outfall 001.
*Unless otherwise indicated, these are gross discharge limitations.

1. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS, FOR DISCHARGE 001; LOCATED AT LATITUDE 40°13'01", LONGITUDE 75°04'28", WHICH RECEIVES WASTE FROM: Sewage Treatment Plant, Airplane Wash Racks, Boiler Blowdown, Cooling Water, Paint Spray Booths, and Print Shop Rinsewater.
   A. The permittee is authorized to discharge during the period from issuance through expiration.
   B. Based on production data and anticipated wastewater characteristics and flows described in the permit application and its supporting documents and/or amendments, the following effluent limitations and monitoring requirements apply:

DISCHARGE PARAMETERS	DISCHARGE LIMITATIONS*					MONITORING REQUIREMENTS		
	MASS UNITS (lbs/day)		CONCENTRATIONS (mg/l)					
	AVERAGE MONTHLY	MAXIMUM DAILY	AVERAGE MONTHLY	MAXIMUM DAILY	INSTANTANEOUS MAXIMUM	MEASUREMENT FREQUENCY	SAMPLE TYPE	24 HOUR REPORT UNDER A.3.C
TEMPERATURE	See Other Requirement 4.				110° F	1/Month	I-S	
SULFATE (AS SO_4) **			Monitor Only			2/Week	8 Hour Comp.	
OIL AND GREASE			15		30	2/Week	Grab	
SURFACTANTS (MBAS)			0.5		1.25	2/Week	Grab	
COPPER, TOTAL ** & ***			Monitor Only			2/Week	8 Hour Comp.	
LEAD, TOTAL ** & ***			Monitor Only			2/Week	8 Hour Comp.	
ZINC, TOTAL **			Monitor Only			2/Week	8 Hour Comp.	

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Outfall 001.

*Unless otherwise indicated, these are gross discharge limitations.
**See Other Requirement 12.
***See Other Requirement 14.

2. Definitions

a. The term "Bypass" means the intentional diversion of wastes from any portion of a treatment facility.

b. The term "severe property damage" means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

c. The "average monthly" mass discharge means the total discharge by weight during a calendar month divided by the number of days in the month that the production or commercial facility was operating. Where less than daily sampling is required by this permit, the average monthly mass discharge shall be determined by the summation of all the measured daily discharges by weight divided by the number of days during the calendar month when the measurements were made.

d. The "maximum daily" mass discharge means the total discharge by weight during any calendar day.

e. The "average monthly' concentration means the arithmetic average of all the daily determinations of concentration made during a calendar month.

f. The "daily determination of concentration" means either the concentration of a composite sample taken during a calendar day or the arithmetic average of all grab samples taken during a calendar day.

g. The "maximum daily" concentration means the daily determination of concentration for any calendar day.

h. The "instantaneous maximum" concentration means the concentration not to be exceeded at any time in any grab sample.

i. The term "Composite Sample" means a combination of individual samples obtained at regular intervals over a time period. Either the volume of each individual sample is proportional to discharge flow rates, or the sampling interval (for constant volume samples) is proportional to the flow rates over the time period used to produce the composite. The maximum time period between individual samples shall not exceed two hours, except that for wastes of a uniform nature the samples may be collected on a frequency of at least twice per working shift and shall be equally-spaced over a 24-hour period (or over the operating day if flows are of a shorter duration).

j. The term "Grab Sample" means an individual sample collected in less than 15 minutes.

k. The term "i-s" means immersion stabilization - in which a calibrated device is immersed in the effluent stream until the reading is stabilized.

l. The "average monthly" temperature means the arithmetic mean of temperature measurement made on an hourly basis, or the mean value plot of the record of a continuous automated temperature recording instrument, either during a calendar month or during the operating month if flows are of a shorter duration.

m. The "maximum daily" temperature means the highest arithmetic mean of the hourly temperatures observed for any two (2) consecutive hours during a 24-hour day, or during the operating day if flows are of a shorter duration.

n. The term "Measured Flow" means any method of liquid volume measurement, the accuracy of which has been previously demonstrated in engineering practice, or for which a relationship to absolute volume has been obtained.

o. The term "At outfall XXX" means a sampling location in outfall line XXX downstream from the last point at which wastes are added to outfall line XXX, or otherwise specified.

p. The term "Estimate" means to be based on a technical evaluation of the sources contributing to the discharge including, but not limited to, pump capabilities, water meters and batch discharge volumes.

q. The term "non-contact cooling water" shall mean water which is used in a cooling system designed so as to maintain constant separation of the cooling medium from all contact with process chemicals but which may on occasion, as a result of corrosion, cooling system leakage or similar cooling system failures contain small amounts of process chemicals: provided, that all reasonable measures have been taken to prevent, reduce, eliminate and control to the maximum extent feasible such contamination: and provided further, that all reasonable measures have been taken that will mitigate the effects of such contamination once it has occurred.

3. SELF-MONITORING, REPORTING, AND RECORDS KEEPING

a. Representative Sampling

Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge.

b. Reporting of Monitoring Results

(1) Monitoring results obtained during each month shall be summarized for that month and reported on a Discharge Monitoring Report (DMR) Form postmarked no later than the 28th day of the following month. Duplicate signed copies of these and all other reports required herein, shall be submitted to the Department and the EPA Regional Office at the following addresses:

Dept. of Environmental Resources
Bureau of Water Quality Mgmt.
1875 New Hope Street
Norristown, PA 19401

Program Mgmt. Section (3WM52)
Permits Enforcement Branch
Water Management Division
U.S. EPA, Region III
841 Chestnut Building
Philadelphia, PA 19107

(2) If the permittee monitors any pollutant, using analytical methods described in A.3.e. below, more frequently than the permit requires, the results of this monitoring shall be incorporated, as appropriate, into the calculations used to report self-monitoring data on the DMR.

c. Non-Compliance Reporting

(1) 24-Hour Reporting - The permittee shall orally report to the Department within 24-hours of becoming aware of the following:

(a) Actual or anticipated non-compliance with any term or condition of this permit which may endanger health or the environment.

(b) Actual or anticipated non-compliance with any "maximum daily" discharge limitation which is identified in Part A.1 of this permit as being either:

(i) A toxic pollutant effluent standard established by EPA pursuant to Section 307(a) of the Clean Water Act,

(ii) For a toxic or hazardous pollutant which, if not adequately treated, could constitute a threat to human health, welfare, or the environment, or

(iii) Any pollutant identified as the method to control a toxic pollutant or hazardous substance (i.e. indicator pollutant).

(c) Any unanticipated bypass which exceeds any effluent limitations in the permit.

(d) Where the permittee orally reports this information within the above mentioned 24-hour time period, a written submission outlining the above information must be submitted to the Department within 5-days of becoming aware of such a condition, unless this requirement is waived by the Department upon receipt of the oral report.

(2) Other Non-Compliance Reporting

(a) The permittee shall give advance notice to the Department of any planned changes to the permitted activity or facility which may result in non-compliance with permit requirements.

(b) Where the permittee knows in advance of the need for a by-pass which will exceed effluent limitations, it shall submit prior notice to the Department at least 10 days, if possible, before the date of the bypass.

(c) The permittee shall report all instances of non-compliance which are not reported above at the time of DMR submission.

(3) The reports and notifications required above shall contain the following information:

(a) A description of the discharge and cause of non-compliance;

(b) The period of non-compliance, including exact dates and times and/or, the anticipated time when the discharge will return to compliance; and

(c) Steps being taken to reduce, eliminate, and prevent recurrence of the non-complying discharge.

d. Specific Toxic Substance Notification Levels - The permittee shall notify the Department as soon as it knows or has reason to believe the following:

(1) That any activity has occured, or will occur, which would result in the discharge of any toxic pollutant which is not limited in the permit. if that discharge will exceed the highest of the following "notification levels".

(a) One hundred micrograms per liter

(b) Two hundred micrograms per liter for acrolein and acrylonitrile

(c) Five hundred micrograms per liter for 2, 4-dinitrophenol and 2-methyl -4, 6-dinitrophenol

(d) One milligram per liter for antimony

(e) Five (5) times the maximum concentration value reported for that pollutant in the permit application

(f) Any other notification level established by the Department

(2) That it has begun, or expects to begin, to use or manufacture as an intermediate or final product or byproduct any toxic pollutant which was not reported in the permit application.

e. Test Procedures

Unless otherwise specified in this permit, the test procedures for the analysis of pollutants shall be those contained in 40 CFR Part 136, or alternate test procedures approved pursuant to that part.

f. Recording of Results

For each measurement or sample taken pursuant to the requirements of this permit, the permittee shall record the following information:

(1) The exact place, date, and time of sampling or measurements;

(2) The person(s) who performed the sampling or measurements;

(3) The dates the analyses were performed;

(4) The person(s) who performed the analyses;

(5) The analytical techniques or methods used; and

(6) The results of such analyses.

g. Records Retention

All records of monitoring activities and results (including all original strip chart recordings for continuous monitoring instrumentation and calibration and maintenance records), copies of all reports required by this permit, and records of all data used to complete the application for this permit shall be retained by the permittee for three (3) years. The three year period shall be extended as requested by the Department or the EPA Regional Administrator.

4. SCHEDULE OF COMPLIANCE -SEE OTHER REQUIREMENT 13 of PART C of this Permit.

a. The permittee shall achieve compliance with the effluent limitations specified for discharges in accordance with the following schedule:

-SEE OTHER REQUIREMENT 13 of PART C of this Permit

b. Periodic Reports Required

No later than 14 calendar days following a date identified in the above schedule of compliance, the permittee shall submit to the Department a written notice of compliance or non-compliance with the specific schedule requirement. In the case of non-compliance, the notice shall include the cause of non-compliance, any remedial actions taken, the estimated date when compliance with the elapsed date shall occur, and the probability of meeting the next scheduled requirement.

1. MANAGEMENT REQUIREMENTS

a. Permit Modification, Termination, or Revocation and Reissuance

(1) This permit may be modified, terminated, or revoked and reissued during its term for any of the causes specified in 25 Pa. Code, Chapter 92.

(2) The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated non-compliance, does not stay any permit condition.

(3) Toxic Pollutants

Notwithstanding the above, if a toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under Section 307(a) of the Act for a toxic pollutant which is present in the discharge, and such standard or prohibition is more stringent than any limitation for such pollutant in this permit, then this permit shall be modified or revoked and reissued by the Department to conform with the toxic effluent standard or prohibition and the permittee so notified.

In the absence of a Departmental action to modify or to revoke and reissue this permit, any toxic effluent standard or prohibition established under Section 307(a) of the Act is considered to be effective and enforceable against the permittee.

b. Duty to Provide Information

(1) The permittee shall furnish to the Department, within a reasonable time, any information which the Department may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit.

(2) The permittee shall furnish to the Department, upon request, copies of records required to be kept by this permit.

(3) Other Information - Where the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Department, it shall promptly submit such facts or information to the Department.

(4) The permittee shall give advance notice to the Department of any planned physical alterations or additions to the permitted facility.

c. Facilities Operation

The permittee shall at all times maintain in good working order and properly operate all facilities and systems (and related appurtenances) for collection and treatment which are installed or used by the permittee for water pollution control and abatement to achieve compliance with the terms and conditions of the permit. Proper operation and maintenance includes but is not limited to effective performance based on designed facility removals, adequate funding, effective management, adequate operator staffing and training, and adequate laboratory and processing controls including appropriate quality assurance procedures. This provision includes the operation of backup or auxiliary facilities or similar systems when necessary to achieve compliance with this permit.

d. Adverse Impact

The permittee shall take all reasonable steps to minimize or correct any adverse impact on the environment resulting from non-compliance with this permit.

e. Bypassing

(1) Bypassing not Exceeding Permit Limitations - The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if the bypass is for essential maintenance to assure efficient operation. This type of bypassing is not subject to the reporting and notification requirements of Part A.3.c above.

(2) Other Bypassing - In all other situations bypassing is prohibited unless the following conditions are met:

(a) A bypass is unavoidable to prevent loss of life, personal injury or "severe property damage";

(b) There are no feasible alternatives to a bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment down-time. (This condition is not satisfied if the permittee could have installed adequate backup equipment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance); and

(c) The permittee submitted the necessary reports required under Part A.3.c above.

(3) The Department may approve an anticipated bypass, after considering its adverse effects, if the Department determines that it will meet the three conditions listed above.

f. Reduction, Loss, or Failure of the Treatment Facilities

Upon reduction, loss, or failure of the treatment facilities, in order to maintain compliance with its permit, the permittee shall control production and all discharges until either the facility is restored or an alternative method of treatment is provided. This requirement applies in the situation where, among other things,the primary source of power of the treatment facility is reduced, lost, or fails.

g. Removed Substances

Solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters shall be disposed of in a manner such as to prevent any pollutant from such materials from adversely affecting the environment.

2. RESPONSIBILITIES

a. Right of Entry

Pursuant to Sections 5(b) and 305 of Pennsylvania's Clean Streams Law and 25 Pa. Code, Chapter 92, the permittee shall allow the head of the Department, the EPA Regional Administrator, and/or their authorized representatives, upon the presentation of credentials and other documents as may be required by law:

(1) To enter upon the permittee's premises where an effluent source is located or in which any records are required to be kept under the terms and conditions of this permit; and

(2) At reasonable times to have access to and copy any records required to be kept under the terms and conditions of this permit; to inspect any monitoring equipment or monitoring method required in this permit; to inspect any collection, treatment, pollution management, or discharge facilities required under the permit; and to sample any substances or parameters at any location.

b. Transfer of Ownership or Control

(1) No permit may be transferred unless approved by the Department.

(2) In the event of any pending change in control or ownership of facilities from which the authorized discharges emanate, the permittee shall notify the Department by letter of such pending change at least 30 days prior to the change in ownership or control.

(3) The letter shall be accompanied by the appropriate Department forms for transfer of the permit and a written agreement between the existing permittee and the new owner or controller stating that the existing permittee shall be liable for violations of the permit up to and until the date of permit transfer and that the new owner or controller shall be liable for permit violations from that date on.

(4) After receipt of the documentation above, the Department shall notify the existing permittee and the new owner or controller of its decision concerning approval of the transfer. In approving a transfer the Department may modify or revoke and reissue the permit.

(5) In the event the Department does not approve transfer of the permit, the new owner or controller must submit a new permit application.

c. Confidentiality of Reports

Except for data determined to be confidential under 25 Pa. Code, Chapter 92 all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Department and the EPA Regional Administrator. Effluent data shall not be considered confidential.

d. Penalties and Liability

Nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for non-compliance pursuant to Section 309 of the Clean Water Act or Sections 602 or 605 of the Clean Streams Law.

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under Section 311 of the Act.

e. Property Rights

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges; nor does it authorize any injury to private property or any invasion of personal rights.

f. Other Laws

Nothing herein contained shall be construed to be an intent on the part of the Department to approve any act made or to be made by the permittee inconsistent with the permittee's lawful powers or with existing laws of the Commonwealth regulating industrial wastes and the practice of professional engineering, nor shall this permit be construed to sanction any act otherwise forbidden by federal or state law or regulation, or by local ordinance. Nor does it pre-empt any duty to obtain state or local assent required by law for the discharge(s).

g. Severability

The provisions of this permit are severable, and if any provision of this permit, or the application of nay provision of this permit to any circumstances, is held invalid, the application of such provision to other circumtances, and the remainder of this permit, shall not be affected thereby.

PART C

OTHER REQUIREMENTS

1. The $CBOD_5$ in the raw wastewater shall be reduced by at least 85% as a monthly average in accordance with the requirements of the Delaware River Basin Commission.

2. Analysis for carbonaceous biochemical oxygen demand ($CBOD_5$) shall be done in accordance with Method 507(5.e.6) as described in Standard Methods, 16th edition.

3. Effective disinfection to control disease producing organisms shall be the production of an effluent which will contain a concentration not greater than 200/100 ml of fecal coliform organisms as a geometric average value, nor greater than 1000/100 ml of these organisms in more than 10% of the samples tested.

4. The following requirements apply with respect to the thermal impact of the discharge from Outfall 001 upon the unnamed tributary of Little Neshaminy Creek:

   Maximum temperatures in the receiving water body resulting from heated waste sources regulated under this permit are as follows. Additionally, these wastes may not result in a change by more than 2°F during a 1-hour period.

Period	Temperature °F
January 1-31	40
February 1-29	40
March 1-31	46
April 1-15	52
April 16-30	58
May 1-15	64
May 16-31	72
June 1-15	80
June 16-30	84
July 1-31	87
August 1-31	87

PART C

OTHER REQUIREMENTS (Continued)

September 1-15	84
September 16-31	78
October 1-15	72
October 16-31	66
November 1-15	58
November 16-30	50
December 1-31	42

5. A copy of the Discharge Monitoring Report is to be sent to the following agency:

   Bucks County Health Department
   Neshaminy Manor Center
   Doylestown, PA 18901

6. If, in the opinion of the Department, the sewage treatment plant is not so operated or if by reason of change in the character of the waste or increased load upon the sewage treatment plant, or changed use or condition of the receiving body of water, or otherwise, that the effluent ceases to be satisfactory or the sewage treatment plant creates a public nuisance, then upon notice by the Department the right herein granted to discharge such effluent shall cease and become null and void unless within the time specified by the Department, the permittee shall adopt such remedial measures as will produce an effluent which, in the opinion of the Department, will be satisfactory for discharge into the receiving body of water.

7. No storm water from pavements, area ways, roofs, foundation drains or other sources shall be admitted to the sanitary sewers associated with the herein approved discharge.

8. The approval herein given is specifically made contingent upon the permittee acquiring all necessary property rights by easement or otherwise, providing for the satisfactory construction, operation, maintenance and replacement of all sewers or sewerage structures associated with the herein approved discharge in, along, or across private property, with full rights of ingress, egress and regress.

PART C

OTHER REQUIREMENTS (Continued)

9. The attention of the permittee is directed to the fact that the herein approved sewage treatment plant discharge is directed to a small stream which affords a limited dilution potential. If the effluent creates a health hazard or nuisance, the permittee shall upon notice from the Department of Environmental Resources, provide such additional treatment as may be required by the Department.

10. No chemical addition for control of corrosion, scaling, algae, slime or fouling shall be made to the cooling or boiler water system which has a discharge covered by this permit, without prior written approval by the Department.

11. The additives and usage rate currently approved are the following:

Name	Usage Rate (lbs/day)
Betz Entec 310A	2.0
Betz Entec 703	1.0
Betz Entec 717	5.0
Sulfite	0.25

Usage rates of additives, and blow-down discharge rates shall be controlled by the permittee to ensure that toxic effects in the receiving stream are prevented. Usage rates shall be limited to the minimum amount necessary to accomplish the intended purposes of chemical addition.

Accurate records of usage (name of additive, quantity added, date added) of any approved chemical additive and of blow-down discharge volumes must be maintained and kept on-site by the permittee.

Whenever a change in additives or increase in usage rates is desired by the permittee, a written request, which includes proposed usage rates and human health toxicity and aquatic life toxicity data of each additive, shall be submitted to the Department for approval.

PART C

OTHER REQUIREMENTS

12. The permittee will ensure that applied chlorine dosages, used for disinfection or other purposes, are optimized to the degree necessary to minimize the level of total residual chlorine (TRC) in the dischargers effluent. In doing so, the permittee is to consider relevant factors affecting required chlorine dosage, such as wastewater characteristics, mixing and contact times, and desired result of chlorination. Dechlorination facilities where required for Federal construction grant AT projects shall be operated as designed.

    Should the Department find that levels of TRC in the permittee's effluent are causing negative water quality impact in the receiving stream, the permittee will be required to institute additional steps to reduce or eliminate such impact.

13. Water Quality-Based Effluent Limitations and Other Requirements for Management of Toxic Pollutants

    a. Water Quality-Based Effluent Limitations

    In addition to the effluent limitations shown in Part A of this permit, the Permittee is expected to achieve the water quality-based effluent limitations shown below.

    No final date for compliance with these limitations is shown. The Department will modify this permit to establish a final compliance date, if necessary, upon the submittal by the Permittee and review by the Department of an acceptable Toxics Reduction Evaluation (TRE), or the failure of the Permittee to submit an acceptable TRE under the schedule established under Sub-Section b. below. The Permittee must submit any of the following requests, along with supporting documentation, to the Department at the time of submission of the TRE:

    (1) A request for modification of water quality-based effluent limitations shown below; and/or,

    (2) A request for an extension of time to achieve the water quality-based effluent limitations shown below; and/or,

PART C

OTHER REQUIREMENTS (Continued)

(3) A request for alternative bioassay-based instream water quality criteria.

For purposes of compliance, effluent limitations listed in Part A of this permit apply unless changed by order, permit modification or other Department action.

Submittal by the Permittee of a TRE shall not be deemed to affect the appeal rights of the Permittee of final water quality-based effluent limitations for the pollutants shown below upon action of the Department to make those limitations effective.

Outfall 001

Parameter	Units	Average Monthly	Maximum Daily	Instantaneous Maximum
Sulfate (as SO_4)	mg/l	250	N/A	500
		250 mg/l		
Copper, Total	mg/l	0.0141	0.028	0.035
Cu2		0.1 mg/l		
Lead, Total	mg/l	0.004	0.008	0.010
Pb		.05 mg/l or 19% of the 96hr LC_{50} test		Table 3 25 Pa Code
Zinc, Total	mg/l	0.126	0.252	0.315
Zn		0.17% of 96hr LC_{50}		

b. Toxics Reduction Evaluation (TRE)

In order to (1) verify the actual extent of the toxic pollutants associated with the wastewater, (2) determine sources of these toxic pollutants, and (3) recommend control and/or treatment technologies to reduce or eliminate these toxic pollutants, the Permittee is directed to carry out a Toxics Reduction Evaluation (TRE) in accordance with guidelines developed by the Department.

The Permittee shall submit three (3) copies of the completed TRE to the Department for review in accordance with the following schedule:

PART C

OTHER REQUIREMENTS (Continued)

Step	Completion Date
Begin Work on the TRE and so Notify the Department	October 1, 1989
Submit a Progress Report to the Department	February 1, 1990
Submit a Progress Report to the Department	June 1, 1990
Submit the Completed TRE to the Department	October 1, 1990

c. Modification of Permit to Incorporate Water Quality-Based Effluent Limitations for Toxic Pollutants

Upon approval of the TRE and any additional submittals for the above toxic pollutants of concern, the Department will modify Part A of this permit to reflect the effluent limitations, monitoring requirements, and other conditions necessary for compliance with water quality standards.

A permit modification may include a schedule of compliance. Any such permit modification will be conducted in accordance with applicable permit modification procedures, which include development of draft and final permits and associated public notification requirements.

d. Procedures for Granting Extensions of Time to Achieve Water Quality-Based Effluent Limitations

At the request of the Permittee, in conjunction with modifying the permit to incorporate water quality-based effluent limitations under Subsection c. above, the Department may grant an extension of time to achieve the water quality-based effluent limitations shown in Subsection a. above, provided the Permittee meets all of the eligibility requirements contained in Section 95.4 of the Department's Rules and Regulations.

Requests for Section 95.4 time extension, including all documentation required to support such a request, must be submitted to the Department along with the Permittee's TRE as required under Subsection b. above.

PART C

OTHER REQUIREMENTS (Continued)

e. Procedures for Demonstration of Alternative Site-Specific Bioassay-Based Effluent Limitations

The final water quality-based effluent limitations for certain pollutants listed in Sub-Section a. above have been developed by the Department for protection of fish and aquatic life using bioassay-derived data and related information pursuant to the procedures contained in Section 93.8 of the Department's rules and regulations. The Permittee may request an opportunity to demonstrate alternative, site-specific, bioassay-based instream "safe concentration values" for those pollutants.

The following water quality-based effluent limitations in this Part C are based on protection of fish and aquatic life:

Copper, Total

Lead, Total

Zinc, Total

The procedures to be used for carrying out such demonstrations shall receive written approval in advance by the Department, and shall be conducted in accordance with the requirements of Sections 93.8(d)-(e) of the Department's Rules and Regulations.

Requests for alternative, site-specific, bioassay-based instream "safe concentration values" including all documentation required to support such a request, must be submitted to the Department along with the Permittee's TRE as required under Sub-Section b. above.

Where the demonstration results in more stringent effluent limitations than those established by the Department in Sub-Section a. above, the more stringent limitations will apply. Any less stringent limitations which are approved by the Department shall not violate applicable criteria for the protection of human health.

This provision does not apply to those parameters for which specific numeric criteria are listed in Section 93.7, Table 3 of the Department's Rules and Regulations.

PART C

OTHER REQUIREMENTS (Continued)

f. Procedures for Demonstrating Alternative Method Detection Limits

Where necessary, the Permittee may request an opportunity to demonstrate alternative facility specific MDL's to account for interfering factors associated with the wastewater in question.

The procedures for determining MDL's, published as Appendix B in 49FR43430, October 26, 1984, must be followed and complete documentation provided.

Requests for alternative, facility-specific, MDL's including all documentation required to support such a request, must be submitted to the Department. The Department, upon evaluation of the documentation submitted, may grant a facility-specific MDL to define not detectable for permitting limit and compliance monitoring purposes.

14. SCHEDULE OF COMPLIANCE

The permittee shall achieve compliance with the final effluent limitations on page 2b of 14 of this permit in accordance with the following schedule:

A.	Feasibility study completion	January 1, 1990
B.	Final design completion	April 1, 1990
C.	Start Construction	September 1, 1990
D.	Construction progress report(s)	March 1, 1991
E.	End construction	January 1, 1992
F.	Compliance with effluent limitations	June 1, 1992

No later than 14 calendar days following a date identified in the above schedule of compliance, the permittee shall submit to the Department a written notice of any non-compliance with the specific schedule requirement(s). A notice of non-compliance shall include the following information:

A. A short description of the non-compliance.

B. A description of any actions taken or proposed by the permittee to comply with the elapsed schedule requirement.

PART C

OTHER REQUIREMENTS (Continued)

C. A description of any factors which tend to explain or mitigate the noncompliance.

D. An estimate of the date that compliance with the elapsed schedule requirement will be achieved and an assessment of the probability that the next scheduled requirement will be met on time.

15. Analysis for the following pollutant(s) shall be performed using the following test method(s) contained in 40 CFR Part 136, Guidelines Establishing Test Procedures for the Analysis of Pollutants, or any approved test method(s) of equal or greater sensitivity.

Parameter	Test Method	Method Detection Limit (mg/l)
Copper, Total	8506 (Colorimetric)	0.010
Lead, Total	239.2 (AA, furnance)	0.001

16. This permit authorizes the discharge of treated sewage until such time as facilities for conveyance and treatment at a more suitable location are installed and are capable of receiving and treating the permittee's sewage. Such facilities must be in accordance with either the applicable municipal official plan adopted pursuant to Section 5 of the Pennsylvania Sewage Facilities Act, the Act of January 24, 1956, P.L. 1535, as amended, or a comprehensive Water Quality Management Plan as set forth in Section 91.31 of the Rules and Regulations of the Department. When such municipal sewerage facilities become available, the permittee shall provide for the conveyance of the sewage to these sewerage facilities, abandon the use of the sewage treatment plant thereby terminating the discharge authorized by this permit, and notify the Department accordingly. This permit shall then, upon notice from the Department, terminate and become null and void, and shall be relinquished to the Department.

APPENDIX C

DESIGN CALCULATIONS

DESIGN CALCULATIONS
EVALUATION OF COMBINED SEWAGE/INDUSTRIAL WASTEWATER TREATMENT PLANT

NADC
Warminster, PA

General Assumptions:

Q(average)=	90,000 gpd	=	0.09 MGD
Q(maximum)=	160,000 gpd	=	0.16 MGD

Average BOD5 influent to primary settling tanks=	200 mg/l
Maximum BOD5 influent to primary settling tanks=	370 mg/l
Average BOD5 influent to trickling filter=	100 mg/l
Maximum BOD5 influent to trickling filter=	185 mg/l
Effluent BOD5 permit requirement	30 mg/l
Average TSS influent to primary settling tanks=	300 mg/l
Maximum TSS influent to primary settling tanks=	500 mg/l
Average TSS influent to trickling filter=	150 mg/l
Maximum TSS influent to trickling filter=	250 mg/l
Effluent TSS permit requirement	30 mg/l
Average TKN influent to trickling filter =	10 mg/l

Comparison of Effluent Mass Limitations and Effluent Concentration Limitations:

Example BOD5 mass and concentration effluent limitations

BOD5 Mass Limitation (current and future):	18 lb/day
BOD5 Concentration Limitations	14.4 mg/l

Design Equation:

Mass limit(lb/day) = concentration limit (mg/l)*8.34*flow limit(MGD)

Calculation:

Therefore, flow limit = 0.15 MGD

This calculation is also valid for all other effluent limitations.

Primary Settling Tanks

Assumptions

Number of tanks =	4		
Length of tank (L)=	32	feet	6 inches
Width of tank (W)=	6	feet	2 inches
Depth of tank (Z)=	5	feet	4 inches
Area of tank (A)=	200.4	sq. ft.	
Volume of tank (V)=	1068.9	cu.ft	
Area of two tanks (A2)=	400 8	sq ft.	
Volume of two tanks (V2)=	2137 8	cu ft	
Area of four tanks (A4)=	801.7	sq. ft	
Volume of four tanks(V4) =	4275 6	cu.ft	

Design Equations:

Detention time (Td) = V/Flow rate (Q)
Overflow rate = Q/A

Design Guidelines (Metcalf and Eddy, Inc., 1991)

Design overflow rate at average flow (ORA)=	600	gal/(ft^2*day)
Design overflow rate at maximum flow (ORM)=	1200	gal/(ft^2*day)

Calculations.

Design Capacity (four PST):

Average Flow Rate:

Q4 (design)= ORA*A4
= 481,000 gal/day
= 0.48 MGD

Td (design)= V4/Q4
= 1 6 hours

Maximum Flow Rate:

Q4 (design)= ORM*A4
= 962,000 gal/day
= 0.96 MGD

Td (design)= V4/Q4
= 0.8 hours

Existing and Future Operation (two tanks in parallel):

Average Flow Rate

OR =	225 gal/day	<	600 gal/day	OK
Td =	0.8 hours			

Maximium Flow Rate

OR =	399 gal/day	<	1,200 gal/day	OK
Td =	0.4 hours			

Trickling Filters

Assumptions:

Number of trickling filters =	2		
Diameter of filter(D)=	65	feet	
Depth of filter (Z)=	6	feet	3 inches
Area of filter (A1)=	3318.3	sq. ft.	
Volume of filter (V1)=	20739 4	cu ft	
Area of two filters (A2)=	6636 6	sq. ft.	
Volume of two filters (V2)=	41478.8	cu.ft	
Area of three filters (A3)=	9954 9	sq ft	
Volume of three filters (V3)=	62218.2	cu ft	
Recycle ratio (R)	1		

Design Equations:

BOD5 Loading (W) =	8.34*[BOD5(mg/l)]*Q(MGD)	lb /day
Hydraulic loading rate (HLR)=	Q/A	gal /sq.ft.*day
Organic loading rate (OLR) =	W*1000/V	lb./1000 cu. ft.*day
Design Equation (NRC)=	Efficiency(E)=100/(1+0 05618(W/(V*R))^.5)	

Design Guidelines (Metcalf and Eddy, Inc., 1991)
(Assuming low rate operation,average design values)

HLR =	50.0	gal/day*sq ft.
OLR =	12.5	lb /1000 cu.ft.*day

Calculations:

Design Capacity:

Because the design capacity is based both on the organic loading rate and the hydraulic loading rate, design capacity calculations are based on design guidelines and assume there is no recirculation.

Existing (Single trickling filter) operation:

Q1 (design)=	HLR*A1		
=		165,915	gal/day
=		0.17	MGD
W (design) =	OLR*V1/1000		
=		259	lb./day
[BOD]influent (design) =	OLR*V1/8.34/Q(MGD)		
=		187	mg/l

Future(Two trickling filter in series) operation:

Q2S (design)=	HLR*A1			
=		165,915	gal/day	
=		0.17	MGD	(limited by the HLR of the first filter)
W (design) =	OLR*V2/1000			
=		518	lb./day	
[BOD]influent (design) =	OLR*V2/8.34/Q2S(MGD)			
=		374	mg/l	

Future (Two trickling filter is in parallel) operation:

Q2P (design) =	HLR*A2		
=	331,830	gal/day	
=	0.33	MGD	
W (design) =	OLR*V2/1000		
=	518	lb./day	
[BOD]influent (design) =	OLR*V2/8.34/Q2P(MGD)		
=	187	mg/l	

Three trickling filter operation (parallel):

Q3 (design) =	HLR*A3		
=	497,746	gal/day	
=	0 50	MGD	
W (design) =	OLR*V3/1000		
=	777	lb./day	
[BOD]influent (design) =	OLR*V3/8.34/Q3(MGD)		
=	187	mg/l	

Existing Operation (single filter operation):

Average flow rate, average influent [BOD5]

HLR=	27	gal/day*sq.ft.	<	50	gal/day*sq.ft.	OK
OLR=	3 6	lb/1000 cu.ft.*d	<	12.5	lb/1000 cu.ft.*d	OK
W=	75.1	lb/day				

E = 99.66%

Although the NRC equation indicates BOD5 removal rates may be greater than 99%, expected effluent concentrations are approximately 5 mg/l — OK

Maximum flow rate, maximum influent [BOD5]:

HLR=	48	gal/day*sq.ft.	<	50	gal/day*sq.ft.	OK
OLR=	11.9	lb/1000 cu ft.*d	<	12.5	lb/1000 cu.ft.*d	OK
W=	246.9	lb/day				

E = 99.39%

Although the NRC equation indicates BOD5 removal rates may be greater than 99%, expected effluent concentrations are approximately 5 mg/l

Future Operation (two trickling filters in parallel):

Average flow rate, average influent [BOD5]:

HLR=	27	gal/day*sq ft.	<	50	gal/day*sq.ft.	OK
OLR=	1.8	lb/1000 cu.ft.*d	<	12.5	lb/1000 cu.ft.*d	OK
W=	75.1	lb/day				

E = 99.76%

Although the NRC equation indicates BOD5 removal rates may be greater than 99%, expected effluent concentrations are approximately 5 mg/l — OK

Maximum flow rate, maximum influent [BOD5]:

HLR=	48 gal/day*sq.ft.	<	50 gal/day*sq.ft.	OK
OLR=	11.9 lb/1000 cu.ft.*d	<	12.5 lb/1000 cu.ft.*d	OK
W=	246 9 lb/day			

E = 99 57%

Although the NRC equation indicates BOD5 removal rates may be greater than 99%, expected effluent concentrations are approximately 5 mg/l

Future Operation (two trickling filters in series):

Average flow rate, average influent [BOD5]:

HLR=	14 gal/day*sq.ft.	<	50 gal/day*sq ft	OK
OLR=	1.8 lb/1000 cu ft *d	<	12.5 lb/1000 cu.ft.*d	OK
W=	75.1 lb/day			

E = 99.76%

Although the NRC equation indicates BOD5 removal rates may be greater than 99%, expected effluent concentrations are approximately 5 mg/l OK

Maximum flow rate, maximum influent [BOD5]:

HLR=	24 gal/day*sq.ft	<	50 gal/day*sq ft	OK
OLR=	11.9 lb/1000 cu.ft.*d	<	12.5 lb/1000 cu ft.*d	OK
W=	246 9 lb/day			

E = 99.57%

Although the NRC equation indicates BOD5 removal rates may be greater than 99%, expected effluent concentrations are approximately 5 mg/l

Secondary Settling Tanks

Assumptions:

Number of tanks =	2		
Length of tank (L)=	40	feet	4 inches
Width of tank (W)=	13	feet	
Area of tank (A)=	524.3	sq. ft.	
Area of 2 tanks (A2)=	1048.7	sq. ft.	
Area of 3 tanks (A3)=	1573.0	sq. ft.	
Area of 4 tanks (A4)=	2097 3	sq. ft.	

Design Equations:

Overflow rate (OR) = Q/A2

Design Guidelines (Metcalf and Eddy, Inc, 1991)

ORA (overflow rate at average flow rate)<	400	gal./sq.ft*day
ORM (overflow rate at maximum flow rate)<	800	gal./sq.ft*day

Design Capacity.

Average Flow Rate:

Q (design) = ORA*A4
= 838,933 gal/day
= 0 84 MGD

Maximum Flow Rate:

Q (design)= ORM*A4
= 1,677,867 gal/day
= 1 68 MGD

Existing and Future Operation (three settling tanks)·

Average Flow Rate:

ORA=	86 gal /sq ft*day	<	400 gal./sq.ft*day	OK

Maximum flow rate:

ORM =	153 gal /sq.ft*day	<	800 gal./sq.ft*day	OK

Anaerobic Digestors

Assumptions

Number of digestors =	3		
Diameter of digestor tank =	16	feet	6 inches
Depth of digestor tank =	10	feet	10 inches
Area of one tank (A1)=	213.82	sq. ft.	
Volume of one tank (V1)=	2316 43	cu. ft	
Volume of three tanks (V3)=	6949 30	cu. ft	
Detention time (Td) =	15	days	

Design Equations (Metcalf and Eddy, Inc, 1991):

Assume that 50% of the average influent BOD5 and 100% of the average influent TSS is treated by the digestors and that only 80% of the solids are volatile (i e , digestable). Also assume that the sludge contains 4% solids. Therefore,

Sludge rate (SR) =((.5*[BOD5]+[TSS])*Q*8.34)/(.04*62.4)	cu.ft./day
Volatile sludge rate (VSR) = .8*SR	cu.ft./day
Digestor efficiency (E) = 50%	
Sludge digestion rate (SDR) = E*VSR	cu.ft /day
Volume of Digestor gas produced (VDG) = 16*(SDR* 04*62.4)	cu ft of digestor gas per day

Design Capacity :

One Digestor:

SR1 = V1/Td
= 154 4 cu. ft. of sludge per day
= 9636.4 lb of sludge per day

Q = SR1*(0 04*62 4)/(8.34*.5*[BOD5]+[TSS])
= 0.12 MGD

Three Digestors:

SR3= V3/Td
= 463 3 cu. ft. of sludge per day
= 28909 1 lb. of sludge per day

Q = SR3*(0 04*62.4)/(8.34*.5*[BOD5]+[TSS])
= 0.35 MGD

Existing and Future Operations (one digestor operating):

Assume that at the Td=15 days the flow and loading rates will be average

SR =	120.3 cu.ft./day	<	154.4288 cu.ft./sludge/c	OK
VSR =	96.2 cu ft./day			
SDR =	48.1 cu ft /day			
VDR =	1921 5 cu ft./day			

APPENDIX D

NAWC QUESTIONS AND COMMENTS ON THE DRAFT REPORT
AND GZA RESPONSES TO THESE QUESTIONS AND COMMENTS
(2 SETS: 23 June 1992, & 24 July 1994)

FAX 23 JUNE 92

TO: MIKE SCHILLER, GZA, FAX 617-965-7769

FROM: MATT JABLONER, NORTHERN DIVISION

SUBJ: EVALUATION OF WWTP, NAWC WARMINSTER

1. Enclosed are my questions/comments regarding the subject study. I will send them officially once we move to our new office. (see para 2.)

2. We are currently in the process of moving. Our new address and phone # will be:

10 INDUSTRIAL HWY
MAIN STOP # 82
LESTER, PA 19113-2090
phone 215-595-0567
starting 6 July.

THANKS
Matt Jabloner

EVALUATION OF WASTEWATER TREATMENT PLANT, NAWC WARMINSTER

NORTHERN DIVISION REVIEW COMMENTS, CODE 1811/M. JABLONER

EFERENCE	COMMENT/QUESTIONS
p. 4	Only one of the three anaerobic digesters is usable - the other two are beyond repair.
p. 11	Would it be worth repairing the one working digester considering its limitations? Could an external heat exchanger be retrofitted to the existing digester?
p. 12	What is the limiting minimum flow through the plant? Possible effects on effluent, septic conditions, pH, etc. at this low flow?
p. 15	What would be the effects if an intermediate settling tank is not installed? Could one of the existing settling tanks be used? Do we really want to operate the TFs in series?
p. 16	Will our current concentrations of copper substantially affect nitrification?
p. 19	Do you have a rough idea of the amount of NH_3-N being recirculated from the anaerobic digester?
p. 21	Could some type of natural system, such as aquatic plants or constructed wetland, be used for nitrogen removal? The lower permit limits are during the summer when such a system would be most effective. The existing IWTP has a large lagoon that is not being used.
FIG 2	Replace "DATE" with "UNIT OPERATIONS".

	Please show data trends if applicable.
FIG 3	Please provide the average value on the graph.
	Why are the Figures divided into two time periods (1989-91, 1991)?
FIG 8	Why are there 0% removal eff.?
FIG 17	Please note that the blackened sections on the Figure are not NPDES violations.
FIG 18	I can not read the dates on the last figure.

Matt Jablonski

MEMORANDUM

TO: Mr. Matt Jabloner

FROM: Mikhail Schiller

DATE: August 17, 1992

FILE NO: 12880.00

SUBJECT: Response to the questions/comments on GZA Draft Report "Evaluation of Wastewater Treatment Plant. Warminster, Pennsylvania"

Dear Matt:

Thank you very much for you notes faxed to me on June 24, 1992. I organized my responses in a table format. Please, let me know if the responses are satisfactory, and, if you need other submittal of the responses before the Final Report is prepared, which format would you prefer.

Reference by Mr. Jabloner	Response by GZA GeoEnvironmental, Inc.
p. 4	Corresponding correction will be incorporated in the Final report. The statement will read: "Three heated anaerobic digesters with floating covers, two of which are decommissioned beyond repair, and".
p.11	Any and all digesters can be repaired and/or retrofitted by external heat exchanger(s), or other heating devices, however, considering already small, and still decreasing quantity of sludge,(volumewise, as well as masswise), it does not seem to be worth it. However, no valid recommendation can be made without proper cost/benefit analyses.

Reference by Mr. Jabloner	Response by GZA GeoEnvironmental, Inc.
p.12	There is no "minimum operational flow" value for a treatment plant. Flow velocity in the gravity sewer should not fall below 3 fps for any substantially long period of time. Pumping station operation should not be adversely affected by flows below the design flow. Primary settling tanks should be generating rather thin sludge (down to as low as 0.1%) which should be removed on an average at least once per 24 hours. Trickling filters should require high recirculation rate to assure a flow of approximately 0.1 MGD or more through one filter. However, BOD should be removed to a desired degree. Secondary settling tanks would hardly be affected because secondary sludge is pumped back to the head of the primary settling tanks.
p.15	1. In the absence of the intermediate settling tank, solids from the first stage trickling filter might negatively affect a separate stage nitrification process; 2. One of the existing settling tanks may be used for this purpose. It will require construction of an additional pumping station and piping, but these units will be required in any trickling filter sequential configuration; 3. Based on the currently available information, operation of trickling filters in series (sequentially) does not seem to be advantageous neither for current, nor for future operations.
p.16	The literature reports that certain nitrification systems may tolerate up to 10 mg/l of copper. Achieving such tolerances requires relatively long sludge acclimation periods. The acclimation period, however, becomes shorter every year (Note: Permit requires only seasonal nitrification, i.e. nitrifiers would have to re-acclimate to copper every year). Reported concentrations of copper do not seem to be absolutely prohibitive for nitrification. However, only proper pilot investigation will allow to evaluate the severity of the toxic effects of copper on nitrification microflora at your facility.

Reference by Mr. Jabloner	Response by GZA GeoEnvironmental, Inc.
p.19	The quantity of ammonia recirculated from the digester is of less importance than the fact that this form of nitrogen (as well as phosphorus, which behaves similarly to nitrogen under conditions existing at your facility) is recirculated inside the facility, thereby preventing newly arriving quantities of these chemicals to be removed via available biological mechanisms. Therefore, the entire mass of nitrogen and phosphorus arriving daily to the treatment plant with the influent, leaves it with the effluent, instead of being incorporated in the sludge and removed from the system completely. Recirculating the digested sludge does not increase the concentration of these constituents in the effluent, but prevents the efficient removal of the same constituencies arriving daily with the influent.
p.21	Solar aquatic treatment systems are known to be reasonably effective in removing nutrients (phosphorus and nitrogen). However, they are not easy systems to operate. A proper cost/benefit analyses should be performed to determine economical feasibility of such approach. Application of a solar aquatic treatment approach will constitute virtual abandonment of the existing units and construction of a new facility.
Fig. 2	Corresponding correction will be incorporated in the Final report.
Fig. 3	Corresponding correction will be incorporated in the Final report. Data sets are divided because 1989 to 1991 represent monthly averages, while 1991 represent daily data.
Fig. 8	This graph represent daily removal of BOD_5 in the SECONDARY SETTLING TANKS only. Zero removal happens when on a given day average values of BOD_5 in the influent and effluent of the SECONDARY SETTLING TANKS (and not the entire plant) are equal. The plant overall BOD_5 removal efficiencies are shown on Fig's 1 and 2.
Fig.17	Corresponding note will be incorporated in the Final report.
Fig.18	Necessary font correction will be incorporated in the Final report.

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To M. SCHILLER	From M. JABLONER
Co. GZA	Co. NORTH DIV
Dept.	Phone # 215 595 0567
Fax # (617) 965-7769	Fax # 0555

Mike, sorry for the delay.

Matt J.

DEPARTMENT OF THE NAVY
NORTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
10 INDUSTRIAL HIGHWAY
MAIL STOP, #82
LESTER, PA 19113-2090

IN REPLY REFER TO

6280
Ser 92818/1812/MLJ

AUG 21 1992

GZA GeoEnvironmental, Inc.
Attn: Mikhail Schiller, Sc. D., P.E.
320 Needham Street
Newton Upper Falls, MA 02164

Re: CONTRACT N62472-90-D-1449, PROJECT 19, EVALUATION OF WASTEWATER TREATMENT PLANT, NAWC WARMINSTER, PA

Dear Mr. Schiller:

GZA GeoEnvironmental, Inc. letter of June 5, 1992, forwarded the draft report for Contract N62472-90-D-1449, Amendment No. 13, Project No. 19, Tasks 2A and 2B. Enclosure (1) provides our final questions and comments concerning the draft report. These and the previously submitted comments by Northern Division (Code 1812/M. Jabloner) should all be addressed in the final report.

Any questions concerning this matter should be directed to Mr. Matthew Jabloner, Code 1812 at (215) 595-0567.

Sincerely,

J. M. ROCHE
Head, Air and Water Section
By direction of the Commanding Officer

Encl: (1) Northern Division Review Comments dtd 24 July 92

Copy to: (w/encl)
NAWC WARMINSTER, Code 8303

24 July 1992

Northern Division Review Comments
Evaluations of Wastewater Treatment Plant
Draft Report by GZA GeoEnvironmental, Inc. of June 1992
Naval Air Warfare Center Warminster, PA.

1. Are the any nitrogen reduction methods (in addition to modifying sludge disposal) that may be used in the short -term to achieve compliance?

2. What types of additional sampling equipment would help assess WWTP effluent quality more accurately and timely?

3. What are, in general terms, some of the requirements for additional influent testing? What would be considered an acceptable (from a initial design standpoint) testing period(s)?

4. What problems with nitrification may occur if WWTP flows decrease significantly?

5. Is there any technical merit to connecting two trickling filters in series?

6. Do you have any suggestions concerning WWTP sampling/ analysis quality control procedures?

7. Provide approximate costs for recommended modifications.

8. Explain in more detail the error in reporting TN concentrations (i.e. what is the source of the problem and what is the solution?)

9. Should the sludge digester be repaired or converted to a holding tank? If the digester is to be used as a holding tank what additional operating procedures are required?

10. A few locations within the treatment process were identified for the placement of phosphorous removal. Provide advantages and disadvantages for each location.

11. Provide simple schematic of existing conditions and proposed modifications at the WWTP.

12. Please minimize the use of acronyms.

13. Address in report that placing trickling filters in series will not correct permit excursion problems.

14. Letters from Northern Division to GZA should be references by date and serial number (i.e. do not use names).

15. Mr. Jabloner's is now in Code 1812. The report states Code #411 which is incorrect.

16. Please change all NADC references to NAWC.

17. Page 7, Section 4.12: the second paragraph states an overall TSS removal efficiency of 85% while other sections state TSS removal of 97%. Correct or explain as appropriate.

MEMORANDUM

TO: Mr. Matthew Jabloner

FROM: Mikhail Schiller

DATE: August 24, 1992

FILE NO: 12880.00

SUBJECT: Response to the final questions/comments on GZA Draft Report "Evaluation of Wastewater Treatment Plant, Warminster, Pennsylvania", dated July 24, 1992, and received by GZA on August 14, 1992

Dear Mr. Jabloner:

Thank you very much for the notes faxed to me on August 14, 1992. These questions and comments fall into four different categories:

1. Revisions and clarifications to the Draft Report. Those are directly incorporated in the Final Report.

2. Questions and requests pertinent to the scope of Tasks 2A and 2B. Those are responded to below in a table format.

3. Questions and requests out of the scope of Tasks 2A and 2B, but falling under the scope of Task 3. We will start to work on answering these questions and requests as soon as GZA will by given authorization to start Task 3, or a part thereof.

4. Questions and requests which we believe are out of the scope of this project. We would be pleased to submit on your request a proposal regarding answering these questions and requests.

The following table contains in the right column a numerical reference to questions and comments contained in the document dated 24 July 1992, and called "Northern Division Review Comments, Evaluation of Wastewater Treatment Plant, Draft Report by GZA GeoEnvironmental, Inc. of June 1992, Naval Air Warfare Center, Warminster, PA". The Left column contains GZA's responses to the referenced comment.

Reference	Response by GZA GeoEnvironmental, Inc.
1	Although modifying sludge disposal does not constitute nitrogen reduction method "per se", it may be qualified as "good housekeeping", which reduces quantity of ammonia (or TKN) to be nitrified and denitrified. We are unaware of any immediate action short of preventing ammonia and TKN from entering the system, to achieve a "short-term compliance". Some non-biological methods of ammonia removal include: 1. Breakpoint Chlorination (effluent dechlorination should be considered); 2. Selective ion exchange (disposal of regeneration wastes should be considered); 3. Air stripping (air pollution should be considered); 4. Reverse osmosis (non-selective process. Disposal of reject should be considered). More detailed analyses of these technologies will constitute a part of the Task 3.I.
2	Proper procedures, equipment, analytical chemicals and analytical glassware for each analyses are MANDATED by 40 CFR Part 136. Table IA lists all approved biological (coliform) test procedures, while Table IB lists all approved inorganic test procedures, including BOD_5. These Tables list publications where these test procedures are described. Nitrogen species dissolved in water, except TKN, may be analyzed using selective ion electrodes in conjunction with a selective ion meter. Determination of TKN will necessarily require digestion of the sample.

Reference	Response by GZA GeoEnvironmental, Inc.
2 (continued)	A family of auto analyzers was developed by different companies over the last 10 to 15 years. Generally, these machines use colorimetric or amperometric procedures for extremely small (drop-size) samples of analite. Different analyzers offer wide specter of automation and precision. However, even with auto analyzers, determination of TKN and Total Phosphorus will require prior digestion of the sample. 40 CFR Part 136 lists types of auto analyzers approved by EPA. Further discussion of analytical procedures and instrumentation is out of scope of Tasks 2A; 2B and even 3.
3	The testing, from a design standpoint, should be sufficient for establishing material balances for the species to be controlled, and relationships between mutually dependable parameters. For example, the concentration and mass of ammonia and TKN entering the Plant via the sewer, industrial discharge, the digester, and recirculation from the final settling tank treated water should be established. This will require correlated measurements of the volumes (flow rates) and ammonia (TKN) concentration of every stream. The TKN mass of the sludge transferred daily to digester should be measured as well. In absence of denitrification, the mass of TKN entering and leaving the Plant should be a constant on an average. The following equation must be true over a period of time, when expressed in (lb/d): $TKN_{in} = TKN_{out}$, or $TKN_{influent} + TKN_{industrial} + TKN_{recirculated} + TKN_{supernatant} =$ $= TKN_{effluent} + TKN_{sludge} + TKN_{recirculated} + TKN_{off\ site\ sludge}$ Depending on operational mode of a Plant, one week to one month data will be required to establish one balanced equation of this type. If nitrification is occurring, like we can see it now, then the following equation should be established: $TKN_{in} = TKN_{out} + NO_{3(out)}$ The presence and concentration of nitrates and nitrites should be checked periodically. Nitrification will be affected by the BOD_5 : TKN ratio, water temperature, TKN : alkalinity ratio, etc. Due to the seasonal nature of these processes and the treatment requirements, the duration of this testing period might be estimated, on a preliminary basis, as one year. Detailed design of an analytical program of this type is out of scope of Tasks 2A; 2B and even 3.

Reference	Response by GZA GeoEnvironmental, Inc.
4	Because nitrification and denitrification are not chemical processes, they do not behave strictly as a function of concentrations, states and conditions of the reagents and environment. Being biochemical processes, they require, for a sustained successful performance, a balance of proper and stable biological population and food supply. A substantial drop of inflow to WWTP, assuming that concentration of TKN stays as is, will require a substantial increase of effluent recirculation to keep trickling filter media wet. If before that effective nitrification/denitrification is established, a substantial dilution of TKN in the trickling filters influent occurs, it will starve the nitrifying and, consequently, denitrifying populations. A gradual increase in concentration of TKN will begin, and when the TKN level is sufficient to sustain nitrifying population, nitrification will be re-established. But by that time, the summer period might approach its end, and the water temperature may drop, further inhibiting the development of nitrifiers. It should be noted, that denitrification requires well established nitrification for its stability. Consequently, if the concentration of TKN in the mixture of the influent and recirculated treated water is high enough to establish nitrification at the beginning of the summer, the TKN will be removed, its concentration in the recirculated treated water will decrease, and the influent TKN will be diluted more and more, until the scenario described above occurs. The system will be unstable, changing between these two modes. Denitrification will hardly have time to became stable under such conditions. It's impossible to estimate, without extensive pilot investigation, the cut-off flow rate and different species concentrations at which these scenarios may become prevalent.
5	If the purpose is to achieve WWTP effluent parameters as required by the Industrial Waste NPDES permit PA 0022420, we can perceive no technical merit to connecting two trickling filters in series.
6	The scope of the project did not include observation and evaluation of sampling and analyses quality control. A useful source of this type of information is Department of Environmental Resources and local Publicly Owned Treatment Works. However, GZA may assist you in establishing such quality control program, if you so desire. Detailed design of a quality control program of this type is out of scope of Tasks 2A; 2B and even 3.

Reference	Response by GZA GeoEnvironmental, Inc.
7	Compiling approximate costs constitutes a part of Task 3.V., which GZA was not authorized to perform yet.
8	We are attaching to this MEMO a separate sheet containing an excerpt from the database provided to GZA by NAWC. It contains data regarding concentrations of ammonia (NH_3), nitrates (NO_3), nitrites (NO_2) and Total Nitrogen (TOTNr) as shown for the indicated dates on the WWTP operating record, and concentration of Organic Nitrogen (ON) calculated by GZA as a difference between the sum of the corresponding values of ammonia, nitrates and nitrites and the value of the Total Nitrogen. As we indicated in our Draft Report, we could not explain discrepancies (negative values for the Organic Nitrogen).
9	Repair or conversion of digester(s) into holding tanks depends on: 1. Availability of an off site recipient of the raw sludge generated at WWTP; 2. Cost of the off site raw sludge disposal; 3. Duration of the existence of the WWTP; 4. Projected capacity of the WWTP (and, consequently, mass of the generated sludge); 5. Availability of means to dispose the digested sludge (off site recipient or incinerator and ash disposal area); 6. Desire to repair existing sludge dewatering facility (drying beds), or to install new dewatering units (mechanical dewatering), and availability of a recipient of dewatered sludge; 7. Desire to build and operate a sludge composting facility and existence of a compost recipient. Based on the information provided by you to GZA - influent flow to WWTP might be substantially reduced; the existence of WWTP beyond next three years is uncertain; there is high probability that WWTP may eventually be connected to the municipal sewer; and a high probability that a hauler will be contracted to dispose of the raw sludge - we feel that conversion of the digester to a sludge storage tank appears to be a better option. Recommendations concerning steps necessary for such conversion and operating procedures associated with such storage tank are out of scope of Tasks 2A; 2B and even 3.

Reference	Response by GZA GeoEnvironmental, Inc.
10	Phosphorus control consists of two steps: flocculation preceded by coagulation, and floc separation. There are four locations at a WWTP, where phosphorus is traditionally removed: **Location 1. In the Primary Settling Tanks.** Coagulation and flocculation might be achieved either in front of the Tanks, or directly in the Tanks, assuming the Tanks are modified slightly to provide for chemical injection and rapid mixing steps. Advantage: Low construction cost. The same unit is used for dual purposes. Especially attractive if digestion is not used at the facility. Disadvantage: If not operated properly, phosphorus removal at location 1 might cause a phosphorus deficiency in the biological treatment processes which follow it; Depending on the type of coagulant/flocculant used, phosphorus removal at location 1 might substantially (up to 200%) increase the volume and mass of the primary sludge, what is especially important for WWTP using sludge digestion. Phosphorus removal at location 1 produces a mixture of organic and mineral sludges, which might limit certain sludge disposal options (agricultural use, for example). **Location 2. Separate unit located after PST but in front of the biological treatment units.** A reactor - clarifier is often used for this purpose. This unit combines functions of a flocculator and a settling tank. Advantage: This system is more efficient than the location 1. The generated sludge is mineral in nature, more compact, and dewaters easier than a mixture of organic and mineral sludges. Disadvantage: Higher capital cost. If not operated properly, phosphorus removal in front of biological treatment units might cause phosphorus deficiency in the biological treatment processes which follow it.

Reference	Response by GZA GeoEnvironmental, Inc.
10 (continued)	**Location 3. In the Secondary Settling Tanks.** This method can be used when biological system does not employ recirculation of the biological mass back into the reactor (like aeration tanks). Trickling filters usually can be adapted to this approach. The engineering configuration for phosphorus removal at this location is similar to the one described for location 1. Advantage: Low construction cost. The same unit is used for dual purposes. Especially attractive if digestion is not used at the facility. Does not interfere with biological treatment. Disadvantage: Depending on the type of coagulant/flocculant used, might substantially (up to 200%) increase the volume and mass of the secondary sludge, what is particularly important for WWTP using sludge digestion. Phosphorus removal at this location produces a mixture of organic and mineral sludges, which might limit certain sludge disposal options (agricultural use, for example). **Location 4. Separate unit located after the Secondary Settling Tanks.** The engineering configuration for phosphorus removal at this location is similar to the one described for location 2. Advantage: Does not interfere with biological treatment. Does not interfere with sludge digestion. Does not interfere with sludge disposal. This system is more efficient then the one described for location 3, and produces the least amount of sludge. Generated sludge is mineral in nature, more compact and dewaters easier then mixture of organic and mineral sludges.

Reference	Response by GZA GeoEnvironmental, Inc.
10 (continued)	**Location 4. Separate unit located after the Secondary Settling Tanks.** Disadvantage: High capital investment, which might be even higher then for the location 2 if construction of an additional pumping station is required. Effluent suspended solids concentration might increase above the limits set by the NPDES Permit. Polymer addition might be required to control effluent suspended solids concentration. More detailed analyses of these technologies will constitute a part of the Task 3., which GZA was not authorized to perform yet.
11	Development of flow diagrams constitutes a part of Task 3.V., which GZA was not authorized to perform yet.
12	Corresponding correction will be incorporated in the Final report.
13	The Permit specifies allowed concentrations and mass values for ammonia, nitrite/nitrate and phosphorus in the WWTP effluent after 'completion of upgrade'. The "permit excursion problem", if all these parameters are considered, will not be corrected by placing trickling filters in series. Trickling filters configuration will not affect processes of phosphorus removal and denitrification. Nitrification might be achieved in either trickling filters configuration. To achieve nitrification degree required by the Permit, usage of a second trickling filter in series, as well as in parallel to the currently operated one, does not appear warranted. As can be seen from Figure 25 in the Report, WWTP was very near to compliance with requirements of both the current and the future Permit in regard to ammonia during the summer of 1991. However, concentration of the nitrite/nitrate was already higher then will be allowed by the future permit. The sum of all forms of nitrogen entering the WWTP does not change, unless denitrification occurs. Ammonia is a precursor of the nitrite/nitrate pair. Low concentration of ammonia and presence of nitrite/nitrate in the WWTP effluent indicates that certain degree of nitrification was already achieved since at least spring of 1989. However, meeting the Permit requirements in respect to ammonia will increase concentration of nitrite/nitrate in the effluent, and lead to even worst "permit excursion problem" in regard to nitrite/nitrate limitations.

Reference	Response by GZA GeoEnvironmental, Inc.
14	Corresponding correction are incorporated in the Final report.
15	Corresponding correction are incorporated in the Final report.
16	Corresponding correction are incorporated in the Final report.
17	Corresponding correction are incorporated in the Final report.

Reference 8 12821.00

Total Nitrogen Balance (excerpt)

DATE	TOTNr PPM	NO3 PPM	NO2 PPM	NH3 PPM	ON PPM
02-Jan-91	11	10	0.1	8	-7.1
09-Jan-91	10	10	0.1	8	-8.1
16-Jan-91	6	16	0.13	2.5	-12.63
23-Jan-91	4	15	0.05	1.5	-12.55
30-Jan-91	16	11	0.08	1.7	3.22
06-Feb-91	5	15	0.1	3.5	-13.6
13-Feb-91	27	12	0.09	4.5	10.41
20-Feb-91	25	15	0.02	0.96	9.02
27-Feb-91	10	12	0.08	3.6	-5.68
06-Mar-91	6	16	0.1	3	-13.1
13-Mar-91	30	11	0.03	2.6	16.37
20-Mar-91	17	15	0.02	0.65	1.33
27-Mar-91	17	14	0.02	0.61	2.37
03-Apr-91	6	15	0.05	3.8	-12.85
10-Apr-91	4	10	0.07	3.0	-9.07
17-Apr-91	16	17	0.1	1.5	-2.6
24-Apr-91	8	8	0.05	1.2	-1.25
01-May-91	19	12	0.06	1.3	5.64
08-May-91	26	6	0.07	3.5	16.43
15-May-91	25	9	0.05	1.3	14.65
22-May-91	28	8	0.1	3.0	16.9
05-Jun-91	31	7	0.11	2.0	21.89
12-Jun-91	16	8	0.05	0.9	7.05
19-Jun-91	22	11	0.09	1.7	9.21
26-Jun-91	13	7	0.05	3.0	2.95
03-Jul-91	20	7	0.8	4.5	7.7
10-Jul-91	16	10	0.1	1.2	4.7
17-Jul-91	20	8	0.12	3.5	8.38
24-Jul-91	14	8	0.1	3.3	2.6
07-Aug-91	21	10	0.9	1.4	8.7
14-Aug-91	19	5.5	0.09	1.7	11.71
21-Aug-91	15	10	0.05	2.8	2.15
28-Aug-91	16	5	0.08	1.4	9.52
04-Sep-91	27	12	0.11	1.2	13.69
11-Sep-91	18	6	0.07	1.3	10.63
18-Sep-91	12	6	0.05	3.3	2.65
25-Sep-91	19	6	0.01	3.5	9.49
02-Oct-91	25	10	0.12	1.4	13.48
09-Oct-91	17	7	0.09	1.7	8.21
16-Oct-91	17	12	0.07	2.8	2.13
23-Oct-91	18	7	0.18	1.9	8.92
30-Oct-91	12	11	0.1	1.08	-0.18
06-Nov-91	55	3	1.5	18	32.5
13-Nov-91	35	6	0.3	27	1.7
20-Nov-91	53	5	0.23	8.5	39.27
27-Nov-91	49	11	0.85	15.2	21.95
04-Dec-91	24	12	0.4	3.5	8.1
11-Dec-91	17	7	0.5	2.6	6.9
18-Dec-91	19	18	0.3	5.5	-4.8

NOTES

NO3 -nitrate concentration
NO2 -nitrite concentration
NH3 -ammonia concentration
TOTNr-reported concentration of total nitrogen, calculated, according to WWTP chemist, as a sum of: TKN+NO3+NO2=TOTNr

The WWTP chemist explained to us that he determines TKN, but does not report it. Then he determines NH3; NO2; & NO3, summarizes TKN+NO3+NO2, and reports this sum as Total Nitrogen (TOTNr). The ammonia, nitrites and nitrates are reported separately.

TKN analyses determines the sum of ammonia and Organic Nitrigen (ON). Therefore, the difference between Total Nitrogen, as calculated by the WWTP chemist, and sum of ammonia, nitrate and nitrite should represent the concentration of the Organic Nitrogen, or:
ON=(TOTNr)-(NO3)-(NO2)-(NH3)

However, when we attempted to back calculate Organic Nitrigen concentration, some of the values turned out to be negative.

Those are the "negative values" mentioned on page 20, Section 9.00 of the Draft Report .

This Table represent available to GZA nitrogen data for year 1991, and concentrations of Organic Nitrogen (ON) calculated as descibed above.